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FOR PROMOTING USEFUL KNOWLEDGE.

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EXTRACT

FROM THE

LAWS OF THE SOCIETY RELATING TO THE TRANSACTIONS.

1. The Transactions shall be published in numbers, at short intervals, under the direction of the Committee of Publication.

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.

3. If the committee shall report in favour of publishing the communication, they shall make such corrections therein, as they may judge necessary to fit it for the press; or if they shall judge the publication of an abstract or extracts from the paper to be most eligible, they shall accompany their report with such abstract or extracts. But if the author do not approve of the corrections, abstract, or extracts, reported by the committee, he shall be at liberty to withdraw his paper.

4. The order in which papers are read before the Society shall determine their places in the Transactions, priority of date giving priority of location.

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OBITUARY NOTICE.

Since the publication of the last volume of these Transactions, the following members have been reported as deceased:

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Sylvanus Godon.
Charles Bonnycastle, of the University of Virginia.
Benjamin R. Morgan, of Philadelphia.
James Prinsep, of Calcutta.
J. P. F. Deleuze.

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TRANSACTIONS

OF

THE AMERICAN PHILOSOPHICAL SOCIETY.

ARTICLE I.

Observations to determine the Magnetic Dip at various places in Ohio and Michigan. By Elias Loomis, Professor of Mathematics and Natural Philosophy in Western Reserve College. In a letter to Sears C. Walker, Esq., M. A. P. S. Read June 21*st*, 1839.

THE instrument employed for the following observations was made by Gambey, for Western Reserve College. The vertical circle upon which the dip is read is graduated to ten minutes, which I am accustomed to divide, by estimation, to single minutes, by the aid of two microscopes attached to the glass case which covers the instrument. This circle is made of copper, and plated with silver. The horizontal circle is graduated to half degrees, and reads by a vernier to single minutes. The axis of the needle rests upon agate supports, and is centred by two copper y's. A sensitive level is attached to the instrument, which rests upon three adjusting screws. The two needles which accompany the instrument are each of them nine inches and six tenths in length. Their breadth, in the middle, is a half inch, and they terminate at each extremity in a sharp point. They have, throughout, a uniform thickness of about the fortieth of an inch.

The observations were invariably made in an open area, at the distance of several rods from any building, or any apparent local cause of attraction. Particular care was taken to remove all iron in the form of knives, keys, &c. The instrument was placed upon a solid block of wood of convenient height, and levelled. The vertical circle was then turned in azimuth until the needle assumed a vertical position, and the azimuth read off from the horizontal circle. The needle was then turned upon its supports, (the north extremity of the axis to the south,) and the observation repeated. Needle No. 1, in which the distribution of the magnetism was most uniform, was always used for this purpose, and the two readings ordinarily differed by less than a degree. The mean of the two was taken as indicating the vertical plane at right angles to the magnetic meridian. In order to test the degree of accuracy of which the method is susceptible, I made repeated observations at Hudson, where I had a meridian mark, and knew the variation of the needle. The preceding method was found to give the magnetic meridian within a fraction of a degree. Let us inquire what influence such an error would produce upon the observed dip.

Put δ = the dip in the magnetic meridian.

δ' = the dip in any vertical plane.

A = the magnetic azimuth of the plane in which δ' is observed. Then we shall have tang δ' = tang δ. sec. A.; from which formula we learn that at Hudson the dip increases less than one minute, from being observed two degrees out of the magnetic meridian. The method employed for determining the magnetic meridian possesses, therefore, all the accuracy which could be desired for this purpose.

Both needles were observed at each station, and an equal number of times. In needle No. 1 the magnetic axis was found always to coincide very nearly with the geometrical axis. Although I have reversed the poles more than a dozen times, the inclination of the magnetic axis to the geometrical has never exceeded a small fraction of a degree. In needle No. 2, although it has been magnetized in the same way, and its poles reversed the same number of times, the magnetic axis has invariably been found quite oblique to the geometrical axis, the inclination varying from one to three degrees. For reversing the poles I always employ a bar magnet of about a foot in length. I draw the flat side of one half the needle over a pole of the magnet; then the opposite side over the same pole. The other half of the needle I apply, in a similar manner, to the opposite pole of the magnet, and repeat the entire operation three times. In each set of observations the poles of the needles are reversed, and the same number of observations made in the two magnetic states of the needle. My mode of observing is as follows:—Having brought the plane of the vertical circle into the magnetic meridian by the method already explained, with the face of the instrument to the east, and the marked side of the needle also to the east, I read off the graduation at both extremities of the needle. I do not, ordinarily, wait for the needle to come to a state of entire rest, but when the arc of vibration is reduced to ten or fifteen minutes; take the mean of the extreme oscillations. Without disturbing the position of the instrument, I now vibrate the needle, centring it, and at the same time checking its vibrations by the copper y's. When the arc of vibration is sufficiently reduced, I read off again, as before. I repeat the same operation five times, thus obtaining ten readings in the same position of the instrument and needle. These readings are commonly nearly identical. In two or three instances, however, the extreme readings have differed from each other to the amount of about forty minutes. This occasional sluggishness of the needle may, perhaps, be ascribed to moisture, or minute particles of dust settling upon the axis of the needle and upon the agate supports, and acting, by friction, to retain the needle at rest, though out of the position it would naturally assume. Leaving still the instrument in its first position, I turn the east side of the needle to the west, and make ten readings as before. Turning, then, the face of the instrument to the west, I repeat the observations in the same order, making forty readings in one magnetic state of the needle. Reversing the poles, I repeat the entire operation, which gives me eighty readings with one needle. The other needle furnishes the same number of readings, making a hundred and sixty in all; and this is the number actually taken at each of the places mentioned below, with the exception of Hudson, where the observations were still more numerous. The preceding method was adopted in all of the observations, with the exception of those made at Hudson in September, 1838, where only two readings (one of each pole) were made in each position of the needle, but the system of reversal was precisely the same as that above described.

Magnetic Dip at Hudson, Ohio. Latitude 41° 15′ *N.; Longitude* 81° 24′ *W.*

The place of observation was the college yard, distant several rods from the buildings, and the instrument was placed upon a solid block of wood, which was due north from the transit instrument of the observatory.

Date.	Hour.	Needle.	No. Readings.	Observed Dip.
1838, Sept. 4	11—12, A. M.	No. 2	16	72° 54′·3
5	5—6, P. M.	1	16	40 ·5
6	11—12, A. M.	1	16	54 ·3
6	" " "	2	16	34 ·8
7	11—12, A. M.	1	16	57 ·2
20	10—11, A. M.	2	16	48 ·1
Mean of 96 observations in September, 1838,	. . . .			72 48 ·2
1839, April 6	4—5, P. M.	1	80	72 46 ·9
26	9—11, A. M.	2	80	46 ·5
27	9—11, A. M.	1	80	44 ·3
May 1	9—11, A. M.	2	80	49 ·4
Mean of 320 observations in April and May, 1839,	. . . .			72 46 ·8

Magnetic Dip at Cleveland, Ohio. Latitude 41° 30′ *N.; Longitude* 81° 51′ *W.*

The place of observation was by the Lake shore, nearly in front of the American Hotel.

Date.	Hour.	Needle.	No. Readings.	Observed Dip.
1839, May 9,	8—12, A. M.	No. 1	80	73° 21′·2
" "	" "	2	80	30 ·8
Mean of 160 observations with two needles,	. . . .			73 26 ·0

Magnetic Dip at Detroit, Michigan. Latitude 42° 19′ *N.; Longitude* 83° 3′ *W.*

The place of observation was an open area west of the city, and not far from the Michigan Exchange.

Date.	Hour.	Needle.	No. Readings.	Observed Dip.
1839, May 11,	2—6, P. M.	No. 1	80	73° 37′·2
" "	" "	2	80	48 ·1
Mean of 160 observations with two needles,	. . . .			73 42 ·6

Magnetic Dip at Ann Arbor, Michigan. Latitude 42° 18′ *N.; Longitude* 83° 45′ *W.*

The place of observation was an open field, a few rods west of the village.

Date.	Hour.	Needle.	No. Readings.	Observed Dip.
1839, May 14,	4—6, P. M.	No. 1	80	73° 6′·5
" "	" "	2	80	21 ·2
Mean of 160 observations with two needles, ...				73 13 ·9

Magnetic Dip at Ypsilanti, Michigan. Latitude 42° 14′ *N.; Longitude* 83° 38′ *W.*

The place of observation was a hill on the east side of Huron river, a few rods from the village.

Date.	Hour.	Needle.	No. Readings.	Observed Dip.
1839, May 15,	12—2, P. M.	No. 1	80	73° 11′·9
" "	" "	2	80	24 ·1
Mean of 160 observations with two needles, ...				73 18 ·0

Magnetic Dip at Monroe, Michigan. Latitude 41° 55′ *N.; Longitude* 83° 28′ *W.*

Place of observation an open field, a few rods south-east of the village.

Date.	Hour.	Needle.	No. Readings.	Observed Dip.
1839, May 16,	4—6, P. M.	No. 1	80	73° 24′·1
" "	" "	2	80	40 ·6
Mean of 160 observations with two needles, ...				73 32 ·3

Magnetic Dip at Toledo, Ohio. Latitude 41° 41′ *N.; Longitude* 83° 33′ *W.*

Place of observation an open field, a few rods west of the village.

Date.	Hour.	Needle.	No. Readings.	Observed Dip.
1839, May 17,	5—7, P. M.	No. 1	80	73° 1′·2
" "	" "	2	80	10 ·9
Mean of 160 observations with two needles, ...				73 6 ·1

Magnetic Dip at Maumee City, Ohio. Latitude 41° 34′ *N.; Longitude* 83° 38′ *W.*

Place of observation an open field, a few rods north of the village.

Date.	Hour.	Needle.	No. Readings.	Observed Dip.
1839, May 18,	5—7, P. M.	No. 1	80	72° 50′·8
" "	" "	2	80	47 ·4
Mean of 160 observations with two needles, ...				72 49 ·1

Magnetic Dip at Sandusky City, Ohio. Latitude 41° 29′ *N.; Longitude* 82° 48′ *W.*

Place of observation an open field, a few rods south of the village.

Date.	Hour.	Needle.	No. Readings.	Observed Dip.
1839, May 20,	9—11, A. M.	No. 1	80	73° 0′·0
" "	" "	2	80	72 55·6
Mean of 160 observations with two needles, ...				72 57·8

From the preceding observations, compared with such as have been made in other parts of the United States, and of which a collection may be seen in the American Journal of Science, Vol. xxxiv. p. 308, it will appear that the same dip is found in a higher latitude in the western than in the eastern states. The lines of equal dip, consequently, intersect the parallels of latitude, their direction being from about N. 82° W. to S. 82° E.

ARTICLE II.

1. *Letter from the Rev. Charles Gutzlaff to John Vaughan, Esq., on the Chinese System of Writing. Read June* 21*st*, 1839.

MACAO, *January* 2*d*, 1839.

DEAR SIR,

I am very much obliged for your valuable present of Mr. Duponceau's Dissertation. Will you condescend to receive, for the library of your Society, the four books and five classics in Chinese. I have also requested Mr. Tracey, at Singapore, to forward to you, of all my Chinese works, both scientific as well as religious, a copy, with the contents noted at the covers in English.

Not making, myself, any pretensions to learning, the grand object of my life has been practical usefulness. Providence having brought me in contact with all the nations that have adopted the Chinese character, I merely wish to communicate the result of experience, without bias.

1st. China was the great focus of civilization, from whence it diverged to all the countries of Eastern Asia at a very early period of our era. The southern parts of the empire were completely overrun by Chinese colonists, the aborigines driven into the mountains, and the country itself, including Tunkin and Annam, (though now for many centuries independent,) incorporated with the central kingdom. A constant influx took place into Corea, but the Chinese emigrants were less numerous in Japan and the Loo-Choo islands.

2d. The natives of those countries were as rude as the Germanic tribes when the Romans first invaded their forests, devoid even of the art of writing.

The Chinese, therefore, made them adopt their characters, and as they had for many ideas no words, introduced their own to make up their deficiency.

3d. By this process Chinese books became the literature of all the above named countries, and has remained so, exclusively, until this very day. Government availed itself of these characters to communicate its commands to the people; authors wrote in them, and every man of education studied the same with all the ardour of a native Chinese.

4th. Not only the works published by authors of those respective nations in the Chinese character, but every other work introduced from China, are considered as a national property, which they share with other countries. Though well aware that the Chinese character was not of their invention, yet so many centuries have now elapsed since it was first made known, that they have ceased to view it as a foreign idiom.

5th. All the nations that adopted this mode of writing speak a language more or less distinct from the Chinese written idiom; and we may also add, that the oral medium of all the dialects spoken in China is very distinct from the language of books. This applies to all dialects, the Mandarin included, though the latter deviates less from the books written in a colloquial style. The Chinese, therefore, have to learn the meaning of the characters from teachers, who explain them in the dialect spoken amongst the people. The same is the case, in a greater measure, with the nations who adopted the Chinese character; few of the sounds with which they read them are current in conversation. Though a Cochinchinese reads 頭 *dow*, and also calls it *dow*, the head—a Japanese reads it *tsze*, and calls it *kasira*. A Fo-kéen man reads it *tow*, and calls it *tow kak*, &c., whilst a Corëan, in many instances, adds the native appellation to the sound of the Chinese character.

6th. This is very clear, that the dialects spoken by the nations conversant with the Chinese character are very distinct from the idiom of the central kingdom. Both the Corëans, as well as the Japanese, have invented a syllabary, with which they write their own language, whilst every important business is transacted by means of the Chinese character. The Cochinchinese have no such aid, but use, occasionally, the Chinese character in a contracted form, without any reference to its meaning, merely to express sound.

7th. Though it has been again and again said that sound was not inherent in the Chinese character, this axiom requires considerable modifications. A great part of these signs are not pronounced by the Chinese at random, nor do the nations that have introduced them amongst themselves entirely abandon the analogy observed in reading them, though their modes vary very much.

8th. Having, myself, acquired the Japanese, as well as Cochinchinese, and also had intercourse with the Coreäns, of whom several are now at Macao, I can only extol the ease with which one may communicate to them by means of the Chinese character, though not understanding a single word of their idiom. This does not refer to the learned classes only, but to the very fishermen and peasants, with only some exceptions. In the Loo-Choo islands men of distinction talk the Chinese with great fluency, but the bulk of the people speak a dialect of the Japanese, and use the Chinese character as well as the Japanese syllabary.

9th. It is, therefore, certain that the nations who have adopted the Chinese character attach the same meaning to it as the natives from whence it originally came, and that its construction is likewise retained, with scarcely any alterations.

I have the pleasure of transmitting to you a copy of the Chinese Magazine, which I have now been publishing for several years. I, myself, possess a Cochinchinese dictionary, which I compiled some years ago, and also a Cambodian one. If your society wishes to publish the latter, it is at your service. Whatever I can do for promoting your objects will be readily undertaken; and I should be happy if you would continue your correspondence.

I have the honour of subscribing myself, dear sir,

Yours respectfully,

(Signed) CHARLES GUTZLAFF.

To John Vaughan, Esq.,
Librarian to the American Philosophical Society.

2. *Letter from Mr. Duponceau to the same, ordered by the Society to be published with the preceding one, to which it is an answer. Read September* 20, 1839.

My Dear Sir,

I have read, with great pleasure, the letter addressed to you by the Rev. Mr. Gutzlaff, dated Macao, the 2d of January, in the present year. I regret that that writer's excessive modesty has induced him to confine himself to a statement of facts which, interesting as they are, do not afford the solution of the important questions which are the object of my "Dissertation on the Nature and Character of the Chinese System of Writing." Possessed as he is, not only of the Chinese language, in which he has written a universal history, but of those of Cochinchina and Japan, he appears to me to overstep the bounds of Christian humility in disclaiming all pretensions to learning; I wish, therefore, that your respectable correspondent had entered into more details on the subject of which he treats, and not confined himself to generalities, as he appears to have done. I would have been happy to learn from him from what causes, in what manner, and to what extent the Chinese characters have become a kind of *pasigraphy* among those nations whom philologists distinguish by the name of *Indo-Chinese.* It is an object of curious inquiry, and which, when fully understood in all its bearings, will, in my humble opinion, throw considerable light on the history of the human mind.

I am particularly struck with the spirit of candour and the love of truth which pervades the whole of Mr. Gutzlaff's letter, therefore I am not disposed to controvert any thing that he asserts of his own knowledge; which, indeed, I should do with a very ill grace, as I cannot pretend to any thing like that knowledge he possesses of the Indo-Chinese languages, and their various systems of writing; I therefore must be considered, in the observations I am going to make, as the disciple asking questions of his master. It is in that sense only that I desire to be understood.

I fear that your learned correspondent has formed a higher opinion of the Chinese system of writing than I can bring my mind to acquiesce in. He considers it to be *a gigantic effort of human genius*, and as performing what we should have deemed impossible.* For my part, I confess that I cannot see it in that exalted light. The invention of writing, generally, may be, and is still every where, and, probably, with justice so considered. Almost all nations have attributed that invention to their gods, or to their heroes, but when comparing the Chinese system with the syllabic and elementary alphabets, I do not think that its invention is to be attributed to a greater effort of human genius. It was naturally pointed out by the peculiar structure of the spoken language. The analysis of sounds, separated from any meaning, required, indeed, an effort of the human mind; but when a language consisted only of a small number of monosyllables, each of which was a word, the most natural method that presented itself was to appropriate a written sign to each word, first by rude pictures of visible objects, afterwards by metaphorical images, and when these failed, then some new method, still founded on the system of a character or group of characters to each word, was gradually adopted, and at last methodized, when civilization had made sufficient progress to require it. For we must not believe that the Chinese system of writing was originally invented by philosophers, and came out complete, like Minerva from the head of Jupiter; it is more probable that it was the work of ages; and, indeed, the ancient illegible inscriptions that still exist are sufficient to convince us of it. The method that, in the end, has been adopted, to wit, the grouping of two or three words in their appropriate characters, to recall to the memory another word by something more or less connected with the idea that it represents, and the classing those groups under a certain number of keys or radicals is, indeed, ingenious; but I cannot see in it such an effort of the human mind as the analysis of unmeaning sounds which produced the syllabic and elementary alphabets. I believe, however, that the Chinese *lexigraphy* (as I have taken the liberty to call it) is well suited to the language for which it was made, and that it would be no improvement to substitute for it a common syllabary or an elementary alphabet. The reason is in the great number of hemophonous words in the Chinese language, which could not be so well distinguished, in writing, from each other, as by the system now in use. This ocular discrimination is the great advantage of the Chinese characters, which

* Hist. of China, c. iii.

prevents much obscurity and ambiguity in books, where it cannot be explained or corrected as in oral conversation. Yet, we are told by M. Remusat that the merchants and others in China, in their familiar correspondence, make use but of one character for each monosyllable of the language; but as M. Remusat never was in China, and could know that only from hearsay, I shall make no observation upon it. I wish, however, that your friendly correspondent would throw some light upon this subject, and let us know how far M. Remusat is supported by facts in the statement that he makes.

But I am wandering from the main object that has induced me to address this letter to you. I wish to investigate, with the aid of your learned correspondent, if it can, without too much indiscretion, be obtained, the extent to which the Chinese characters serve as a means of communication between different nations who can neither speak nor understand each others' oral language, and the causes by which such a remarkable effect is produced. I once doubted the fact, because it was asserted as the proof of the alleged superiority of the Chinese alphabet, independently of the languages to which it is applied, and as a kind of pasigraphic system that might be applied to every idiom; but farther reflection, and an attentive study of the peculiar structure of the Chinese language, satisfied me that that fact might be admitted to a certain extent; hence, in my Dissertation, and before that, in my letter to Captain Hall, which is annexed to it, I did not venture to deny it in general terms, but only mentioned it as a subject requiring farther investigation; it is with a view to that investigation that I now address this letter to you.

Your correspondent is very explicit in his statement of the fact which we are investigating. I beg leave to quote here his own words:

"Having," says he, "myself acquired the Japanese, as well as Cochinchinese, and also had intercourse with the Coreans, of whom several are now at Macao, I can only extol the ease with which one may communicate to them by means of the Chinese characters, though not understanding a single word of their idiom. This does not refer to the learned classes only, but to the very fishermen and peasants, with only some exceptions. In the Loo-Choo islands men of distinction talk the Chinese with great fluency, but the bulk of the people speak a dialect of the Japanese, and use the Chinese characters as well as the Japanese syllabary."

From these facts, which the writer asserts of his own knowledge, and, therefore, which I am not disposed to controvert, he draws the following inference:

"It is, therefore, certain that the nations who have adopted the Chinese character attach the same meaning to it as the natives from whence it originally came, and that its construction is likewise retained, with scarcely any alterations."

Here I must acknowledge that I find myself embarrassed. Fortunately the writer does not state this as a fact founded on his knowledge of those languages, but as a mere inference. Were it otherwise, it would have embarrassed me still more; for your learned friend would have been in contradiction, not only with the grammars and other works that we possess concerning those idioms, but also with learned and respectable missionaries, like himself, from whose assertions I cannot withhold my assent. Thus, the Rev. Mr. Medhurst, in his excellent work upon China, relates, (chapter 13th,) that among a number of books which he sent to Drs. Morrison and Milne, and either copied or caused to be copied for them, there were the four books of Confucius, in Chinese, with a Japanese translation *interlined,* a work, says he, of *incalculable importance,* as showing that Chinese books, as they stand, are not intelligible to the mass of the Japanese, and need some addition, in order to general circulation. And a little farther he says: "It appears, from a comparison of these books, that the Chinese books are not in general use in Japan, *except when interlined with Japanese.*" Thus, in Roman Catholic countries, the liturgical books are given to the faithful in the Latin language, accompanied with a translation in the vernacular tongue.

And yet the same gentleman, in the fourth chapter of the same work, no doubt written before he had seen the books above mentioned, and reflected upon them, speaks of the Chinese characters precisely as your correspondent does, and says that they are generally read and understood, not only throughout the vast empire of China, but throughout Cochinchina, Corëa, and Japan; and that not only the characters, but the *style,* that is to say, the arrangement of the ideas, is likewise understood; which implies that in all those languages the structure, the metaphors, and the grammatical forms are the same, or nearly the same, which appears to be the opinion of your learned correspondent. You have seen how Mr. Medhurst afterwards corrects himself, with respect to the Japanese; and he seems to be astonished at his discovery, which, he says, is of *incalculable importance.* And so, in fact, it is; but he does not seem to have sufficiently inquired into the cause of the fact that he points out, for he ascribes it to the difference between the Chinese and the Japanese systems of writing, the one being symbolic, as he conceives it, and the other alphabetical; whereas, in my opinion, it is rather to be attributed to the difference which exists between the oral languages, to which the same system of writing cannot be applied. I speak here only of the *Yomi* or polysyllabic languages of the Japanese, which is properly their *vernacular* tongue.

It is remarkable that these two gentlemen, Mr. Gutzlaff and Mr. Medhurst, both profess to be, and no doubt are, acquainted with the Japanese, as well as with the Chinese language; how, then, does it happen that they differ so widely on a subject which must be equally familiar to them both? With the most unfeigned respect for those venerable missionaries, I am forced to presume that they have studied the Chinese and Indo-Chinese languages so as to make them subservient to the performance of the duties of their holy office, without paying much attention to them in a philological point of view, so that they have been led into, perhaps, too general conclusions from the facts which have come under their observation. This appears to me to be sufficiently proved by the example of the Rev. Mr. Medhurst, who did not rectify his ideas on the subject of the Japanese language until an interlineal translation, joined to a Chinese text, convinced him that the Chinese characters were not so familiar to the Japanese as he had conceived.

In what I have ventured to write on the subject of the Chinese system of writing I have had no object in view but the discovery of truth. I found that subject involved in mystery; the Chinese characters represented by enthusiasm as something supernatural; their origin attributed to the philosophical combinations of a barbarous people; their effects magnified to a degree that exceeds belief; in short, I saw those characters raised to the rank of an original, of a universal language, to which spoken idioms were subordinate, and, as it were, auxiliary. My plain common sense revolted against those extravagant ideas, and I tried, with feeble means, to discover what that so much extolled system really was, and to bring it within the general rule by which it appears to me that all systems of writing are governed, which is to make it an ocular representation or image of spoken language, with which mankind began to communicate with each other, long before they thought of representing speech by figures or characters; I, therefore, submitted my views to the learned, in the hope of profiting by their knowledge, which so much exceeds mine. I am happy to find that they have been honoured with the notice of your correspondent, than whom, from his profound knowledge of the Chinese and Indo-Chinese languages, and their respective systems of writing, no one is better able to form a correct judgment upon the subject, and to throw light upon the obscurity in which it is still involved. I therefore submit to him, with due humility, the few observations that are to follow.

I admit, without difficulty, the fact stated by your respectable friend, to wit, that he has seen Japanese, Corëans, and Cochinchinese communicate, with ease, with each other by means of the Chinese characters. He adds that they did so without understanding "one single word" of each others' spoken language. This appears to me to be a very strong expression, which, perhaps, Mr. Gutzlaff will be disposed to modify. I shall not, however, contradict it for the present. This faculty, he says, is not confined to the learned classes, who speak the Chinese with great fluency, but extends to the very "fishermen and peasants." This cannot be meant to imply that all, or nearly all, the fishermen and peasants of those countries can read and write the Chinese; for Mr. Medhurst tells us that there are villages, even on the coast of China, where few, "if any," of the inhabitants can either read or write. This expression, therefore, must be understood in a restricted sense.

The fact that persons who do not understand each others' language can communicate with ease by means of a common written character is, as I have already observed, important enough to require to be critically examined, particularly in respect to its extent and the causes which produce it. Nothing that has been written on the subject as yet satisfies me. This phenomenon (if it may be so called) has been attributed to the almost magical powers of the Chinese alphabet; to its representing ideas unconnected with sounds; to its "permanent perspicuity," as Dr. Marshman expresses himself; nothing has been said of the monosyllabic character of the languages which employ that lexigraphic alphabet, and of the similarity of their grammatical structure: the polysyllabic languages of Japan and other countries have been confounded with those, and, upon the whole, many things have been left obscure, which still require to be elucidated and explained. Not only the Indo-Chinese nations, but the Chinese themselves, inhabitants of different provinces or districts, have been said to interchange ideas *merely* in writing, because of their ignorance of each others' dialects; all these things appear to me to demand investigation, and with this view I submit the following observations to your learned correspondent, in hopes that he will deign to favour us with his own.

In order to observe some method in this examination, and for the sake of clearness, I shall consider, separately, the four following languages, or classes of languages, to wit:—1. The various dialects of the Chinese empire. 2d. The Annamitic languages. 3d. The languages of Japan and the Loo-Choo Islands. 4th. The Corëan. I shall not do this with a view to contradict the fact stated in a general manner by your learned friend, but to reconcile it, as far as will be in my power, to the natural order of things, and, if possible, to ascertain its extent and its causes. That several thousand written characters should serve as a means of communication between hundreds of millions of people, between provinces and districts, and even independent nations, who do not understand each others' oral languages, is a fact that strikes, at first view, with wonder and astonishment. Mankind are now too enlightened to ascribe such things to causes out of the ordinary course of nature, or to gaze upon them with stupid wonder; they will inquire and investigate, and will not be satisfied with theories founded on mere conjecture. I have shown, in my Dissertation, what wild theories were recurred to, to explain this apparent phenomenon; theories which led to the absurd inference that the art of writing existed before the exercise of the natural gift of speech. It is time to adopt more rational conclusions, and for that purpose facts must be collected and brought together in one point of view, so that fair deductions may be obtained from their concentrated light. It is with this view that I submit the following facts and observations to the superior knowledge of your learned correspondent.

I. *Dialects of the Chinese Language.*

We are told by the Rev. Mr. Medhurst, in the Preface to his Dictionary of the Dialect of the Province of Fo kien, which he writes "Fŭh-këèn," and I know no other work of the same kind, that there are no less than two hundred of those dialects in the Chinese empire. The people of the different districts, it is said, or most of them, do not understand each other when speaking, but communicate together by means of the Chinese *written language,* as it is called.

This, says Dr. Marshman, is to be attributed to the *permanent perspicuity* of the characters which he calls κατ' εξοχην, the Chinese *language*. This is a strong fact, if true to the extent that it is represented. I fear, however, that there is in this a great deal of exaggeration.

Very little is known in this part of the world, and in Europe, respecting those dialects. It is said that a vocabulary of that of Canton has been printed at Macao or Serampore, (I do not remember which,) but it has never made its way to this country, at least that I know of. The indefatigable Mr. Medhurst has given us, as I have said before, a copious dictionary of the dialect of Fo-kien, but I do not feel myself competent to compare it with the pure Chinese, or, in other words, with the mandarin dialect; I leave that to your learned correspondent, who is skilled in both, and I shall content myself with stating facts, extracted from the works of the most approved authors.

Dr. Marshman, in his *Clavis Sinica*, or Grammar of the Chinese Language, has a chapter entirely devoted to the dialects of the Celestial Empire. In that chapter, p. 560, he clearly describes the general character of those dialects, and their differences from the mandarin dialect, or pure Chinese. "Besides," says he, "the difference of pronunciation, the modes by which the colloquial dialects are varied are generally three: the introduction of words which have no characters; the use of words to which certain spurious characters are affixed; and the application of certain characters in a sense not given them in the dictionaries. The variations observable in the Canton dialect" (which, by the by, is the southernmost province of the empire, while Petchelee, in which Pekin is situated, is the northernmost) "do not affect the substantives; these, as well as most of the verbs, are the same as in the mandarin dialect, except as varied by a corrupt pronunciation. The principal variations are in the pronouns."

These differences are very trifling; and it appears, also, that they consist as much in the alteration, substitution, and misapplication of the characters as in the spoken language. The greatest difference appears from Dr. Marshman's statement to be in the pronunciation; and that, if carried to the extent which is insinuated, would, in fact, prevent all oral communication between the inhabitants of the different provinces, and reduce them to the necessity of conversing in writing as well as they could. But, according to the relation of a learned English missionary, who is worthy of the highest credit, that difficulty of conversing orally does not appear to be, by any means, so great as it has been represented; it appears to me, on the contrary, that there is no such difficulty at all, and that the inhabitants of China may converse, with the greatest ease, with those who speak the mandarin language, and be understood by them, notwithstanding the difference of their dialects.

The Rev. Mr. Medhurst, whose various writings have thrown considerable light on this important subject, in his interesting work entitled "China, its State and Prospects," relates that, in the year 1835, he hired, at Canton, the brig Huron, for a voyage of several months along the eastern coast of China. Their object was to stop at every place where they could get admittance, to converse with the inhabitants and distribute to them Chinese Bibles, tracts, and other religious books. Mr. Medhurst took with him the Rev. Mr. Stevens, who had accompanied your correspondent, in 1831, on a similar voyage, and who was acquainted with the Chinese language. They sailed from Canton, and visited the whole coast and all the maritime provinces of the empire, except Petchelee, which is the northernmost, and where the capital of the empire is situated. They landed at a great number of towns and villages in the different provinces, and there freely conversed with the inhabitants, and distributed their books, sometimes with, and sometimes without interruption from the authorities. At every place where they landed they held conversations, not only with the mandarins and officers of the government, but with persons of all descriptions, and with *assembled multitudes*, even in places where, as he says, "few of the inhabitants, *if any*, could either read or write." There is not, at any time or at any place throughout the whole of this widely extended coast, containing several large provinces and a multitude of districts, the least mention made of an interpreter being employed or conversation carried on in writing, but every thing, as far as appears, was said, and all business transacted by word of mouth, always with the greatest ease. The pure Chinese or mandarin dialect would seem to have been the medium used. In one place the people wondered that foreigners could speak so purely the Chinese language; they believed the missionaries to be natives of the empire; in another they believed that as their emperor was the master of the whole world, there could be but one language on the face of the earth, and that was the Chinese. The missionaries were acquainted with the dialect of Canton, and with three of those of the adjoining province of Fo-kien, to wit, that of

Fo-kien proper, and those of the county of Chang-chow, and the district of Chang-poo, in the same province, with the natives of which they had had much communication in the Chinese colonies in the Indian seas; but they could not be familiar with the dialects of the more northern provinces which they visited; there must, therefore, have been a common medium of oral communication between them and the inhabitants. Why, then, was not the written medium, that universal language, as it is called, made use of, or even at any time or on any occasion called to their aid in those distant places? This, I must confess, shakes my belief in a great degree; at least as far as respects China itself, where sinologists tell us that even those who can converse together in the mandarin tongue, even the learned mandarins, are sometimes obliged to trace characters with their fingers in the air, when they cannot make themselves understood by word of mouth. I suspect that there is here a great deal of exaggeration; no one is better able than your learned correspondent to explain it.

II. *Annamitic Languages.*

We are now out of the limits of the Celestial Empire; but we have not yet taken leave of the Chinese race, to which the people of the country I am going to describe appear to me to belong.

The country called *Annam*, or *Anam*, which means "the country of the south," is situated on a tongue of land at the southern extremity of the China Sea. It is bounded to the north by the Chinese empire, to the east and south by the sea, and to the west by a chain of mountains, which separates it from the kingdom of Siam, and from the countries that are called the Birman empire. It contains the kingdoms of Tunkin and Cochinchina, to which the name of Annam is more especially applied, and the lesser states of Cambodia, Laos, and Ciampa. Of the languages of the last three we know absolutely nothing; we only presume that they are monosyllabic, like those of Tunkin and Cochinchina. I see, with pleasure, that your correspondent has composed a dictionary of the Cambodian language, which he kindly offers to present to our society, who, I have no doubt, will receive with gratitude that valuable present, and be the first to make known the Cambodian language to America and Europe, as they have done the Cochinchinese. We may hope, hereafter, to become acquainted with the idioms of Laos and Ciampa. There is nothing that cannot be expected from the efforts of the zealous propagators of the Christian faith.

The languages of Tunkin and Cochinchina are considered as the same, or nearly the same. They are both monosyllabic, and their grammatical structure does not appear to differ from that of the Chinese. Indeed, it would seem as if the simplicity of monosyllabic languages did not admit of much difference in their syntax. Mr. Naxcra, in his Dissertation on the Language of the Othoni Indians, which has been published in the fifth volume of the new series of our Transactions, has shown the most striking coincidences between the phraseology of that language and that of the Chinese. I am told that there are persons in Europe, and in this country, who contest the fact of the Othoni idiom being monosyllabic. If they will only take the trouble to read attentively Mr. Naxcra's Dissertation, with the numerous examples that he has given of that language, and the translations that he has made into it, with the addition of grammatical explanations and notes, they will be convinced that it is impossible for human ingenuity to invent and impose upon the learned world such a tissue of imposture as he must necessarily have been guilty of, if his accusers are well grounded in their assertions, and to make a monosyllabic out of a polysyllabic language, without ever contradicting himself or betraying the imposition; besides that there are, in print, several grammars and vocabularies of that idiom, by which he might easily be confuted. But it is easier to criticise than to read.

We should know but very little of the Annamitic languages if it were not for the Cochinchinese vocabularies, for which our country and philology are indebted to the munificence of the reverend father Joseph Morrone. We understand that a complete dictionary of that idiom, compiled by the Vicar Apostolical of the Catholic church in Cochinchina, is now in a course of publication under the auspices of the Honourable the East India Company; and what adds to my satisfaction is, that your respectable correspondent is himself master of that language, and has a dictionary of it in his possession. I regret that he did not take the trouble to give you his opinion of Father Morrone's vocabularies, which, hitherto, I have no reason to believe otherwise than correct, and deserving of full credit. The comparison of this language with the Chinese, by M. de la Palun, is a hasty production, for reasons which I have explained in the preface which precedes them; therefore it would have been very gratifying to me to know whether the inferences that I have drawn from it are justified by a full comparison of the two languages and their system of writing, made by such a master hand as that of your correspondent. It would show clearly whether and how far the Chinese characters, as applied by the two nations to their respective idioms, can serve as a common medium of communication between them, when they are ignorant of each others' spoken language.

From the lights that we possess it would appear that the languages of China and Cochinchina, though both monosyllabic, and having the same grammatical structure, are yet very different from each other. That there are in the latter a number of Chinese words more or less corrupted cannot be denied; but the mass of the language shows clearly that the two nations cannot understand one another when speaking. The same difference appears in the written characters; they have been originally Chinese, and many of them remain such, but a great number are so altered in their form as not to be recognised, while those, the form of which has not been varied, are either differently combined or associated together, or are applied to represent words different from those which they express in Chinese; and what is most remarkable is, that, in many instances, they have been applied to words which, in Chinese and Cochinchinese, have the same sound, but not the same meaning. From this I would naturally conclude that the two nations cannot understand each other in writing any more than orally, at least to any considerable extent.

There can be no doubt that those nations are all of the same race, and descended from the same stock. It also clearly appears that civilization and the art of writing was introduced into the land of Annam by the Chinese; but the Annamites have been so long independent of the Celestial Empire, if ever they were subjected to it, that it is not extraordinary that their language and their writing should have experienced considerable changes in the course of so many ages.

That being the case, it will be asked: How comes it, then, that the Cochinchinese and the Chinese understand each other in writing, though they cannot by word of mouth? The enthusiasts attribute this to some mysterious virtue in the Chinese characters; to their *permanent perspicuity*, as Dr. Marshman expresses it; but the philosopher seeks for more natural causes; he knows that writing was invented to be the representation of some oral language, and it is by comparing the forms of the graphic system with those of the spoken idiom that he hopes to obtain the solution of the important problem that has so much *puzzled* the sinologists of Europe.

If there is any perspicuity in the Chinese written characters, it is not in their outward forms, which, whatever some of them may have been in the beginning, are now nothing more than linear and angular figures, which present, of themselves, no idea to the mind, but in the method and arrangement of them that has been adopted by the Chinese grammarians, and which the languages to which that system was to be applied necessarily required. The monosyllabic languages are devoid of grammatical forms; their words are not, as in the idioms of Europe and Western Asia, derived from roots that lead to the understanding of their numerous derivatives; no one monosyllable is connected, as to its sense or meaning, with another by means of some slight alteration; but, on the contrary, the same word or monosyllable sometimes serves to express twenty or thirty, and sometimes even fifty different ideas; and the only mode of discrimination between them is by the tone of voice or accent, by the juxta-position of the words to each other, and by joining two words together to show the separate meaning of one. This, in speaking, is of little consequence; for it is well known, whatever may have been said to the contrary, that the Chinese, in conversation, understand one another perfectly well, and without the least difficulty. For this I have the testimony of the Chinese themselves, several of whom I have interrogated on this particular point, and who have uniformly given me the same answer. I have also heard them converse together, and never have seen them embarrassed. Besides, if there was any ambiguity in their discourse, it might be easily corrected at the moment.

But, in inventing a system of writing for such a language, it was necessary to prevent ambiguities which the author would not be at hand to correct. For this reason different characters were applied to the same monosyllable, to show in what sense it was to be understood. This was done by uniting two or more characters, each representing a particular word, to show in what sense the word represented was to be taken. This has given rise to the notion that Chinese characters represent abstract ideas, when, in fact, they are but a method of spelling the same word, analogous to the different orthography that we employ in writing homophonous words, such as *sea* and *see*; *scene* and *seen*; *grate* and *great*, &c. Thus the Chinese system of writing was invented to suit the language to which it was to be applied. The inventors never thought of representing ideas any farther than was necessary to recall to the memory a particular word by a short explanation of its meaning, in which they have not always been very successful.

In process of time they have methodized the system by classing their words under a certain number of keys, or radicals, which, while they facilitate the understanding of the words placed under them, afford to the student an easy way of finding them in the dictionaries.

The Chinese system, therefore, may be considered as an ingenious invention, as applied to monosyllabic languages; and it is, perhaps, the only system suited to them; but, abstractedly speaking, it does not appear to me to be more ingenious than that of syllabic and elementary alphabets, which are also suited to the languages for which they were made.

What has contributed most to the admiration which the Chinese system of writing every where commands, is the facility with which nations who cannot speak or understand each others' oral language communicate with each other by means of the Chinese written characters. Hence it has been supposed, and it has become almost the general belief, that those characters represent ideas entirely abstracted from speech. Your learned correspondent, with better judgment, has attributed that facility, as far as it extends, to the similarity of the grammatical structure of the languages of the various nations who thus communicate. As far as it regards the monosyllabic languages, like those I am now speaking of, I agree with him so far, that this similarity in the structure of those languages contributes much to the facility to which he adverts, but I am far from thinking that it is its only cause. I must explain myself a little farther.

It being admitted that the Chinese and Annamitic languages, though differing in the sounds of their words, do not differ materially in their structure and grammatical forms; that every Chinese word (with, perhaps, a few exceptions) has a corresponding word in the Tunkinese and Cochinchinese which has precisely the same meaning, and that they use, in writing, the same characters, though their forms and their application to the words of the language have much varied in the course of a long series of ages, it naturally follows that, as far as those forms have not materially varied, and are still applied to the corresponding words in the two languages, the Chinese and Cochinchinese may communicate by writing, though they cannot by words. But, if we can judge from Father Morrone's Cochinchinese Vocabulary, with the characters annexed, it would seem that that cannot take place to a very great extent. We must look, therefore, to some other cause.

We find, from the Cochinchinese and Latin Dictionary published with my Dissertation, that the Chinese language is taught in the schools of Cochinchina, as well as their own. As the Chinese is the religious and literary language of the country, which does not appear to have a literature of its own, it is necessary that it should be learned, in order to understand Chinese books. There is no need, for that purpose, of their learning the spoken language; at least, they need not pay much attention to the spoken words; they study the characters as a different *spelling* of their own, as in our schools we might be taught the ancient Gothic letters, if there were an object deserving of it. As far, therefore, as respects the Annamitic nations, I do not differ much from your learned correspondent; but we do not seem to agree as regards the polysyllabic languages, of which I am now going to speak.

III. *Languages of Japan and the Loo-Choo Islands.*

We must now take leave of the Chinese race. We are among different nations, the origin of whom is not well ascertained. From the physical conformation of the Japanese, some naturalists have thought that they were a mixture of the Chinese and Tartar races; but their language does not warrant this supposition. It seems evident, however, that they were civilized by the Chinese, and they, at present, acknowledge the literary and moral supremacy of the great empire, but they are under no kind of civil subjection to it. They are, and have been, independent from time immemorial.

We know very little as yet of the vernacular language of the Loo-Choo Islands. It is, however, well ascertained that it is a dialect of the Japanese, and, like it, polysyllabic. It is probable that those islands are inhabited by colonies from Japan. I shall therefore confine my observations to the language of the latter country; from the information we have, they may, I think, also be applied to the Loo-Chooan.

We are, fortunately, well acquainted with the national language of Japan. The works of Thunberg, Siebold, Klaproth, and Medhurst, and, above all, the excellent grammar of that language by Father Rodriguez, translated into French by M. Landresse, with the explanations of M. Remusat, and the supplement to it by the learned William Humboldt, chiefly extracted from the grammars of the same language by Fathers Alvarez, Collado, and Oyanguren, which are now very rare, leave us nothing to wish for upon the subject. The whole Japanese language is thus spread before us. It is called the *Yomi*.

This language is entirely different from the Chinese; there is no analogy or affinity between them. A number of Chinese words have crept into it, but their foreign origin is easily perceived. The Japanese is polysyllabic, and abounds in grammatical forms. The nouns are declined by suffixed particles, and the verbs are conjugated by means of terminations and inflections; they have adjective verbs, like our Indian languages. The syntax is subject to rules, and the order in which the words are placed, says Father Rodriguez, is quite the reverse of that of the Chinese. It is evident, therefore, that the Chinese system of writing could not be applied to it.

The Japanese received the art of writing from the Chinese. But their teachers, as well as themselves, soon perceived that the same system could not be applied to both languages, and that the Japanese could not be written *lexigraphically*. They therefore determined upon giving them a syllabic alphabet. Out of the many thousand Chinese characters they chose forty-seven, without paying any regard to their meaning, but only to their sounds, and applied these to the forty-seven syllables of which the Japanese language is composed. Thus was formed the Japanese alphabet, which they call *i ro fa*, or, according to Medhurst, *i lo ha*, from the first three letters of which it is composed.

If the Japanese had no other language and no other alphabet than those I have described, it is evident that they could not understand or make themselves understood by the Chinese, verbally or in writing.

But the Chinese, when they introduced civilization into Japan, introduced, also, their language, which is there called the *koye*, which means *Chinese words*. The pure koye, says Father Rodriguez, is the *Chinese*. It is there a spoken as well as a written language, for it is clear that it could not be read into Yomi, any more than Greek or Latin into English, without translating. But such is the difference between the vocal organs of the two nations, that they cannot understand each other when speaking the same idiom. The Japanese cannot pronounce the nasal vowels of the Chinese, who have consonants that the Japanese cannot articulate, and *vice versâ*. Thus the pronunciation has become so different as to make it almost two different languages, although it is easy to perceive that it is the same idiom differently articulated. I have given examples of this difference in my Dissertation, p. 91.

I can thus easily understand how the Japanese cannot converse orally with the Chinese, either by means of the Yomi, of the Koye, or of the Mandarin dialect, and how they can more easily communicate by means of the Chinese characters. But I cannot so easily conceive how peasants and fishermen acquire sufficient knowledge to enable them to do so. I can only account for it by the Chinese, or Koye, being a religious as well as a learned language. Religion can perform wonders.

Father Rodriguez tells us that there are three languages or dialects in Japan, which he thus describes:

"The first is the pure *Yomi*, which is the natural and primitive dialect of the nation; they write in it works of light poetry and literature.

"The second is the pure *Koye* (or Chinese;) the priests employ it in their religious works.

"The third is a mixture of Yomi and Koye; it is the vulgar language of the empire. It must be observed, however, that the ordinary language, that is to say, that in common use, is almost entirely composed of Yomi, with some mixture of Koye, while in the literary and oratorical style there is much more Koye than Yomi."

It follows from the above, that books of light reading, in poetry or prose, are written in the national language, or Yomi; that religious books are written in pure Koye, or Chinese, and scientific and literary works in a mixed dialect, containing more of the Koye than of the Yomi. I presume that in those books the Koye is written in the Chinese lexigraphic, and the Yomi in the Japanese syllabic alphabet. It must make a curious mixture; and it is worth inquiry how and how far the peasants and fishermen are instructed in the Koye language and system of writing. I suppose that the same thing may be said of the people of Loo-Choo.

IV. *The Corëan.*

The peninsula of Corëa is situated between China and Japan, and separated from those countries, on each side, by a narrow straight. It is bounded on the north and north-west by Chinese Tartary, every where else by the sea. It is tributary to the empire of China.

We should know very little of the language of that country if it were not for the recent publication of the Rev. Mr. Medhurst, entitled "A Comparative Vocabulary of the Chinese, Corëan, and Japanese Languages," compiled by a native of Corea, which has lately made its way into this country. I have had the book but a few days in my possession, through the kindness of my learned friend Mr. Pickering, of Boston, to whom it belongs. I have not, therefore, been able to study it as much as I wished. It is to be regretted that the venerable missionary contented himself with publishing a translation of that interesting work, to which he added very few observations of his own, from which, and the work itself, I have been able to deduce the following facts.

Corea, like Japan, has two languages, the one vernacular, the other learned. In the former are written all works intended for common reading; works of higher literature are in the learned idiom.

The vernacular or popular language has no affinity with either the Chinese or Japanese; it is probably derived from some Tartar dialect. It is not, as far as I can judge, monosyllabic; and yet it does not appear to have words of a greater length than two syllables, but on this I have not had a sufficient opportunity to form a decided opinion. Of its syntax or grammatical forms I can say nothing. It has, like the Sanscrit, an alphabetic syllabary, which, I think, is much superior to that, from its simplicity and clearness. It is not, like the Japanese, formed out of Chinese characters. It consists of fifty-two elementary signs, of which twenty-seven, called initials, are single, double, or aspirated consonants, and twenty-five, called finals, are vowels or diphthongs. I mean diphthongs to the ear, and not to the eye.

By means of these fifty-two characters, joined or placed close to each other in the most ingenious manner, the six hundred and seventy-five syllables, of which the language consists, are represented, and never leave, as in the Sanscrit, the vowel sounds to be understood. They are so simple in their forms that they may be joined, as we sometimes join in our printed books, the letters *fi*, *ffi*, *fl*, *ffl*, &c. Thus the consonant K is written ㄱ, and the consonant N thus ㅏ. The sign of the long vowel A is ㄴ. Now the syllable KA is written 가, and the syllable Na 나. I know of no other syllabary formed on this simple and elegant model.

The learned language is Chinese, but differently pronounced than in China, and for the same reason that has already been given for the Japanese. The Corëans want the nasal vowels of the Chinese, and cannot articulate them. They want the consonant *f*, of which the Chinese make such frequent use, and they have the consonant *b*, which the Chinese want. They have a multitude of double, successive, and aspirated consonants, very difficult to be pronounced. It is well known that the Chinese cannot articulate two consonants successively, and always interpose a vowel between. Besides, there are the four tones, or accents, by which the Chinese, in speaking, distinguish their homophonous words. These, probably, are not much attended to out of China, or are differently expressed. Though their words are Chinese, their manner of uttering them is so different that the two nations cannot make themselves understood of each other by word of mouth. Their vocal organs seem to be cast in different moulds.

There is nothing extraordinary in this. We vary, more or less, in the same manner in our pronunciation of the dead, and even of some living languages. M. Silvestre de Sacy, the author of the best Arabic grammar extant, could not understand Arabs when speaking, nor make himself understood by them. If an ancient Roman were to come again into this world, an Oxonian could hardly understand him, nor make himself understood by him in his own Latin; he would be obliged to take to his pen, or to his tablets, after the manner of the Corëans and the Japanese.

Thus the great miracle, which has exercised the fancy of so many enthusiasts and produced such strange theories, is naturally explained. This explanation is not to be sought in any thing inherent in the Chinese characters, in their external forms or in their greater perspicuity, but in their connexion with the languages for which they were formed, and in their peculiar adaptation to them. This was well understood by your learned correspondent when he inferred from the facts that he stated that all the languages which made use of the Chinese alphabet were formed on the same model, because he knew that those characters could not be applied to languages differently constructed. But in speaking thus generally, he did not advert to the vernacular languages of Japan, the Loo-Choo Islands, and Corea, so different from the Chinese that it was found impossible to apply to them the Chinese system of writing, though it was by the Chinese that they were civilized. Therefore I humbly conceive that when those people read Chinese characters, they do not read them in their own vernacular tongue, but in the Chinese which they have learned, with only a different pronunciation of the words. It is otherwise with the people of Tunkin and Cochinchina, their language or languages being formed on the model of that of the Celestial Empire, with only some variations, which, in their schools, they learn to correct, and to employ the proper characters as a superior orthography, they are thereby enabled to read the Chinese, as well as their own language.

I submit these ideas to your learned correspondent, which, I hope, he will have the goodness to correct, if found erroneous. I beg you will be pleased to transmit to him a copy of this letter, with the assurance of my respect.

Your friend and obedient servant,

PETER S. DU PONCEAU.

Philadelphia, Sept. 20, 1839.

To John Vaughan, Esq.

ARTICLE III.

On the Extrication of the Alkalifiable Metals, Barium, Strontium, and Calcium. By Robert Hare, M. D., Professor of Chemistry in the University of Pennsylvania. Read October 4, 1839.

In the autumn of 1820, I devised an innovation in the mechanism and in the mode of completing the circuit of an *extensive* voltaic series. Previously to that time, in using any form of the voltaic battery, the circuit had always been completed by making a communication between the electrodes,* after the submersion of the plates. In the case of the deflagrator, the electrodes might be made to communicate before the immersion of the plates, the circuit being completed by their immersion. Or, in case the electrodes should not be in contact before immersion, the operator was enabled to bring them together so nearly about the same time, as to avail himself of the pre-eminently energetic action which immediately succeeds the encounter between the plates and the solvent.

Fourteen years had elapsed, during which I had the regret of perceiving that the advantages of the deflagrator were not sufficiently estimated in Europe, when, about the year 1835, the celebrated Faraday,† while investigating the principles upon which galvanic apparatus should be constructed, came to a conclusion that the deflagrator eminently associated the requisites of which he

* Agreeably to the suggestion of Faraday, I use the word electrode, for the pole of a voltaic series; also anode, for the positive pole, and cathode for the negative pole.

† See London and Edinburgh Philosophical Magazine and Journal, vol. viii., for 1836, p. 114.

was in search, and stated many facts and arguments tending to prove that it was the most perfect form of the apparatus at that time known. More than twelve years ago, while I was operating with a deflagrator of three hundred pairs, each seven inches by three, I observed that, in a circuit made through a saturated solution of chloride of calcium, by means of a coarse platina wire (No. 14) and a fine wire, (No. 26,) that when the latter was made the cathode and the former the anode, a most intense ignition resulted, causing the rapid fusion of the fine wire into globules like common shot. But when the situations of the wires were reversed, so that the smaller wire was made to form the anode, the ignition became comparatively so feeble as to be incompetent to fuse the fine platina wire. This phenomenon had continued to appear inexplicable, when, during the last winter, it occurred to me that the evolution and combustion of the calcium might be the cause of the superior heat produced at the cathode.

This led to the employment of chlorides in the process of Seebeck, Berzelius, and Pontin, for the production of amalgams from the earths, in which a cathode of mercury, and anode of platina were used. Accordingly, in operating with a deflagrator of three hundred and fifty Cruickshank pairs of seven inches by three, a mercurial amalgam was speedily obtained, which appeared sufficiently imbued with calcium to become speedily buried under a pulverulent stratum of lime, and mercury in a minute state of division.

Nevertheless, after exposure of the amalgam thus produced to the air, till all the calcium had been separated, and igniting the resulting powder to drive off the adhering mercury, the ratio of the weight of the lime thus obtained, to the mercury with which it had been united, was not over a five hundredth part. With a view to procure an amalgam in which the proportion of calcium should be greater, I was led to devise the following apparatus and process, of which an engraving and description is now laid before the society.

How far the result of my exertions, subsequently stated, may be considered in advance of the steps previously taken, will be evident from the fact that all the knowledge which exists, respecting the isolation of the metals of the alkaline earths, is due to the experiments and observations of Davy; and to what point they extended may be learned from the following quotations from the Bakerian lectures of that celebrated chemist. In reference to his efforts to isolate the radical in question, the distinguished lecturer mentions "that to obtain a complete decomposition was extremely difficult, since nearly a red heat was required, and that at a red heat the bases of the earths acted upon the glass, and became oxygenated. When the tube was large in proportion to the quantity of amalgam, the vapour of naphtha furnished oxygen sufficient to destroy a part of the bases; and when a small tube was employed, it was difficult to heat the part used as a retort sufficiently to drive the whole of the mercury from the base without raising too highly the temperature of the part serving for a receiver so as to burst the tube." "When the quantity of amalgam was about fifty or sixty grains, I found that the tube could not be conveniently less than one-sixth of an inch in diameter, and of the capacity of about half a cubic inch. In consequence of these difficulties, in a multitude of trials I had few successful results; and in no case could I be absolutely certain that there was not a minute portion of mercury still in combination with the metals of the earths."*

The observations are more than confirmed by my experience, which leads me to the conviction that the removal of the mercury is not to be accomplished thoroughly in glass vessels, and, of course, that Davy was perfectly correct in supposing that the products which he described as barium and strontium were alloys with mercury. I am also under the impression that the metals above mentioned decompose naphtha, when heated with its vapour, and enter into combination with its constituents. Had the barium which Davy obtained been free from mercury, it would not have been fusible below a red heat, as alleged by him. Agreeably to my experience, that metal requires no less than a good red heat for its fusion.

In a subsequent paragraph he adds: "The metal from lime I have never been able to examine exposed to air or under naphtha. In the case in which I was enabled to distil the mercury from it to the greatest extent, the tube unfortunately broke while warm, and at the same moment when the air entered the metal, which had the colour of silver, took fire and burnt, with an intense white light, into quicklime."*

Had the failure of Sir Humphrey, in his efforts to isolate calcium, been due only to the accidental fracture of a glass tube, it would be inexplicable that a chemist so indefatigable should not have successfully reiterated the experi-

* See Transactions of the Royal Society, part II. Nicholson's Journal, vol. xxi., for 1808; or, Tilloch's Philosophical Magazine, vol. xxxiii.

ment; or that no other chemist, during thirty intervening years, should have succeeded by resorting to the same means. No doubt exists in my mind that, without using a larger quantity of mercury than the sixty grains which he employed, and resorting to other materials than glass for a distillatory apparatus, no chemist could succeed in the isolation of calcium, nor in the complete distillation of the mercury from the amalgams of the other metals, so as to obtain available quantities for examination.

In a subsequent communication to the Royal Society, Davy mentions that, "by passing potassium through lime and magnesia, and then introducing mercury, I obtained solid amalgams, consisting of potassium, the metal of the earth employed, and mercury."

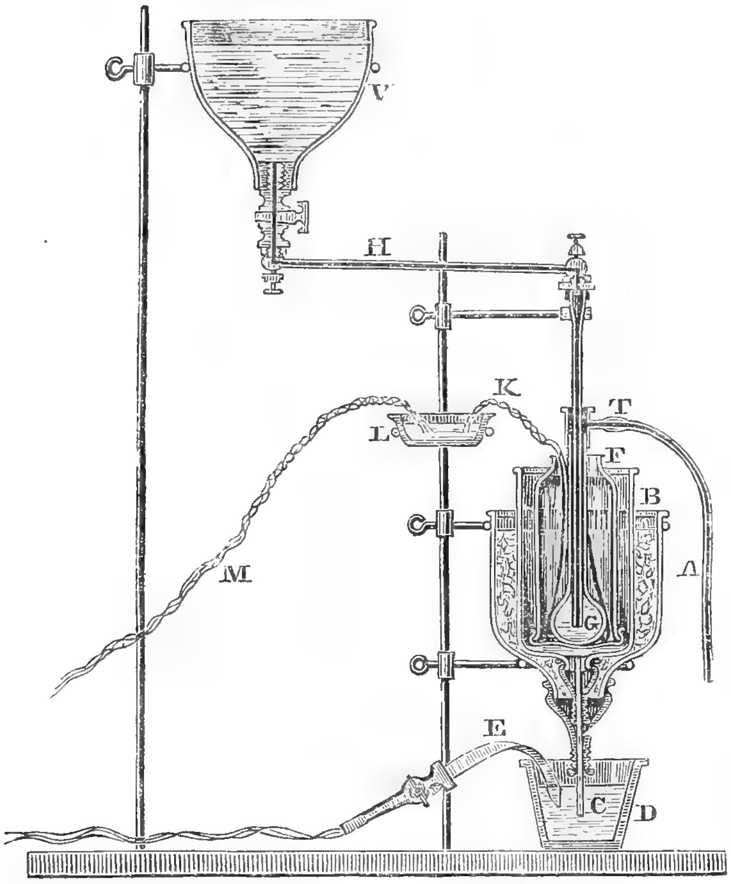
"The amalgam from magnesia was easily deprived of its potassium by water." Of the amalgam containing calcium he makes no farther mention, but suggests the possibility of obtaining, by operations performed in this manner, quantities of the metals of the earths sufficient for determining their nature and agencies.*

But I will proceed to explain and describe the apparatus and process to which I have resorted, and to communicate the results which I have obtained.

A Description of the Apparatus and Process for obtaining Amalgams of Calcium, Barium, and Strontium from saturated solutions of their Chlorides, by exposure to the Voltaic Circuit in contact with Mercury.

A and B, two bell glasses, with perforated necks, were inverted and placed one within the other, so that, between them, there was an interstice of half an inch, which was filled with a freezing mixture. Concentrically within B a third similar bell, F, was placed, including a glass flask, of which the stem extended vertically through the neck of F. From a vessel, V, with a cock intervening, a tube luted to the orifice of the flask extended to the bottom of it, so as to convey thither from V a current of ice-water, which, after refrigerating the bulk of the flask, could escape through the nozzle projecting, horizontally, from the neck, T. The mercury in the capsule D communicates through the rod with the negative poles of one or more deflagrators. The capsule L in like manner with the corresponding positive poles.

* Transactions Royal Society for 1810, part I., p. 62. Tilloch's Magazine, vol. xxxvi. p. 87.



A rod of platina reaches from some mercury in the capsule D, through the necks of the beds A and B, into a stratum of mercury, resting upon shoulder of the bell glass B, so as to be about a quarter of an inch beneath the flask. Several circumvolutions of platina wire, No. 14, forming a flat coil, were interposed between the mercury and the bottom of the flask. The recurved ends of this wire were made to reach into the mercury in the capsule L. Over the mouth of the bell F, after the introduction of the flask and coil, some bed-ticking was tied, so as to prevent contact between the platina and mercury, and to check, as much as possible, any reunion between the radical taken up by the one and the chlorine liberated by the other. Into the bell T, a saturated solution of the chloride to be decomposed was poured, and some coarsely powdered crystals of the same compound added. Of course the solution, by penetrating the ticking, came into contact with the mercury.

Electrolytic Process.

The peculiar mechanism of my apparatus, by which, in ten seconds, the acid may be thrown *on* or *off* of the plates, enables the operator, within that time, after a due arrangement of the poles is made, to put either or both of the deflagrators in operation, or to suspend the action of either or both. This mode of completing or breaking the circuit gives a great advantage in deflagrating wires; or in the processes, wherein dry cyanides, phosphurets, or carburets are to be exposed to voltaic action in vacuo, or in hydrogen. It enables us to arrange every part of the apparatus so as to produce the best effect upon the body to be acted upon, and then to cause a discharge of the highest intensity of which the series is capable, by subjecting the plates to the acid previously lying inactive in the adjoining trough.

In the case in point, where a chloride was to be decomposed, the deflagrators could be made to act through the same electrodes, either simultaneously or alternately. Of these facilities I thus availed myself:

Having supplied each deflagrator with a charge of diluted acid of one fourth of the usual strength, I began with No. 1, and at the end of five minutes superseded it by putting No. 2 into operation. Mean while, having added to No. 1 as much more acid as at first, at the end of the second five minutes I superseded No. 2 by No. 1; and, in like manner, again superseded No. 1 by No. 2. Having thus continued the alternate action of the deflagrators for about twenty minutes, both were made to act upon the electrodes simultaneously, the balance of acid requisite to complete the charge having been previously added.

By these means the reaction was rendered more equable than it could become in operating with one series more highly charged. Although, under such circumstances, the reaction may, at the outset, be sufficiently powerful to produce ignition, as I have often observed, after fifteen or twenty minutes it may become too feeble in electrolyzing power to render the continuance of the process in the slightest degree serviceable. Agreeably to my experience, as the ratio of the calcium to the mercury increases, the amalgam formed becomes so much more electro-positive as to balance the electro-negative influence of the voltaic current. After reacting with one series of two hundred pairs, of one hundred square inches each, for seventy minutes, I have found the proportion of calcium to be only one six-hundredth of the amalgamated mass obtained.

In this lies the great difficulty of obtaining any available quantity of the radicals of the alkaline earths by electrolization; especially in the case of calcium. It is easy, by a series of only fifty pairs, to produce an amalgam with that metal, which, when exposed to the air, will become covered with a pulverulent mixture of lime and mercury; but, in such case, the quantity of calcium taken up by the mercury, when estimated by the resulting oxide, will be found almost too small to be appreciated by weighing. To increase the quantity of calcium to an available extent I have found extremely difficult, since, as the process proceeds, the chemical affinity becomes more active while the electrolyzing power becomes more feeble.

That a change should be effected in mercury, giving to it the characteristics of an amalgam, by the addition of a six hundredth part of its weight, cannot be deemed difficult to believe, when it is recollected that Davy found that when, by amalgamation with ammonium, a globule of mercury had expanded to five times its previous bulk, it had gained, in weight, only one twelve thousandth part.*

As the affinity between the chlorine and the radicals of the alkaline earths increases in strength with the temperature, and as heat is evolved in proportion to the energy of the voltaic action, the disposition of the elements separated by electrolyzation to reunite is, in this way, promoted. Hence the necessity of refrigeration.

The best index of the success of this process is the evolution of chlorine; since in proportion to the quantity of this principle extricated at the anode, must be the quantity of calcium separated at the cathode. During my operations, chlorine was evolved so copiously as to tinge the cavity of the innermost bell with its well known hue. Hence, when the evolution of chlorine ceases to be very perceptible, the amalgam should be extricated from the apparatus, and separated by a funnel and the finger from the solution of chloride, and immediately subjected to distillation.

It has been mentioned, that in the electrolytic process above described I resorted to the alternate action of two deflagrators. This was effected by making the negative poles of both communicate with the mercury in capsule D, while the positive poles communicated with some mercury in capsule L. For a description of the deflagrators employed, I refer to the American Philo-

* See Tilloch's Magazine, vol. xxxiii. p. 213.

sophical Transactions, vol. v., or to Silliman's Journal, vol. xxxii. p. 285, as those which I employed were of the kind there described. There has, however, been an improvement introduced. Formerly, the plates were secured by cement; but, of late, I have had them so shaped and fitted as to slide out of the grooves when pulled by means of forceps. This has enabled me to have them washed after each operation, and, when necessary, scraped.

Instead of a coating of cement, the wood is defended by mutton suet or bees' wax, in which, while melted, it is soaked, after being made as hot as possible without taking fire.

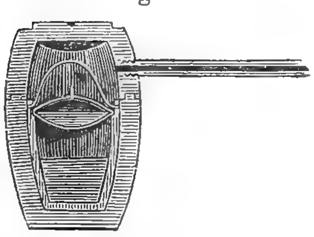
I have found great benefit to arise from Mr. Sturgeon's expedient of amalgamating the surfaces of the zinc; which Faraday has represented as giving, to a great extent, the properties of a sustaining battery. Agreeably to my experience, it renders the plates less liable to be encrusted with suboxide of zinc and copper, which always impairs the energy of a voltaic series.

In order to facilitate the insertion or extrication of the plates into or out of the grooves, the plates are cut so as to be about one-eighth in breadth less at the lower ends. In addition to the advantage of being enabled to cleanse the plates, this liberty of removing or replacing them is beneficial in another respect. It must necessarily ensue, that those edges of the plates which are lowermost, when the acid is in the act of being transferred, must be much more corroded than those portions of the surface which are otherwise situated. In fact, under the circumstances alluded to, the zinc is liable to be eaten through, near one of the lateral edges, when otherwise not more than half worn. But, in consequence of the construction above described, by a reversal of their relative position, each edge may, in turn, be made lowermost, so as to equalize the degree of corrosion sustained.

Distillatory Apparatus and Process.

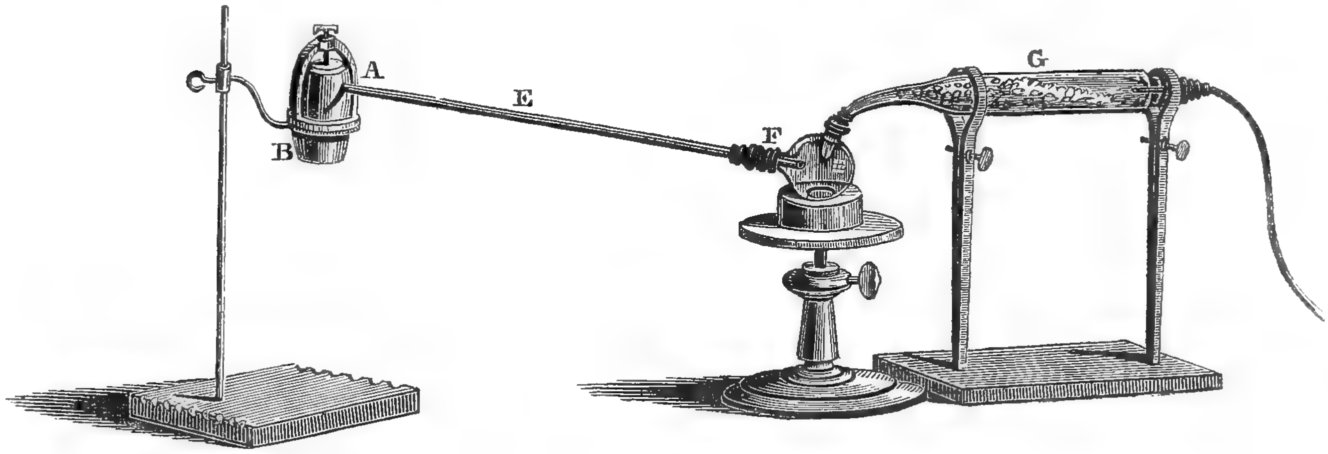
A quantity of the amalgam, weighing about three thousand grains, was introduced into an iron crucible. Of this crucible a section is represented by Fig. 2, which was forthwith closed by a capsule seated in a rabbet, or groove, made on purpose to receive it. The capsule being supplied with about half a dram of caoutchouchine, was then covered by the lid. In the next place, by means of a moveable handle, or bail,

Fig. 2.



of wire so constructed as to be easily attached, the crucible was transferred to the interior of the body of the alembic, A. Into the cavity thus occupied, about a dram measure of naphtha was poured. The canopy, A, and body of the alembic, B, were then joined, (as represented in Fig. 3,) with the aid of a luting of clay and borax between the grooved juncture and the pressure of the stirrup screw provided for that purpose.

Fig. 3.



A communication was made between the alembic and a small tubulated glass receiver, by means of an iron tube thirty inches long, and a quarter in bore. The tubulure of the receiver received the tapering end of an adopter, G, which communicated with a reservoir of hydrogen by means of a flexible lead pipe. The length of the tube prevented the alembic, or receiver, from being subjected to the agitation which results from the condensation of the mercurial vapour. Before closing the juncture completely, all the air of the alembic was expelled by a current of hydrogen, desiccated in its passage by a mingled mass of chloride of calcium and quicklime contained in the adopter. By keeping up the communication with the reservoir of this gas, while subjected to a column of about an inch or two of water, the pressure within the alembic being greater than without, there could be no access of atmospheric oxygen.

The bottom of the alembic was protected by a stout capsule of iron, (a cast iron mortar, for instance.) The next step was to surround it with ignited charcoal, in a chauffer or small furnace, taking care to cause the heat to be the greatest at the upper part. By these means, and the protection afforded by the mortar, the ebullition of the mercury may be restricted to the part of its mass nearest to the upper surface. Without this precaution, this metal is liable to be thrown into a state of explosive vaporization, by which it is driven out of the crucible, carrying with it any other metal with which it may be united.

On the first application of the fire, the caoutchouchine distilled into the receiver. Next followed the naphtha from the body of the alembic. Lastly, the mercury of the amalgam distilled; the last portions requiring a bright red heat, in consequence of the affinity between the metal and the alkalifiable radical.

After the distillation was finished, the apparatus having been well refrigerated, the alembic was opened and the crucible removed. As soon as the lid was taken off, some naphtha was poured between the rim of the capsule and sides of the crucible, so as to reach the metal below. This was found adhering to the bottom of the crucible.

When the heat was insufficient to carry off all the mercury, the metal was found in a state somewhat resembling metallic arsenic in texture, though its susceptibility of oxidation, and its affinity for carbon, caused it to be deficient of metallic lustre, until the surface was removed by the file or burnisher.

Properties of the Metals obtained by the processes above mentioned.

Either metal was rapidly oxydized in water, or in any liquid containing it; and afterwards, with tests, gave the appropriate proofs of its presence. They all sank in sulphuric acid; were all brittle and fixed; and, for fusion, required at least a good red heat. After being kept in naphtha, their effervescence with water is, on the first immersion, much less active. Under such circumstances they react, at first, more vivaciously with hydric ether than with water, or even chlorohydric acid; because in these liquids a resinous covering, derived from the naphtha, is not soluble, while to the ether it yields readily.

By means of solid carbonic acid, obtained by Mitchell's modification of Thilorier's process, I froze an ounce measure of the amalgam of calcium, hoping to effect a partial mechanical separation of the mercury by straining through leather, as in the case of other amalgams. The result, however, did not justify my hopes, as both metals were expelled through the pores of the leather simultaneously, the calcium forming, forthwith, a pulverulent oxide, intermingled with, and discoloured by mercury in a state of extreme division.

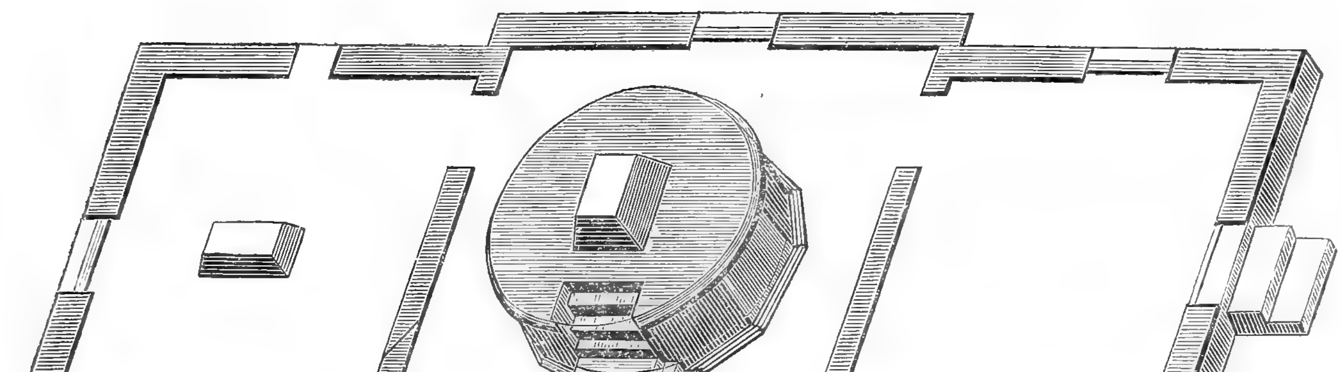
By the same means I froze a mass of the amalgam of ammonium as large as the palm of my hand, so as to be quite hard, tenacious and brittle. The mass floated upon the mercury of my mercurial pneumatic cistern, and gradually liquified, while its volatile ingredients escaped.

When the freezing of the amalgam was expedited by the addition of hydric ether, the resulting solid effervesced in water, evolving ethereal fumes. This seems to show that a portion of this ether may be incorporated with ammonium and mercury, without depriving the aggregate thus formed of the characteristics of a metallic alloy.

ARTICLE IV.

Astronomical Observations made at Hudson Observatory, Latitude 41° 14′ 37″ *North, and Longitude* 5 *h.* 25 *m.* 42 *s. West; with some Account of the Building and Instruments. By Elias Loomis, Professor of Mathematics and Natural Philosophy in Western Reserve College, Hudson, Ohio. Read October* 4, 1839.

HUDSON OBSERVATORY comprises a central room and two wings. Externally, its entire length is thirty-seven feet, and the breadth of the centre sixteen feet. The foundations are of hewn sand-stone, and the walls, which are of



brick, are one foot in thickness. The transit room is represented upon the left hand in the annexed figure. It is ten feet by twelve upon the inside, and seven and a half feet high, having a flat roof covered with tin. In its centre is a pier of fine sand-stone. Its top is twenty-seven inches by thirteen, and rises twenty-four inches above the floor. It has a slope of one inch to the foot, and descends about six feet below the surface of the earth. It is entirely detached from the building, and the floor is no where in contact with it. The openings for the transit are fifteen inches wide; the side openings being closed by solid wooden shutters, and a single trap-door covers the entire top. This covering is such as effectually to exclude the most violent rain. The transit commands an unobstructed meridian from ninety degrees zenith distance on the south, to eighty-nine degrees on the north.

The central room of the observatory is occupied by the equatorial, and is fourteen feet square upon the inside. In its centre is raised a circular platform, ten feet in diameter and four feet high, upon whose circumference rest twelve small cherry columns, which help to sustain the dome. The dome is a hemisphere of nine feet internal diameter. It rests upon ten wheels of lignum vitæ, five inches in diameter, placed equidistant from each other, running in a grooved channel, and set in a wooden ring, consisting of five arcs, joined by hinges, to allow greater freedom of motion to the wheels. The dome has an opening fifteen inches wide, reaching from the base to eight inches past the zenith, closed by three doors, the top one closing last, and the joints being so secured as effectually to exclude the rain. The whole is covered with tin, and a single person can readily revolve it by hand. The top of the equatorial pin is twenty inches by thirty, and rises three feet six inches above the platform. Its slope is one inch to the foot, and it descends six feet below the surface of the ground. It is of the same material with the transit pier, and, like that, is also entirely detached from the building.

The right hand room in the above figure, which is the west room, contains no instruments, but is provided with a stove, and serves as a convenient ante-room.

The instruments of the observatory are a transit circle, an equatorial telescope, and a clock. The transit circle was made by Simms, of London, in 1837. It has a telescope of thirty inches focal length, with a very superior object glass, whose clear aperture is 2.7 inches. This is supported by broad cones, forming an axis of eighteen inches in length. The pivots are of steel, and rest on brass y's. It is supported by a heavy cast iron frame, which rests upon the pier, and is secured immoveably to it by stout screws entering brass sockets, which are leaded to the stone. In the focus of the telescope are five vertical equidistant spider lines, besides the micrometer, and they are crossed by five horizontal ones. There are three eye-pieces, one of them being a diagonal eye-piece, which I almost exclusively employ; and they may be slid back and forth so as to be brought opposite either of the vertical wires. The object end has a cap pierced with two apertures. The level for securing the horizontality of the axis is a *rider* of seventeen inches length, and is accompanied by a small bubble at right angles. My observations make the value of the division of the level $1''.278$. I have two meridian marks, one to the north and the other to the south; the former distant about sixty rods, and the latter nearly a mile. The circle is eighteen inches diameter, with six radii, and is firmly connected with another of equal size, but not graduated, separated by an interval of three and a half inches, and between the two is the telescope. The graduation of the circle is on platina to five minutes; and there are three reading microscopes, each measuring single seconds. These microscopes are of the kind called Troughton's reading microscope, and are represented in Pearson's Practical Astronomy, Plate XI., Fig. 9. They are screwed upon a stout brass circle attached to the frame, and may be set to any part of the limb. Microscope A, which carries the pointer, I have set to indicate the polar point; microscope B at 120° north polar distance; and C at 240°. To the frame which sustains the microscopes is permanently attached a delicate spirit level, pointing north and south.

The equatorial telescope, made also by Simms, is five and a half feet focal length, with an object glass of 3.8 inches clear aperture. It has six celestial eye-pieces, with magnifying powers from 20 to 400; a terrestrial eye-piece; an eye-piece with five parallel spider lines, crossed by as many others at right angles; and a position micrometer, represented in Pearson, Plate XI., Figs. 1, 2, 3. A lamp, suspended from the side of the tube, illumines the field of view, when it is necessary to use the micrometer by night. The frame of the equatorial is of cast iron, secured immoveably to the pin by screws entering sockets leaded into the stone. It was made for the latitude of the observatory, and the polar axis admits but a slight motion in altitude and azimuth, by means of screws at its lower extremity. The right ascension circle is twelve inches diameter graduated to single minutes, and reads by two verniers to single seconds of time. A tangent screw, with a long handle, gives a slow motion, and enables an observer to keep an object readily in the field of view. The declination circle is also twelve inches in diameter, graduated to ten minutes, and reads by two verniers to ten seconds of arc.

The clock was made by Molineux, of London. It has a mercurial pendulum, the cistern for the mercury being of glass, and the cylinder is terminated by a steel point, which indicates the arc of vibration upon a fixed scale. It loses no time in winding, an operation which I perform every Monday morning. It is regulated to sidereal time, and its rate is tolerably uniform. It is suspended by a stout iron hook, which was inserted in the north wall of the transit room as the building was erecting, and which passes through the oak back of the clock case. It is rendered steady by two screws, which pass through the back of the case, near the bottom, and enter a timber inserted in the brick wall. The case does not touch the floor. An opening in the side wall, between the transit and equatorial rooms, allows the clock dial to be easily seen from the platform of the dome, and thus one clock is made to serve two instruments.

The instruments were first placed in the observatory, September 8th, 1838, and I at once applied myself diligently to their adjustment. Having verified the line of collimation of the transit and levelled the axis, the telescope was brought into the plane of the meridian approximately by high and low stars, and, subsequently, by repeated observations of Polaris, both above and below the pole. In noting the transits of Polaris, I do not attempt, by a single observation, to estimate the time when the star is bisected by a wire. The uncertainty of such an observation I have found to amount to several seconds. The star, in approaching a wire, appears to make an indentation upon it; and, also, itself suffers a partial eclipse. After passing the wire, the indentation appears upon the other side; and the deficiency, also, appears upon the other side of the star. When the light of the star is faint, as when the sun is several hours above the horizon, the star is entirely occulted for three or four seconds. At such times I note the instants of the star's disappearance, and of its reappearance; the mean I consider the instant of the star's passage over that wire. At other times I note the two instants when the star makes equal indentations upon the two sides of the wire, or suffers an equal loss of brilliancy, taking the mean of the two observations. For all transit observations, I take a second from the clock a short interval before the transit over the first wire, and preserve the counting by listening to the beats. Having recorded the observation for the first wire, I look again at the clock, and so on for each of the five wires. The equatorial intervals of the wires in their orders for stars above the pole were found to be 18*s*.456; 18*s*.419; 18*s*.180; 18*s*.374. The reduction to the central wire is, consequently, 0*s*.112 × secant of declination; positive above the pole, and negative below.

The pendulum of the clock, as it came from the maker, was found to be over-compensated. At three different times a portion of the mercury has been removed, namely: about two ounces, Nov. 30th, 1838; three ounces, Feb. 12th, 1839; and five ounces, March 5th, 1839. At each of these dates the rate of the clock was, of course, changed. I am of opinion that the pendulum is still over-compensated, though in a very slight degree. The column of mercury is now 6.3 inches high. Since March 5th the clock has not been stopped, nor the pendulum touched. The inequalities of the clock's rate, as shown in the accompanying list of moon-culminating stars, are to be ascribed to imperfect compensation; to a change in the adjustment of the pendulum; to errors of observation, the rate having commonly been determined from a small number of stars, and to other causes of a more uncertain character. Fortunately, from the nature of the observations, the results deduced from them cannot be greatly affected by the small uncertainty in the clock's rate.

I. *Latitude of Hudson Observatory.*

For the determination of my latitude, I have made repeated observations of the pole star, near the meridian, both directly and by reflection from the surface of mercury. The three microscopes were read at each observation; the observations were reduced to the meridian by the usual method, and corrected for refraction by Bessel's Tables. The mean latitude deduced from sixteen culminations, nine below, and seven above the pole, allowing each culmination a weight proportioned to the number of reflected observations, is 41° 14′ 33″.7. This is the mean of all the observations I have made, and supposes them all entitled to equal confidence, which is far from being the case. In the first observations the reflected image was quite indistinct, owing chiefly to the mercury being placed too near the telescope; and I have reason to believe that the latitude deduced from them is too small. In the later observations, the mercury was removed about thirty inches from the object-glass of the telescope, and the reflected observations were then found to accord quite as well as the direct observations. The direct and reflected observations were made alternately, from ten to sixteen at a culmination, and with the following result:

Upper culmination, August 8, ...	41° 14′ 39″·8
" " 10, ...	36 ·7
" " 13, ...	36 ·8
" " 14, ...	37 ·8
" " 15, ...	40 ·8
" " 17, ...	36 ·6
Mean of these six culminations, ...	41 14 38 ·1

The latitude deduced from the upper culmination of δ Ursae Minoris, August 13th, is 41° 14′ 35″.1; August 17th, 41° 14′ 36″.2. Mean latitude by δ Ursae Minoris, 41° 14′ 35″.7. Mean of observations on α ard δ Ursae Minoris, 41° 14′ 37″.5.

In order to determine the error of the readings of the microscopes, the following observations were made August 12th. The object was to ascertain if five revolutions of the micrometer exactly measure the interval between two divisions upon the limb. The numbers below give the excess of each microscope, for a reading of five minutes, for the north polar distances contained in the first column, being the points employed for the observations of Polaris.

North Polar Distance.	A.	B.	C.	Mean.
358° 25′—30′	— 1″·3	+ 1″·0	+ 2″·9	+ 0″·87
1 30 —35	— 1 ·7	+ 1 ·2	+ 4 ·7	+ 1 ·40
275 55 —60	— 1 ·9	— 0 ·2	+ 5 ·8	+ 1 ·23
279 0 — 5	— 1 .3	+ 0 .4	+ 3 ·8	+ 0 ·97

The numbers in the last column furnish the correction to be subtracted from the micrometer reading when this amounts to five minutes. A proportional part is to be taken for any other reading. This correction, although affecting the latitude by only a fraction of a second, has, nevertheless, been applied to all the observations. I assume, then, for the latitude of Hudson Observatory, 41° 14′ 37″, and think that future observations cannot vary much from this result.

II. *Observed Transits of the Moon and Moon Culminating Stars, at Hudson Observatory.*

It is hoped these observations may furnish the means of determining the longitude of the Observatory with some precision. At present I assume this element to be 5*h.* 25*m.* 42*s.* west from Greenwich. The table will sufficiently explain itself. The stars observed are generally those indicated by the Nautical Almanac. In only two or three instances is there a deviation from this rule.

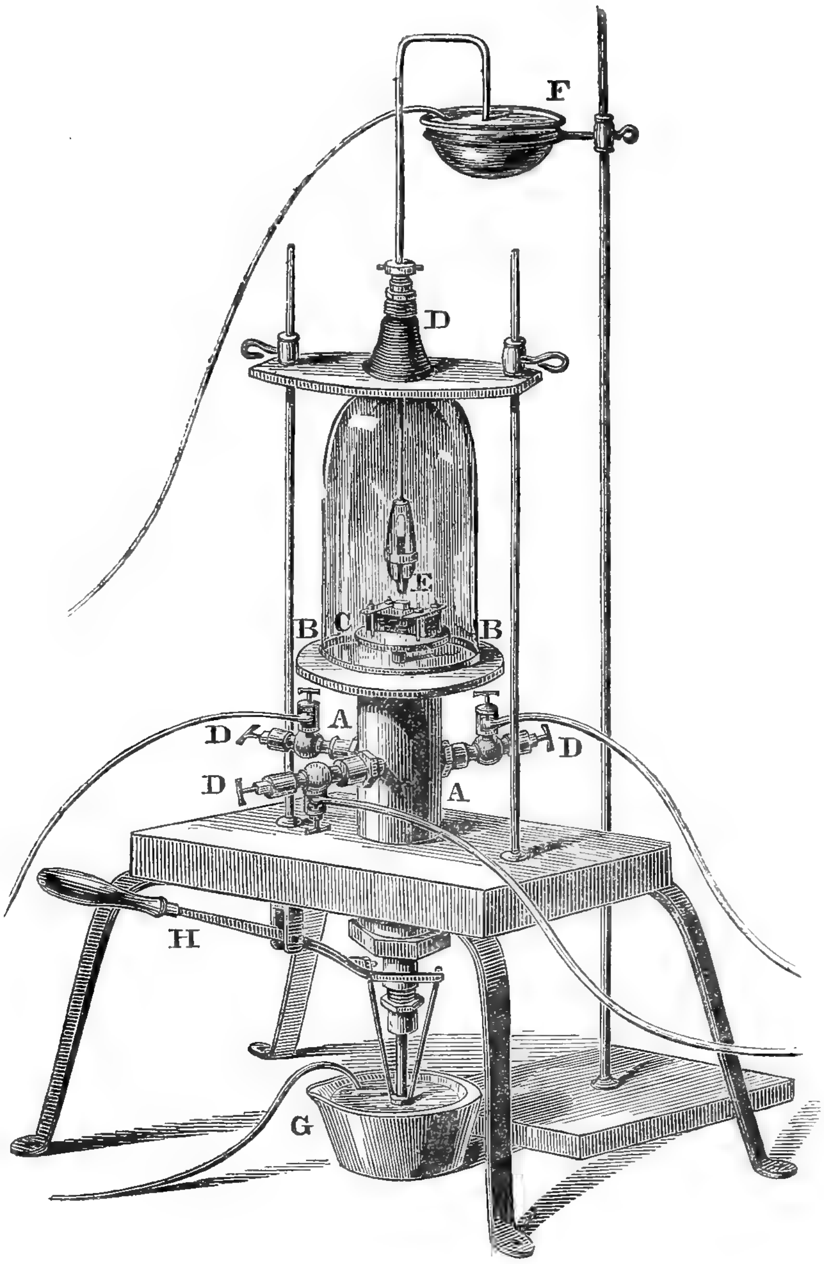
No.	Date.	Star.	No. Wires Obs.	Meridian Transit.	Clock's Rate.
	1838.			*h. m. s.*	*s.*
	Sep. 27	φ Sagittarii	2	18 35 34·74	+ 0·03
		σ Sagittarii	5	18 45 15·95	
1		Moon 1 L.	5	19 20 5·99	
		h² Sagittarii	5	19 26 53·60	
	29	ψ Capricorni	5	20 36 33·25	— 0·20
		η Capricorni	5	20 55 13·76	
2		Moon 1 L.	5	21 22 25·82	
		γ Capricorni	5	21 31 10·00	
		δ Capricorni	5	21 38 9·00	
	Oct. 1	σ Aquarii	5	22 22 7·00	+ 2·67
		λ Aquarii	5	22 44 12.66	
3		Moon 1 L.	5	23 16 50.16	
		κ' Piscium	3	23 18 40·76	
	27	γ Capricorni	3	21 30 58·45	— 1·39
4		Moon 1 L.	5	21 54 46·82	
	Nov. 13	α Virginis	3	13 16 9·56	— 1·25
5		Moon 2 L.	5	13 18 47·02	
	29	ν Arietis	5	2 28 47·57	— 1·37
6		Moon 1 L.	5	3 2 39·41	
	1839.				
	Jan. 23	ε Arietis	5	2 49 12·20	+ 0·01
7		Moon 1 L.	5	3 17 55·05	
		η Tauri	5	3 37 7·79	
		A' Tauri	5	3 54 22·77	
	24	η Tauri	5	3 37 5·59	— 1·62
		A' Tauri	5	3 54 21·73	
8		Moon 1 L.	5	4 19 0·49	
		τ Tauri	5	4 31 45·87	
		ι Tauri	5	4 52 39·11	
9	Feb. 19	Moon 1 L.	5	3 0 21·26	— 1·23
		α Tauri	5	4 26 37·56	
	21	υ' Tauri	5	4 16 34·31	— 1·21
		τ Tauri	3	4 32 28·74	
10		Moon 1 L.	5	5 3 48·69	
		C Tauri	5	5 43 6·49	
	Mar. 22	κ Aurigæ	3	6 5 22·23	+ 0·34
11		Moon 1 L.	5	6 50 28·78	

No.	Date.	Star.	No. Wires Obs.	Meridian Transit.	Clock's Rate.
				h. m. s.	*s.*
		δ Geminorum	5	7 10 45·96	
		α² Geminorum	5	7 24 35·15	
	Mar. 23	δ Geminorum	5	7 10 45·94	— 0·21
		α² Geminorum	5	7 24 34·63	
12		Moon 1 L.	5	7 50 2·50	
		6 Cancri	5	7 53 53 22	
		θ Cancri	5	8 22 40·66	
	24	ε Hydræ	5	8 38 30·62	— 0·21
13		Moon 1 L.	5	8 45 14·78	
		ξ Cancri	4	9 0 22·08	
	25	ξ Cancri	5	9 0 21.33	— 0·48
		q Cancri	5	9 10 15·26	
14		Moon 1 L.	5	9 36 11·14	
		ν Leonis	5	9 49 49·24	
		η Leonis	5	9 58 48·74	
	27	l Leonis	5	10 41 3·16	— 0·01
15		Moon 1 L.	5	11 8 27·28	
		σ Leonis	5	11 13 5·82	
		υ Leonis	5	11 28 58·36	
16	Apr. 18	Moon 1 L.	5	6 26 54·31	— 0·68
		ε Geminorum	5	6 34 15·87	
17	19	Moon 1 L.	5	7 29 32·63	— 0·55
		β Geminorum	5	7 35 41·67	
		ε Leonis	5	9 36 57·41	
	20	β Geminorum	5	7 35 41·11	— 0·51
18		Moon 1 L.	5	8 27 19·67	
		δ Cancri	5	8 35 45·88	
		ξ Cancri	5	9 0 20·15	
	21	δ Cancri	4	8 35 45·34	— 0.61
		ξ Cancri	5	9 0 19·31	
19		Moon 1 L.	5	9 20 8·66	
		λ Leonis	5	9 22 45·27	
		ψ Leonis	5	9 35 11·24	
	23	γ Leonis	5	10 11 19·48	+ 0·04
20		Moon 1 L.	5	10 54 16·36	
	24	χ Leonis	5	10 56 56·72	+ 0·04

No.	Date.	Star.	No. Wires Obs.	Meridian Transit.			Clock's Rate.
	1839.			h.	m.	s.	s.
	Apr. 24	τ Leonis	5	11	19	53·58	
21		Moon 1 L.	5	11	37	53·84	
		β Virginis	5	11	42	32·96	
		ο Virginis	5	11	57	14·78	
	25	β Virginis	5	11	42	31·76	— 0·48
		ο Virginis	5	11	57	14·50	
22		Moon 1 L.	5	12	20	47·18	
		γ' Virginis	5	12	33	44·80	
		ψ Virginis	5	12	46	13·48	
	26	γ' Virginis	5	12	33	44·12	— 0·61
		ψ Virginis	5	12	46	12·94	
23		Moon 1 L.	5	13	4	3·50	
		α Virginis	5	13	16	57·24	
	27	α Virginis	4	13	16	56·72	— 0·52
24		Moon 1 L.	5	13	48	43·38	
		λ Virginis	5	14	10	38·28	
	May 3	φ Sagittarii	5	18	35	50·47	+ 0·04
		σ Sagittarii	5	18	45	31·39	
25		Moon 2 L.	5	19	14	6·81	
		h² Sagittarii	5	19	27	8·29	
26	5	Moon 2 L.	5	21	7	42·83	— 0·46
		β Aquarii	5	21	23	16·84	
		δ Capricorni	4	21	38	21·01	
	25	κ Virginis	5	13	41	22·46	+ 0·10
27		Moon 1 L.	5	14	19	27·16	
		α² Libræ	5	14	42	13·10	
	26	α² Libræ	3	14	42	13·71	+ 0·35
28		Moon 1 L.	3	15	8	32·69	
29	June 20	Moon 1 L.	4	13	16	41·23	+ 0·87
		α Virginis	2	13	17	5·08	
	22	λ Virginis	5	14	10	48·94	+ 0·84
30		Moon 1 L.	5	14	50	7·45	
		20 Libræ	5	14	55	3·59	
		ι Libræ	5	15	3	27·28	
	24	σ Scorpii	5	16	11	51·93	+ 0·84
		α Scorpii	5	16	19	58·45	
31		Moon 1 L.	5	16	36	21·31	
		A Ophiuchi	5	17	5	53·13	
	25	A Ophiuchi	5	17	5	55·37	+ 1·54
32		Moon 1 L.	5	17	34	13·33	
		p Sagittarii	5	17	37	54·31	
		γ² Sagittarii	5	17	55	55·61	
	29	ψ Capricorni	5	20	37	3·51	+ 0·61
		ο Capricorni	5	20	57	23·82	
33		Moon 2 L.	5	21	28	3·44	
		δ Capricorni	5	21	38	38·98	
		ι Aquarii	5	21	58	15·46	
	July 1	λ Aquarii	5	22	44	42·82	+ 0·84
34		Moon 2 L.	5	23	11	45·66	
		κ' Piscium	2	23	19	10·63	
	4	β Arietis	5	1	46	15·96	+ 0·24
35		Moon 2 L.	4	1	47	49·96	
		α Arietis	5	1	58	37·07	
36	17	Moon 1 L.	5	12	58	52·92	+ 0·02
		α Virginis	5	13	17	19·76	
	18	α Virginis	5	13	17	18·66	— 0·84
	1839.			h.	m.	s.	s.
37		Moon 1 L.	5	13	43	42·36	
38	July 19	Moon 1 L.	5	14	30	35·26	+ 0·24
		α² Libræ	5	14	42	33·60	
		20 Libræ	2	14	55	15·14	
	22	α Scorpii	5	16	20	9·07	+ 0·24
		τ Scorpii	5	16	26	29·01	
39		Moon 1 L.	5	17	10	29·87	
		θ Ophiuchi	5	17	12	44·63	
		p Sagittarii	5	17	38	3·15	
40	23	Moon 1 L.	5	18	9	40·99	+ 0·53
		λ Sagittarii	5	18	18	40·05	
		σ Sagittarii	4	18	45	55·56	
	24	λ Sagittarii	4	18	18	40·00	— 0·21
		σ Sagittarii	5	18	45	54·63	
41		Moon 1 L.	5	19	9	43·19	
		χ' Sagittarii	5	19	16	6·67	
		h² Sagittarii	5	19	27	32·31	
	25	χ' Sagittarii	5	19	16	6·91	+ 0·28
		h² Sagittarii	5	19	27	32·81	
42		Moon 1 L.	5	20	8	52·49	
		π Capricorni	5	20	18	44·26	
		ψ Capricorni	5	20	37	11·65	
	28	θ Aquarii	4	22	8	58·31	+ 0·25
		σ Aquarii	5	22	22	45·38	
43		Moon 2 L.	5	22	55	8·38	
		φ Aquarii	5	23	6	36·90	
		κ' Piscium	4	23	19	18·32	
	31	δ Piscium	5	0	40	58·48	— 0·24
44		Moon 2 L.	5	1	31	10·60	
		ο Piscium	5	1	37	31·72	
		β Arietis	4	1	46	23·40	
45	Aug. 2	Moon 2 L.	5	3	26	48·49	— 0·17
		η Tauri	5	3	38	32·31	
	20	γ² Sagittarii	5	17	56	0·08	— 0·16
		δ Sagittarii	5	18	11	13·63	
46		Moon 1 L.	5	18	42	46·39	
		σ Sagittarii	5	18	45	49·07	
		τ Sagittarii	5	18	57	25·39	
	21	τ Sagittarii	5	18	57	24·96	— 0·43
47		Moon 1 L.	5	19	42	17·41	
		c Sagittarii	5	19	53	17·55	
		σ Capricorni	5	20	10	38·11	
	22	c Sagittarii	5	19	53	17·27	— 0·54
		σ Capricorni	5	20	10	37·30	
48		Moon 1 L.	5	20	40	31·75	
		η Capricorni	5	20	55	45·82	
		s Capricorni	5	21	7	21·50	
	23	η Capricorni	5	20	55	45·62	— 0·27
		s Capricorni	5	21	7	21·16	
49		Moon 1 L.	5	21	36	44·72	
		δ Capricorni	5	21	38	40·22	
		ι Aquarii	5	21	58	15·84	
	25	λ Aquarii	5	22	44	43·70	— 0·29
50		Moon 2 L.	5	23	26	8·32	
		λ Piscium	5	23	34	20·70	
		q Piscium	5	23	54	5·00	

III. *Observed Occultations of the Sun and Fixed Stars at Hudson Observatory.*

No.	Date.	Star.	Immersion. Sidereal Time.			Emersion. Sidereal Time.			Remarks.
	1838.		*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	
1	Sep. 18	Sun	14	27	26·70				Good observation.
2	Nov. 13	α Virginis	11	3	51·66				Good observation.
	1839.								
3	Apr. 19	c Geminorum	9	7	17·37	10	15	28·57	Immersion good; Emersion 1*s.* or 2*s.* late.
4	" 20	γ Cancri	12	0	9·36	12	48	5·16	Immersion, good observation.
5	July 6	b Peiadum				22	55	1·34	
6	" 6	d "	22	31	9·34	23	21	11·83	
7	" 6	η Tauri	23	1	1·34				Uncertain.



ARTICLE V.

Description of an Apparatus for Deflagrating Carburets, Phosphurets, or Cyanides, in Vacuo or in an Atmosphere of Hydrogen, with an account of some Results obtained by these and by other means; especially the Isolation of Calcium. By Robert Hare, M. D. Read October 18, 1839.

Upon a hollow cylinder of brass (A A) an extra air-pump plate (B B) is supported. The cylinder is furnished with three valve cocks, (D D D,) and terminates at the bottom in a stuffing-box, through which a copper rod slides so as to reach above the level of the air-pump plate. The end of the rod supports a small horizontal platform of sheet brass, which receives four upright screws. These, by pressure on brass bars extending from one to the other, are competent to secure upon the platform a parallelopiped of charcoal. Upon the air-pump plate a glass bell is supported, and so fitted to it, by grinding, as to be air-tight. The otherwise open neck of the bell is also closed air-tight by tying about it a caoutchouc bag, of which the lower part has been cut off, while into the neck a stuffing-box has been secured air-tight. Through the last mentioned stuffing-box a second rod passes, terminating within the bell in a kind of forceps, for holding an inverted cone of charcoal, (E.)

The upper end of this sliding rod is so recurved as to enter some mercury in a capsule, (F.) By these means and the elasticity of the caoutchouc bag, this rod has, to the requisite extent, perfect freedom of motion.

The lower rod descends into a capsule of mercury, (G,) being, in consequence, capable of a vertical motion, without breaking contact with the mercury. It is moved by the aid of a lever, (H,) connected with it by a stirrup working upon pivots.

Of course the capsules may be made to communicate severally with the poles of one or more deflagrators. The substance to be deflagrated is placed upon the charcoal forming the lower electrode, being afterwards covered by the bell, as represented in the figure. By means of the valve-cocks and leaden pipes a communication is made with a barometer gage; (see fifth volume of this work;) also with an air-pump, and with a large self-regulating reservoir of hydrogen.

The air being removed by the pump, a portion of hydrogen is admitted, and then withdrawn. This is repeated, and then the bell glass, after as complete exhaustion as the performance of the pump will render practicable, is prepared for the process of deflagration in vacuo. But, if preferred, evidently hydrogen or any other gas may be introduced from any convenient source by a due communication through flexible leaden pipes and valve-cocks.

Having described the apparatus, I will give an account of some experiments, made with its assistance, which, if they could have illuminated science as they did my lecture room, would have immortalized the operator. But, alas, we may be dazzled, and almost blinded by the light produced by the hydro-oxygen blow-pipe, or voltaic ignition, without being enabled to remove the darkness which hides the mysteries of nature from our intellectual vision.

I hope, nevertheless, that some of the results attained may not be unworthy of attention; and that, as a new mode of employing the voltaic circuit, my apparatus and mode of manipulation will be interesting to chemists.

An equivalent of quicklime, made with great care from pure crystallized spar, was well mingled, by trituration, with an equivalent and a half of bicyanide of mercury, and was then enclosed within a covered porcelain crucible. The crucible was included within an iron alembic, such as has been described by me, in this volume, as employed for the isolation of metallic radicals. (See page 38.)

The whole was exposed to heat approaching to redness. In two experiments the residual mass had such a weight as would result from the union of an equivalent of cyanogen with an equivalent of calcium.

A similar mixture being made, and, in like manner, enclosed in the crucible and alembic, it was subjected to a white heat. The apparatus being refrigerated, the residual mass was transferred to a dry glass phial with a ground stopper.

A portion of the compound thus obtained and preserved was placed upon the parallelopiped of charcoal, which was made to form the cathode of two deflagrators of one hundred pairs, each of one hundred square inches of zinc surface, co-operating as one series.

In the next place, the cavity of the bell-glass was filled with hydrogen, by the process already described, and the cone of charcoal being so connected with the positive end of the series as to be prepared to perform the office of an anode, was brought into contact with the compound to be deflagrated. These arrangements being accomplished, and the circuit completed by throwing the acid upon the plates, the most intense ignition took place.

The compound proved to be an excellent conductor; and during its deflagration emitted a most beautiful purple light, which was too vivid for more than a transient endurance by an eye unprotected by deep-coloured glasses. After the compound was adjudged to be sufficiently deflagrated, and time had been allowed for refrigeration, on lifting the receiver minute masses were found upon the coal, which had a metallic appearance, and which, when moistened, produced an effluvium, of which the smell was like that which had been observed to be generated by the silicuret of potassium.

Similar results had been attained by the deflagration, in a like manner, of a compound procured by passing cyanogen over quicklime, enclosed in a porcelain tube, heated to incandescence.*

Phosphuret of calcium, when carefully prepared, and, subsequently, well heated, was found to be an excellent conductor of the voltaic current evolved from the apparatus above mentioned. Hence it was thought expedient to expose it in the circuit of the deflagrator, both in an atmosphere of hydrogen and in vacuo. The volatilization of phosphorus was so copious as to coat nearly all the inner surface of the bell-glass with an opake film, in colour resembling that of the oxide of phosphorus, generated by exposing this substance under hot water to a current of oxygen.†

The phosphuret at first contracted in bulk, and finally was, for the most part, volatilized. On the surface of the charcoal, adjoining the cavity in which the phosphuret had been deflagrated, there was a light pulverulent matter, which, thrown into water, effervesced, and, when rubbed upon a porcelain tile, appeared to contain metallic spangles, which were oxydized by the consequent exposure to atmospheric oxygen.

In one of my experiments with the apparatus above described, portions of the carbon forming the anode appeared to have undergone complete fusion, and to have dropped in globules upon the cathode. When rubbed, these globules had the colour and lustre of plumbago, and, by friction on paper, left traces resembling those produced by that substance. They were susceptible

* After the above mentioned experiments were made, I was led to believe that the compound, obtained as above described by heating lime with bicyanide of mercury, contained fulminic acid, or an analogous substance. The mass being dissolved in acetic acid, and the filtered solution subjected to nitrate of mercury, a copious white precipitate resulted. This, being desiccated, proved to be a fulminating powder. It exploded, between a hammer and anvil, with the sharp sound of fulminating silver.

† The compound usually designated as the phosphuret of calcium consists, according to Thomson, of one atom of phosphate of lime, as well as two atoms of pure phosphuret. Hence it is easy to see that the oxygen which enters into the constitution of the oxide, deposited, as above mentioned, upon the interior surface of the bell-glass, is derived from the phosphate.

of reaction neither with chloro-hydric nor with nitric acid, neither separately nor when mixed. They were not in the slightest degree magnetic.

About 1822, Professor Silliman obtained globules, which were at first considered as fused carbon, but were subsequently found to be depositions of that substance transferred from one electrode to the other. Several of these globules were, by him, sent to me for examination, of which none, agreeably to my recollection, appeared so much like products of fusion as those lately obtained.

Formerly plumbago was considered as a carburet of iron, but latterly, agreeably to the high authority of Berzelius, has been viewed as carbon holding iron in a state of mixture, not in that of chemical combination. It would not, then, be surprising if the globules which I obtained consisted of carbon converted from the state of charcoal into that of plumbago.

ARTICLE VI.

Upon a new Compound of the Deuto-Chloride of Platinum, Nitric Oxide, and Chloro-hydric Acid. By Henry D. Rogers, Professor of Geology in the University of Pennsylvania, and Martin H. Boyè, Graduate of the University of Copenhagen. Read November 1, 1839.

1. When platinum is dissolved in an excess of nitro-muriatic acid, and the solution is slowly evaporated, a yellow powder may sometimes be seen gradually to collect. The nature and properties of this substance we propose to describe in the following paper.

Mode of Preparation.

2. The method by which we succeeded in obtaining the compound referred to in quantities sufficient for the investigation of its properties and composition is as follows:—A solution of chloride of platinum, procured in the ordinary way, is evaporated, at a rather low temperature, in a porcelain capsule, nearly to dryness. When it has reached this point, *aqua regea,* freshly prepared from concentrated hydro-chloric and nitric acids, containing an excess of the former, is added in small portions, the mixture being continually stirred with a glass rod. Nitric oxide gas is given off in thick fumes, and the mixture, which is now perfectly liquid, is allowed again to evaporate for some time, during which, chlorine gas is evolved in numerous small bubbles. It is then transferred to a glass vessel and cold water added drop by drop, the whole being continually stirred while it is cooling. If these steps be properly performed, a yellow pow-

der, sometimes possessing a crystalline texture, is seen to precipitate.* Should the solution, when transferred to the glass vessel, show a tendency to pass too rapidly to the solid state, the best remedy is to heat it again on the sand bath, when it will be again liquefied.

3. When the powder has separated, and is fully settled, the liquor is to be decanted and again evaporated nearly to dryness, and the other steps of the process just described repeated. The several parcels of the precipitate thus procured are added together, and the mass filtered and pressed between bibulous paper, to free it as completely as possible from the mother liquid. Still more effectually to dry it, it is exposed, under an exhausted receiver, to the desiccating agency of sulphuric acid.

Description and Properties of the Salt.

4. When prepared according to the process above described, the precipitate has the form of a yellow powder, often minutely crystalline, and has a considerable resemblance to the chloro-platinates of potassium and ammonium. It absorbs water quickly from the atmosphere with deliquescence, undergoing decomposition at the same time. In a close vessel it may be preserved for any length of time without decomposition.

5. When water is added, an active effervescence takes place, with disengagement of nitric oxide gas. That the gas thus extricated is pure nitric oxide is proved by its giving no precipitate with a solution of nitrate of silver, and by its being entirely absorbed by a solution of sulphate of protoxide of iron. The solution which remains after the disengagement of the nitric oxide gas is acid; it does not smell of chlorine, and gives copious precipitates with nitrate of silver and chloride of potassium.

6. Alcohol, hydro-chloric acid, and a solution of chloride of sodium, when added to the salt, act upon it as pure water does, extricating the nitric oxide and dissolving the chloride of platinum. A saturated solution of chloride of platinum has no action on it.

7. Before we had estimated the quantity of chlorine in the salt, we did not suppose any hydro-chloric acid essential to its constitution, attributing the acid

* An addition of too much water will redissolve it.

reaction to nitrous acid, imagined to have been derived from the nitrous oxide. But the following experiment settled this point. A portion of the salt was introduced into a small tubulated retort. Cold water, recently boiled to free it from atmospheric air, was added to it, until all the nitric oxide was disengaged. A concentrated solution of fused chloride of potassium was next added, and the whole distilled nearly to dryness. The product of this distillation was a colourless liquid, first slightly acidulated, but becoming afterwards strongly acid. It precipitated nitrate of silver very copiously, and left, when evaporated, no residuum. At no period of the process could any free chlorine be noticed.

8. Heated in an atmosphere of dry hydrogen, the salt first gives off water, and afterwards a white sublimate of chloride of ammonium, in accordance with the fact that hydrogen and nitric oxide gas, in contact with heated spongy platinum, form ammonia, which, in this case, combines with the hydro-chloric acid, and forms chloride of ammonium. The reduced platinum is black, much resembling, in appearance, the preparation of *Liebig*. It ignites hydrogen, and assumes a metallic appearance when rubbed upon a burnisher.

9. Heated by itself in a closed vessel it also gives off a great amount of water.

Analysis of the Salt.

10. A portion of the salt was prepared by the foregoing process, and left to dry for several days over sulphuric acid *in vacuo*. It was then promptly introduced into a small glass tube, sealed at its lower end. This tube was inserted into a vessel of boiling water. Its upper end was closed by a cork, through which were fitted two small bent glass tubes, the one connected with a tube of chloride of calcium, and reaching nearly to the salt, the other connected with the air-pump. By this arrangement a current of dry air could be passed over it, while the water surrounding the tube was kept boiling. A quantity, 1.677.5 grammes, of the salt was subjected for half an hour to this process, and lost only 0.002 grammes, or about one-tenth of one per cent.; evidently proving that *the salt parts with all its moisture in vacuo at ordinary temperatures.* A correction for this amount of water was made in calculating the results of the subsequent experiments.

11. The same portion of the salt was then decomposed by the introduction of water, and an alcoholic solution of chloride of potassium added. The chlo-

ro-platinate of potassium thus precipitated was collected on a weighed filter, and washed with moderately concentrated alcohol, dried at 212° Farhenheit, and its weight ascertained. The 1.701 grammes thus obtained is equivalent to 0.6875 grammes of platinum, *giving* 41.08 *per cent. of metallic platinum in the salt.*

12. Another quantity, 1.502 grammes of the dried salt was next decomposed by water, evaporated to dryness, and ignited in a porcelain crucible. This yielded *platinum* 0.603, *or* 40.19 *per cent.*

13. Another portion, 1.580 grammes of the salt was introduced into a small glass tube, sealed at its lower end, and heated over a spirit lamp (Berzelius's) until it became brightly red hot, and all volatile matters were effectually driven out of the tube. This left, of *platinum,* 0.655 *grammes, or* 41.51 *per cent.*

14. In order to estimate the quantity of *nitric oxide,* a graduated tube was filled with mercury and inverted over the mercurial cistern. A small quantity of the salt was then weighed and promptly enveloped, as tightly as possible, in blotting-paper. This was then passed up, by aid of a fine copper wire, into the tube, and a small portion of water, previously deprived of air, was also introduced. A little care in the manipulation enabled the pellet containing the salt to be kept in contact with the water. The quantity of gas thus extricated was shown upon the graduation of the tube, care being taken to preserve the mercury at the same level inside and outside.

15. Adopting this method, 0.7875 grammes of the salt gave 33.2 cubic centimetres of nitric oxide gas, at 82.25° Far. The barometric pressure being 29.46 inches at 80° Far. Applying the proper reductions for pressure, temperature, and moisture, this gives 28.37 cubic centimetres, equivalent, in weight, to 0.0382 *grammes, or* 4.86 *per cent. of nitric oxide gas.*

16. By another experiment, 1.028 grammes yielded 44.5 cubic centimetres of nitric oxide gas, at a temperature of 79° Far., and barometric pressure of 29.81 inches at 81° Far. The proper reductions for pressure, temperature, and moisture being made, there resulted 38.81 cubic centimetres of the gas, equivalent, in weight, to 0.0524 grammes, or 5.09 *per cent.*

17. With a view to estimate, in the next place, the quantity of the *chlorine,* 1.5275 grammes of the salt were introduced into a platinum crucible, and a sufficient proportion of carbonate of potassa and water added. It was then carefully evaporated to dryness, and ignited; after which it was repeatedly

edulcorated, first with boiling water, and afterwards with diluted nitric acid. The filtered solutions thus derived being saturated to excess with nitric acid, were precipitated by nitrate of silver, and the chloride of silver collected on a filter, washed, dried, and heated to fusion, (the proper precautions with the filter being observed,) when it was weighed. The amount thus obtained was 2.679 grammes, equivalent to 0.661 grammes of *chlorine, or* 43.32 *per cent.*

18. The platinum obtained by this process was also collected on a filter, ignited and weighed, giving 0.628 *grammes, or* 41.16 *per cent.*

19. As 41.16 platinum requires 29.55 chlorine, to form the deuto-chloride of platinum, and as the quantity obtained, namely, 43.32 per cent., is nearly one and a half times 29.55, it is evident that the *chlorine* in the salt under examination *exists in the proportion of* 3 *atoms to* 1 *atom of platinum.*

It is obvious, also, from a previous experiment (7) that this one atom of chlorine must exist in union with hydrogen as chloro-hydric acid. We, therefore, show, *that for each atom of deuto-chloride of platinum, the salt contains one atom of chloro-hydric acid.*

20. Another portion of the salt, 1.2976 grammes, being introduced into a weighed platinum crucible, and there mingled with an adequate quantity of carbonate of potassa, a thin stratum of which should cover the mixture, it was fused, the crucible being covered. It was then edulcorated with boiling water and dilute nitric acid, and was otherwise treated as in the previous experiment, (17 and 18.) Thus operated upon, it furnished 2.336 grammes of chloride of silver, equivalent to 0.5763 *grammes of chlorine, or* 44.46 *per cent.*

21. The platinum obtained by this experiment weighed 0.549 *grammes, or* 42.36 *per cent.*

22. As 42.36 of platinum requires 30.41 of chlorine to form the deuto-chloride, and as 44.46 per cent. is nearly one and a half times 30.41, it is not less plain from this experiment than from that already recorded, (17, 18, 19,) that the chlorine exists in the proportion of three atoms to one atom of the platinum in the salt.

Summary.

23. Making a summary of the foregoing several experiments, we find that the *per centage of the platinum*,

By experiment 11, is	. . . .	41.08
" 12, "	. . . .	40.19
" 13, "	. . . .	41.51
" 18, "	. . . .	41.16
" 21, "	. . . .	42.36
		5)206.30
Giving, as a mean,	. . . .	41.26

24. The per centage of the *chlorine*,

By experiment 17, is	. . . .	43.32
" 20, "	. . . .	44.46
		2)87.78
Giving, as a mean,	. . . .	43.89

25. The per centage of the *nitric oxide gas*,

By experiment 15, is	. . . .	4.86
" 16, "	. . . .	5.09
		2)9.95
Giving, as a mean,	. . . .	4.98

26. The platinum and the chlorine have already been shown (19 and 22) to exist in the salt in the proportion of one atom to three atoms. But, of the three atoms of chlorine, two go to form one atom of the deuto-chloride of platinum, while the remaining one atom, united with one atom of hydrogen, exists in the form of hydro-chloric acid.

27. The platinum and the nitric oxide are present, as we have shown, (23 and 25,) in the proportion of 41.26 to 4.98. These numbers, divided by the atomic weights of their respective substances, will give the relative numbers of the atoms of these ingredients in the salt.

Thus the platinum $\frac{41.26}{1233.5} = 3.345$

Nitric oxide, $\frac{4.98}{377.04} = 1.321$

But, $3345:1321 = 5:2$

Therefore, for every five atoms of platinum, or deuto-chloride of platinum in the salt, with their corresponding five atoms of chloro-hydric acid, we have two atoms of nitric oxide.

28. We have no *direct* results establishing the proportion of the *chemically combined water* in the salt. But, estimating it from the data furnished by experiments 16, 20, and 21, made at the same time and with complete success, it would amount to 7.66 *per cent.*, or two atoms of water for every atom of deuto-chloride of platinum.

29. Throwing these results into the shape of a formula, we have the following convenient expression for its chemical composition.

$$\left(Pt\,Cl^2\right)^5 + \left((Cl\,H)^5 + (N\,O^2)^2\right) + Aq.$$

By this formula the compound is regarded as a simple chloride of platinum united with a muriate of nitric oxide.

Should we, on the other hand, deny the existence of muriates altogether, we may consider it, in accordance with the enlarged views of Dr. Hare on the Constitution of Salts, and the convenient systematic nomenclature by which he expresses their composition,* as a chloro-salt, consisting of a chloro-acid (chloride of platinum, or chloro-platinic acid,) and two chloro-bases. Thus viewed, it would be a chloro-platinate of nitrogen with a chloro-platinate of hydrogen, and expressed by the following formula:—

$$\left[(Pt\,Cl^2)^2 + N\,Cl^2\right]^2 + \left[Pt\,Cl^2 + H\,Cl\right] + Aq^{14}.$$

* American Journal of Pharmacy, Vol. iii. No. 1.

The proportions of the several constituents of the salt, as respectively calculated, in accordance with one of the above formulæ, and as derived from our experiments, will stand as follows:—

	By Exper.	No. of At.	By Calculation.
Platinum,	41.26	5	41.82
Chlorine,	43.89	15	45.01
Hydrogen,	.42	5	.43
Nitric Oxide,	4.98	2	5.11
Water,	7.66	10	7.63
	98.21		100.00

The agreement here exhibited is as close as could be expected when we advert to the complicated nature of the salt, and the difficulties which attend its preparation and analysis.

In conclusion, we may be allowed to hope that the compound here described may cast some light on the chemical nature of *aqua regia*, and on the question of its mode of action in dissolving the metals.

NOTE.—Since the above article was read, we have received *Poggendorf's Annalen*, vol. xlvii., containing an interesting paper by H. Rose, of Berlin, in which he has shown that anhydrous sulphuric acid absorbs nitric oxide, forming a neutral sulphate, in which the oxygen in the sulphuric acid is three times that in the nitric oxide. From this he infers that the nitric oxide acts the part of a true base; a conclusion to which we have arrived in the present paper, where we regard the compound examined by us as a double salt, in which nitric oxide is one of the bases. The compound described by Rose is decomposed by water in exactly the same manner as that here investigated.

ARTICLE VII.

On the Longitude of Several Places in the United States, as deduced from the Observations of the Solar Eclipse of September 18*th*, 1838. *By E. Otis Kendall, Professor of Mathematics in the Central High School of Philadelphia. Read November* 1, 1839.

This eclipse was observed at the following places:—

	Latitude.			Longitude. From Greenwich.		
				h.	*m.*	*s.*
Hudson Obs'y, Western Reserve College, Ohio, .	+ 41°	14′	37″	— 5	25	47·5
Alexandria, D. C., ...	+ 38	49	0	— 5	8	16·0
Washington, Capitol, ...	+ 38	53	23	— 5	8	6·0
Haverford School, Delaware County, Pa., . . .	+ 40	1	12	— 5	1	15·0
Philadelphia, State House, ...	+ 39	56	58	— 5	0	39·0
Germantown, Pa., C. Wister's private Observatory,	+ 40	1	59	— 5	0	41·9
Burlington, N. J., S. Gummere's School, . . .	+ 40	5	10	— 4	59	30·1
Princeton, N. J., Nassau Hall, ...	+ 40	19	56	— 4	58	38·3
Weasel Mountain, N. J., Station of Coast Survey,	+ 40	52	35	— 4	57	25·7
New Haven, Yale College, ...	+ 41	17	58	— 4	51	47·5
Southwick, Mass., A. Holcomb's private Obs'y, .	+ 42	0	41	— 4	51	16·0
Wesleyan University, Conn., ...	+ 41	33	8	— 4	50	2·0
Williamstown College, Mass.	+ 42	42	44	— 4	52	52·0
Dorchester Observatory, Mass., ...	+ 42	19	11·5	— 4	44	17·3
Dover, Tuscarora County, Ohio, ...	+ 40	30	52	— 5	25	56·2
Brooklyn, N. Y., E. Blunt's private Obs'y, . . .	+ 40	42	0	— 4	56	0·0

When there were more observers than one at the same place, I have taken the mean of all the observations, giving to each its proper weight. In Philadelphia it was observed by several persons, in different parts of the city. The following table contains a list of the Philadelphia observations, with the differences of latitude and longitude between the places of observation and the State House, which has been already published in the Proceedings of the Society, vol. I. p. 36.

Observer.	Latitude, + North, — South of State House.	Longitude, + East, — West of State House.	Beginning.	Formation of Ring.	Rupture of Ring.	End.
			h. m. 3 13	*h. m.* 4 31	*h. m.* 4 35	*h. m.* 5 45
		s.			*s.*	
E. J. Bean	+ 70″·0	— 1·70			28·4	
Wm. Penn Cresson	+ 1 ·8	— 5·20			27·8	
			s.			*s.*
Prof. W. R. Johnson	+ 1 ·8	— 5·20	10·7		23·5	12·2
				s.		
George M. Justice	+ 10 ·0	— 2·86	7·4	12·8	27·3	11·3
E. O. Kendall	+ 10 ·0	— 2·86	8·3	10·9	28·4	12·9
Joseph Knox	+ 21 ·0	+ 1·39	12·8			
Isaiah Lukens	+ 9 ·0	— 0·86		21·7		
Thomas M'Euen	— 0 ·4	— 2·33	3·0	18·1	29·1	13·2
Prof. Roswell Park	+ 6 ·5	— 1·30		19·1	29·1	
Dr. R. M. Patterson	+ 1 ·1	— 1·20	7·0	19·1	30·1	16·1
Wm. H. C. Riggs	— 0 ·4	— 2·33	7·3	16·3	29·4	7·8
Samuel Sellers	+ 7 ·5	— 0·05	6·0	16·0	31·0	16·0
Tobias Wagner	+ 10 ·0	— 2·86	6·1			
Sears C. Walker	+ 10 ·0	— 2·86	5·6	15·6	28·0	13·0
William Young	— 21 ·0	+ 1·39		12·9		15·0

It was considered most convenient to reduce the above local times to the State House, which has been done by means of the formulæ in the Journal of the Franklin Institute, vol. xx. p. 125, by which I have deduced the following values of the variation of the local time of the several phases for a small difference of terrestrial latitude or longitude.

	Beginning.	Ring.	End.
Variation for + or North 1″ of terr. lat. . . .	= — 0.0397	— 0.0382	— 0.0343
" + or East 1*s*. of terr. lon. in time .	= + 1.2600	+ 1.1400	+ 0.9925

Applying these values, and taking means after giving due weight to each observation, the results for the State House are obtained as stated below.

The method used in making these reductions is that of Bessel. Astr. Nach. No. 321. The sun's semi-diameter there given has been employed; the other elements have been taken from the Nautical Almanac. Bessel's semi-diameter of the sun is less than that of the Nautical Almanac by 1″.112. I have computed the following co-ordinates for this eclipse, and would remark that the reduction of future observations of solar eclipses will be much facilitated by the publication of these co-ordinates in the Berliner Jahrbuch since 1839.

Mean Time. Greenwich.	α	δ	π	α'	δ'	$log\ r$
h.	h. m. s.			h. m. s.		
7	11 41 33.74	+ 2° 57′ 14″·9	53′ 53″·78	11 43 3·48	+ 1° 50′ 10″·5	0·0017425
8	43 17·49	2 43 4 ·6	·67	12·46	49 12 ·3	375
9	45 1·79	2 28 53 ·9	·56	21·44	48 14 ·0	325
10	46 45·75	2 14 42 ·6	·47	30·42	47 15 ·7	275
11	48 29·67	2 0 31 ·0	·38	39·40	46 17 ·4	224
12	50 13·55	1 46 19 ·0	·30	48·38	45 19 ·2	174

Mean Time. Greenwich.	a	d	$log\ g$	x	y	$log\ z$
h.	h. m. s.					
7	11 43 3·72	+ 1° 49′ 59″·8	9·9988515	— 0·4168225	+ 1·2478116	1·8046400
8	12·45	49 3 ·7	512	+ 0·0247623	+ 1·0022355	6936
9	21·17	48 7 ·5	510	+ 0·4663195	+ 0·7566013	7198
10	29·90	47 11 ·3	511	+ 0.9078406	+ 0·5109066	7162
11	38·63	46 15 ·1	511	+ 1·3492845	+ 0·2651588	6852
12	47·36	45 19 ·0	513	+ 1·7906058	+ 0·0193279	6258

Mean Time. Greenwich.	l	$log\ i$	l'	$log\ i'$
h.				
7	0·5695708	7·6682157	0·0231215	7·6661003
8	6110	2210	1615	1056
9	6326	2262	1831	1108
10	6334	2311	1839	1157
11	6150	2362	1662	1208
12	5782	2410	1291	1256

$T = 9^h$			$T = 10^h$		
$p = +\ 0{\cdot}4663195$ $q = +\ 0{\cdot}7566013$			$p = +\ 0{\cdot}9078406$ $q = +\ 0{\cdot}5109066$		
T'	N	$log\ \frac{S}{n}$	T'	N	$log\ \frac{S}{n}$
— 2^h	119° 4′ 59″·4	3·8527713	— 2^h	119° 5′ 26″·7	3·8527704
— 1	5 12 ·4	7696	— 1	5 41 ·1	7713
0	5 26 ·1	7672	0	5 56 ·2	7846
+ 1	5 41 ·1	7713	+ 1	6 15 ·4	8071
+ 2	5 58 ·3	7893	+ 2	6 42 ·3	8358

Then, according to Bessel, calling d the longitude + East, — West of Greenwich, we have

$$d = d' + a\varepsilon + b\zeta + c\eta$$

Where

d' = the resulting longitude, uncorrected for the errors of the tables
ε = the correction of the tabular place of the moon on its orbit
ζ = " " " on a perpendicular to its orbit
η = " " sum of the semi-diameters of the sun and moon
η' = " " difference " "

With these elements and co-ordinates I have computed the following values of d' and the co-efficients a, b, c, assuming the ellipticity of the earth to be 0.00324.

Place of Observation and Observer.	Mean Time of Observation.	d'	a	b	c	d
	h. m. s.	*h. m. s.*				*h. m. s.*
Western Reserve Coll. *Prof. Loomis.*	B. 2 38 17·02	— 5 25 3·59	+ 2·203	— 0·355	+ 2·232	— 5 25 40·70
	E. not observed					
Dover, Ohio, *J. Blickensderfer.*	B. 2 39 38·82	— 5 25 15·71	+ 2·203	— 0·372	+ 2·235	— 5 25 52·71
	F. R. 4 0 25·71	20·28	+ 2·204	— 0·848	+ 2·361	45·44
	R. R. 4 6 9·63	23·67	+ 2·204	+ 0·302	— 2·224	59·60
	E. 5 18 3·64	35·04	+ 2·204	— 0·151	— 2·209	59·45
Alexandria, D. C., *B. Hallowell.*	B. 3 5 52·00	— 5 7 46.94	+ 2·203	— 0·298	+ 2·223	— 5 8 24·44
	F. R. 4 24 6·0	7 58·40	+ 2·204	— 0·093	+ 2·205	29·16
	R. R. 4 30 13·0	7 45·26	+ 2·204	— 0·345	— 2·229	16·46
	E. 5 39 25·0	8 14·22	+ 2·204	— 0·131	— 2·208	38·79
Washington Capitol, *R. T. Paine and Lieut. Gillis, U. S. N.*	B. 3 6 9·23	— 5 7 25·73	+ 2·203	— 0·294	+ 2·223	— 5 8 3·25
	F. R. 4 24 27·61	31·39	+ 2·204	— 0·014	+ 2·204	2·72
	R. R. 4 30 18·05	31·96	+ 2·204	— 0·405	— 2·240	2·73
	E. 5 39 54·76	37·42	+ 2·204	— 0·134	— 2·208	1·96
Haverford School, Pa., *J. Gummere & S. J. Gummere.*	B. 3 12 17·59	— 5 0 34·07	+ 2·203	— 0·231	+ 2·216	— 5 1 12·03
	F. R. 4 30 29·63	32·43	+ 2·204	+ 1·412	+ 2·617	13·98
	R. R. 4 34 44·80	53·95	+ 2·204	— 1·961	— 2·949	13·71
	E. 5 44 28·24	53·43	+ 2·204	— 0·165	— 2·210	17·73
Philadelphia, State House, *Several Observers.*	B. 3 13 10·06	— 4 59 59·81	+ 2·203	— 0·229	+ 2·215	— 5 0 37·79
	F. R. 4 31 18·76	— 4 59 57·12	+ 2·204	+ 1·420	+ 2·621	38·72
	R. R. 4 35 31·35	— 5 0 20·44	+ 2·204	— 1·965	— 2·952	40·16
	E. 5 45 15·46	— 5 0 15·01	+ 2·204	— 0·164	— 2·210	39·32
Germantown, Pa., *Charles Wister & Casper E. Wister.*	B. 3 12 54·9	— 5 0 3·00	+ 2·203	— 0·228	+ 2·215	— 5 0 40·99
	F. R. 4 31 8·9	— 4 59 58·59	+ 2·204	+ 1·501	+ 2·665	40·75
	R. R. 4 35 18·4	— 5 0 19·83	+ 2·204	— 2·070	— 3·023	38·83
	E. 5 45 7·9	— 5 0 12·56	+ 2·204	— 0·166	— 2·210	36·06
Burlington, N. J., *Prof. Hamilton.*	B. 3 14 23·7	— 4 58 46·65	+ 2·203	— 0·220	+ 2·214	— 4 59 24·69
	F. R. 4 32 32·6	58 45·13	+ 2·204	+ 1·743	+ 2·810	28·99
	R. R. 4 36 19·6	59 12·50	+ 2·204	— 2·350	— 3·222	29·55
	E. 5 46 8·5	59 6·07	+ 2·204	— 0·168	— 2·210	30·35

Place of Observation and Observer.	Mean Time of Observation.	d'	a	b	c	d
	h. m. s.	*h. m. s.*				*h. m. s.*
Princeton, N. J., *Profs. Henry & Alexander.*	B. 3 14 43·01	— 4 58 5·27	+ 2·203	— 0·167	+ 2·213	— 4 58 43·69
	F. R. 4 33 11·27	57 56·31	+ 2·204	+ 2·245	+ 3·146	43·68
	R. R. not observed					
	E. 5 46 38·89	58 6·47	+ 2·204	— 0·174	— 2·210	30·70
Weasel Mountain, N. J. *F. R. Hassler.*	B. 3 15 56·98	— 4 56 8·50	+ 2·203	— 0·189	+ 2·211	— 4 56 46·75
	F. R. 4 35 57·09	55 29·15	+ 2·204	+ 6·875	+ 7·220	48·26
	R. R. 4 35 58·09	57 3·33	+ 2·204	— 6·912	— 7·255	49·10
	E. 5 47 13·10	56 27·21	+ 2·204	— 0·187	— 2·213	51·34
Brooklyn Obs'y, N. Y., *E. Blunt.*	B. 3 17 18·80	— 4 55 21·76	+ 2·203	— 0·189	+ 2·211	— 4 56 0·02
	F. R. 4 36 47·30	54 52·24	+ 2·204	+ 5·329	+ 5.766	0·80
	R. R. not observed					
	E. 5 48 23·63	55 38·15	+ 2·204	— 0·184	— 2·211	2·31
New Haven, *Prof. Olmsted, E. P. Mason, & H. L. Smith.*	B. 3 21 14·47	— 4 51 9·15	+ 2·203	— 0·155	+ 2·209	— 4 51 47·65
	E.* 5 51 17·00	32·78	+ 2.204	— 0·199	— 2·213	56·82
Southwick, Mass., *A. Holcomb.*	B. 3 20 19·0	— 4 50 38·31	+ 2·203	— 0·139	+ 2·208	— 4 51 16·92
	E. 5 50 27·0	56·24	+ 2·204	— 0·215	— 2·214	20·16
Wesleyan Univ., Conn., *Prof. A. A. Smith.*	B. 3 22 0·81	— 4 50 5·04	+ 2·203	— 0·145	+ 2·208	— 4 50 43·62
	E. 5 52 1·46	17·74	+ 2·204	— 0·205	— 2·213	41·73
Williamstown Coll., *Prof. Hopkins.*	B. 3 17 19·9	— 4 51 48·27	+ 2·203	— 0·132	+ 2·206	— 4 52 26·93
	E. not observed					
Dorchester, Mass., *W. C. Bond.*	B. 3 28 10·9	— 4 43 44·01	+ 2·203	— 0·099	+ 2·206	— 4 44 22·76
	E. not observed					

From the duration of the ring the following values of ζ were obtained:

At Dover, ... $\zeta^{(i)} = + 2{\cdot}948 + 3{\cdot}987 \times \eta'$

Alexandria, . . . $\zeta^{(ii)} = + 52{\cdot}140 - 17{\cdot}600 \times \eta'$

Washington, . . . $\zeta^{(iii)} = - 1{\cdot}457 - 11{\cdot}370 \times \eta'$

Haverford, . . . $\zeta^{(iv)} = - 6{\cdot}380 - 1{\cdot}650 \times \eta'$

Philadelphia, . . . $\zeta^{(v)} = - 6{\cdot}893 - 1{\cdot}646 \times \eta'$

Germantown, . . $\zeta^{(vi)} = - 5{\cdot}944 - 1{\cdot}592 \times \eta'$

Burlington, . . . $\zeta^{(vii)} = - 6.688 - 1{\cdot}473 \times \eta'$

Weasel Mountain, . $\zeta^{(viii)} = - 6{\cdot}831 - 1{\cdot}050 \times \eta'$

The mean of the five last equations gives,

$$\zeta = - 6{\cdot}547 - 1{\cdot}482 \times \eta'$$

And from the equation for Washington,

$$\eta' = + 0{\cdot}515$$

$$\text{Whence } \zeta = - 7{\cdot}310$$

* It was found necessary to subtract one minute from the time of end as given by Messrs. Olmsted, Mason and Smith.

With the above value of ζ, the duration of the eclipse furnished for the value of η,

At Princeton, ...	$\eta^{(i)}$	$= -\,0{\cdot}261 - 0{\cdot}056 \times \eta'$
Germantown, ...	$\eta^{(ii)}$	$= -\,2{\cdot}255 - 0{\cdot}053 \times \eta'$
Williamstown, . .	$\eta^{(iii)}$	$= -\,2.875 - 0{\cdot}022 \times \eta'$
Washington, ...	$\eta^{(iv)}$	$= -\,2{\cdot}798 - 0{\cdot}022 \times \eta'$
Philadelphia, ...	$\eta^{(v)}$	$= -\,3{\cdot}534 - 0{\cdot}022 \times \eta'$
Southwick, ...	$\eta^{(vi)}$	$= -\,3{\cdot}941 - 0{\cdot}017 \times \eta'$
Weasel Mountain, .	$\eta^{(vii)}$	$= -\,4{\cdot}232 + 0{\cdot}002 \times \eta'$
Burlington, ...	$\eta^{(viii)}$	$= -\,4{\cdot}468 - 0{\cdot}001 \times \eta'$
Haverford, ...	$\eta^{(ix)}$	$= -\,4{\cdot}472 + 0{\cdot}015 \times \eta'$
Dover, ...	$\eta^{(x)}$	$= -\,4{\cdot}675 - 0{\cdot}074 \times \eta'$
New Haven, ...	$\eta^{(xi)}$	$= -\,5{\cdot}409 + 0{\cdot}021 \times \eta'$
Alexandria, ...	$\eta^{(xii)}$	$= -\,6{\cdot}403 + 0{\cdot}025 \times \eta'$
Mean of the twelve equations, . .	η	$= -\,3{\cdot}760 - 0{\cdot}017 \times \eta'$
Mean of first six, " . .	η	$= -\,2{\cdot}611 - 0{\cdot}032 \times \eta'$
Mean of two means, ...	η	$= -\,3{\cdot}185 - 0{\cdot}025 \times \eta'$

Whence $\eta = -\,3{\cdot}198$

Applying these values of ζ, η, η' to the equations derived from the Philadelphia observations, and assuming d equal to $-\,5h.\ 0m.\ 39{\cdot}00s.$, we have

$$\varepsilon = \frac{d - d' - b\,\zeta - c\,\eta}{a} = -\frac{32{\cdot}\,571}{2{\cdot}2035} = -\,14{\cdot}782$$

And making

$$d = d' - 14{\cdot}782 \times a - 7{\cdot}310 \times b + \left\{\begin{matrix} -\,3{\cdot}198 \\ +\,0{\cdot}515 \end{matrix}\right\} \times c$$

we derive the value of d, or the most probable longitude to be deduced from this eclipse, as given in the table above.

ARTICLE VIII.

On the Patellà Amœna of Say. By Isaac Lea. Read March 6, 1840.

In a very able paper, published in the Boston Journal of Natural Science, Mr. Couthouy gives an elaborate description of the animal of the *Patella Amœna* of Say, and places it in a new genus established by Quoy and Gaimard, under the name of *Patelloida*. From the description of the animal by the French zoologists, and the minute one of Mr. Couthouy, there can be no doubt of the propriety of this change, though the form of the shell gives little or no indication of the great distinction developed by the anatomy of the animal.

I agree fully with the American zoologist in the propriety of changing the generic name of this *Patella*, but I do not see the propriety of retaining the specific name *Amœna*, because it was first described by Müller as *Patella testudinalis*. Entertaining this opinion, I have consulted the authors who have described this shell, and now offer the following synonomy:—

Patelloida testudinalis. *Lea.*
Patelloidea amæna. *Couthouy. Bost. Jour. Nat. Hist.* vol. ii. p. 171.
Patella amæna. *Say. Jour. Acad. Nat. Sci.* vol. ii. p. 223.
Patella testudinalis. *Müller Zool. Dan.* p. 237. *Deshayes' Lam.* vol. vii. p. 543. *Fabricius Faun. Groen.* p. 385. *Gmelin*, p. 3718. *Dillwyn*, p. 1045. *Wood's Cata.* No. 63.
Patella testudinaria. *Müller Zool. Dan. Kæmmerer, Rudolst Conch.* p. 12, pl. 2, figs. 4 and 5.
Patella tessellata. *Müller Zool. Dan.* vol. iii. 2868. *Dr. Beck's Letter.*
Patella testudinaria Gröenlandica. *Chemnitz*, vol. x. p. 325, pl. 168, figs. 1614, and 1615.
Patella Clealandii. *Sowerby. Extracts from the Minute Book of the Linn. Soc.* vol. viii. p. 621. *Fleming's British Animals*, p. 287.

Patella virginea. *Müller Zool. Dan.* vol. iii. p. 2867.
Patella virginea? *Gmelin*, p. 3711. *Dillwyn*, p. 1052. *Fleming's Br. Ani.* p. 287.
Patella clypeus. *Mr. S. Ker's Letter.*
Lottia* Antillarum? *Sow. Conch. Manual*, fig. 231.

This species of *Patelloida* seems to have escaped the attention of Lamarck, which surprises me the more as its geographical distribution is very extensive. Linneus and Schröter give the habitat of *Patella testudinaria* as in the Norwegian seas; but it is evident that these writers have confounded the two species, the *testudinaria* being a southern species, while the *testudinalis* is a northern one. Müller says it inhabits Norway. Fabricius mentions it as being common on the shores of Greenland. I have a suite of specimens from Greenland, which came from the extensive cabinet of Prince Christian of Denmark. Some very fine specimens were also sent to me from Hudson's Bay, by Governor Simpson of the Hudson's Bay Company; and Mr. S. Ker, many years since presented it to me under the name of *Patella clypeus*, from Greenock, in Scotland. It is also found in abundance on the rocks at Nahant, in Massachusetts, and in Maine, and other parts of our northern coast.

Chemnitz and Kæmmerer have both made excellent representations of this shell; the former the most perfect. Dillwyn and other authors quote the *Patella radiata* Born, for this species; but a reference to his figure (pl. 18, fig. 10) will satisfy any one who knows the shell that this is an error. Nor is Dillwyn correct in giving the *P. virgata* of Gmelin as a synonym. Deshayes refers to Schröter's *P. testudinaria;* but I think that Schröter had the India shell in view when describing that species, which is very different and much larger.

* Mr. Sowerby, in his Conch. Manual, p. 59, gives precedence to Mr. Gray's generic name of *Lottia* over that of *Patelloida* of Quoy and Gaimard. Deshayes says (vol. vii. p. 549) that he retains the name of *Patelloida* as being the first given.

ARTICLE IX.

Observations of the Magnetic Intensity at twenty-one Stations in Europe. By A. D. Bache, LL. D., President of the Girard College for Orphans, one of the Secretaries of the American Philosophical Society, &c., &c. Read March 6, 1840.

THE following observations of intensity and dip were made during a visit to Europe in 1836–7 and 1837–8, directed by the Trustees of the Girard College for Orphans. The special objects of my journey admitted of only an occasional attention to the observations in question, which I did not attempt unless when time and circumstances were generally favourable to their execution. The stations are twenty-one in number; three in Great Britain, and the others on the continent. At some of the places the magnetic elements are so well known from numerous observations that my results can add but little to the information already before the public; at others, few observations have been made, and my determinations assume a higher relative importance. Those of the former class will serve, by their accordance with the results of other observers, to give a general confidence in the results of the latter, and will especially assist in connecting the European stations with those in the United States, which formed one principal object of experiments, the results of which I propose to communicate to the society in a separate memoir.

At all the places but three the horizontal intensity and dip were observed, and at two the total intensities were, in addition, compared by the statical method of Professor Lloyd. The observations for the horizontal intensity were made by oscillating horizontal needles in a rarefied medium, in the manner explained in a former paper, read before the society.* The dip was determined with a six inch dipping circle by ROBINSON, which yielded quite as satisfactory results as the instrument by GAMBEY, used in my observations in the United States.† The needles for the statical method of Professor LLOYD were also by ROBINSON.‡

Two needles were ordinarily used in the observations for horizontal intensity, a cylinder of the HANSTEEN model and a bar, designated respectively as C and A in the memoir on horizontal intensity just referred to. The correction for temperature, and also, in general, the mode of observing there recorded were employed. To determine the time of beginning and ending of the oscillations, however, five sets of observations were taken,§ and the usual mode of deducing the mean, by comparing the five corresponding observations at the commencement and close of each series, was adopted. A pocket chronometer, by FRENCH, was used to observe the duration of the oscillations, and its rate during the observations was ascertained by comparison with an observatory clock, when such means was at hand. This watch had been selected in reference to its quality of bearing change of position without considerable change of rate, and stood the trial to which it was exposed reasonably well. It is my impression, however, that when more perfect instrumental means are used in the determinations, greater care will be required in regard to those for ascertaining the time. The observed correction for the rate of the chronometer is duly applied in the tables of results. As all the observations were made between the same arcs of vibration, a reduction to indefinitely small arcs is not required.‖ The correction for

* American Philosophical Society's Transactions, vol. v., N. S., Art. xviii.

† Ibid. Art. viii.

‡ They had been heated in boiling water, to discharge as much of the magnetism as could be done by this temperature, according to the recommendation of Mr. Christie. I supposed, from the result of calculations made while in Paris, that these needles lost their magnetism rapidly, but, on farther examination, find that such was not the case, and that they lost but a small portion of their force during more than a year, as will be found stated in a subsequent part of this paper.

§ Besides eliminating errors of observation, this has the farther advantage of correcting errors of division of the dial plate, as noticed by Professor FORBES, in his "Account of some Experiments made in different Parts of Europe on Terrestrial Magnetic Intensity," &c., &c. Edinburgh Transactions, vol. xiv., part I., p. 5.

‖ The semi-arcs of vibration for the cylinders were from 6° to 2°, and for the bar, from 4° to 2°.

the loss of magnetism by the needle is so fully made out, that I believe the results to be as free from error, on this score, as if no loss had appeared from observation. The time of oscillation of the bar (A) was observed at Philadelphia in October, 1835; again in September, 1836, just before I set out from home; and in December, 1838, after my return: it was observed in the intermediate time at London, in June, 1837, and again in August, 1838; at Paris in August, 1837, and in July, 1838. A curve was traced on a large scale by the results thus obtained, the ordinates representing the relative forces of the needle corresponding to the intervals of time from October, 1835, measured by the abscissæ. A regular curve being traced, departed very little from the points obtained by observation, the differences between the ordinates of the mean curve and those given by the particular observations being, in terms of the original force of the needle, 0.000, — 0.0005, + 0.0030, + 0.0034, and — 0.0031. As these individual results must be affected by small errors of observation, there can be no doubt of the satisfactory correction for loss of magnetism by using the ordinates of the curve, and, accordingly, the correction thus obtained is applied to the results, and is entered in the tables. This needle shows a tendency towards a permanent magnetic state, and its loss is less than half that of the other. The diminution of force of the cylindrical needle, (B,) since September, 1835, has been nearly uniform, and, accordingly, the curve representing it differs but little from a straight line. The observations used to trace this curve were obtained at Philadelphia in September, 1835, in September 1836, and in December, 1838; and in addition at the same times and places as stated in reference to the other needle. Although the correction for loss of force is so much greater for this needle than for the bar, there is no reason to suppose, from a comparison of their results, that this correction is not quite as well ascertained as the former. The differences between the observed losses of force and those given by the ordinates of the curve are, 0.0000, 0.0000, + 0.0035, + 0.0051, and — 0.0042. The time of oscillation of this needle was farther satisfactorily observed at Florence, before passing into lower Italy, and again in returning to upper Italy; but while the general accordance of the results was such as to show that the force had undergone no irregular change which was appreciable, the time which had elapsed between the two observations was too short to justify their use in the numerical determination of the loss of magnetism by the needle. I have had no cause to suspect irregular changes in either of the needles since they came into my possession. The needles were always kept separate from each other; while travelling, they were carried about my person, and, when stopping for any considerable length of time, were deposited as far from iron as was necessary to their safety. From the experiments made with these needles, both of which have been magnetised several years, and which have been kept carefully for more than six years, I should be disposed, in future, to adopt the plan of procuring needles of as nearly equal force as possible,* and keeping them in pairs, which renders them much more convenient to carry. It is certain that permanence of force has not resulted, in these needles, from the opposite plan, and that the labour of observation and calculation are much increased by the necessity of ascertaining and applying a correction for the loss. In comparing two sets of experiments at a distant date, to ascertain the loss of magnetism by the needle, the results are affected by the change of dip which has taken place in the interval, and as it is not probable that this change is produced by an alteration in the total intensity, a correction is to be applied, which, however, except in the longest interval of my series, was scarcely appreciable.

The magnetic dip was observed in the usual way, the poles of the needles being reversed in each series. The bar magnets for reversing the poles were placed in the top of the box containing the dipping circle, each pair of opposite poles being connected by a keeper. Notwithstanding this arrangement, the bars lost much of their strength, probably from the percussion resulting from a slight play which was allowed in the bed where they were placed; and, on my arrival at Berlin, their magnetism was so much diminished that the dipping-needles could no longer be charged by them to saturation. Since that time I have always taken the precaution, after changing the poles, to oscillate the needles within determinate arcs, and when resting on the agate planes, to ascertain, by the time of oscillation, that they are charged at least nearly to saturation. The statement of this precaution may be of service to others, since, with a diminished force in the needles, the liability to take up some other position than that corresponding to the true dip is increased, and the error cannot, necessarily, be detected by discrepancies in the several readings. Of the two

* The importance of attending to these conditions appears very strikingly from the experiments of Mr. Airy, with large magnetic bars. Royal Society's Transactions, Part I., for 1839, pp. 196, 197.

needles accompanying the dipping circle, No. 2 did not give uniformly as accordant results as No. 1; but, in cases where differences appeared, I endeavoured, by increasing the number of observations, to reduce the amount of probable error.

In presenting these results to the society, I have concluded to give the observations at each place, in general, separately, rather than to tabulate, at once, the whole series; this will enable me more readily to make such remarks as may be necessary, and also to compare the results with those of other observers, as far as I am acquainted with them, which will make the paper more complete than if I had confined it merely to my own conclusions.*

The observations will be given in the following order:—Those at Dublin, Edinburgh, London, Paris, Brussels, Berlin, Vienna, Trieste, Venice, Rome, Naples, Florence, Milan, Turin, Chamberi, Lyons, Chamouni, the Flégierè, Genera, Brientz, and the Faulhorn.

DUBLIN.

The observations at Dublin were made in the PROVOST'S garden. They included only the horizontal intensity, as I was not at this time provided with a dipping-needle. The horizontal intensity is compared with that at London by observations made in July, 1837.

Observations for Horizontal Intensity at Dublin.

Needle.	Date.					Temp.	No. of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Coeffic't of Corr'n for Loss of Magn'm.	Hor. Intensity.
	Year.	Month.	D.	H.	M.	Fah. °		Secs.	Secs.	Secs.		Lond. 1.
Cylinder.	1836	Nov.	21	4	08	45½	200	36.13	36.157			
"	"	"	"	"	21	44¾	"	.14	.168			
"	"	"	"	"	39	44½	"	.12	.149	36.158	0.978	0.935
Bar.	1836	Nov.	19	4	40	40	200	39.77	39.862			
"	"	"	"	"	54	39¾	150	.74	.833			
"	"	"	21	4	53	44½	"	.78	.851	39.849	0.992	0.938

* This is easily done through the abstract contained in Major Sabine's interesting report to the British Association, on the variation of the magnetic intensity observed at different points of the earth's surface. From the Seventh Report of the British Association for the Advancement of Science, London, 1838. I have, however, referred to the originals, whenever they were accessible, in which cases they are quoted in my paper, without other acknowledgment.

These results can add nothing to the laboured deductions of the same element by Professor LLOYD and Major SABINE, but they are important here, as indicating the accuracy with which the corrections for my needles are known, an interval of nine months having elapsed between the observations at Dublin and London. The mean of the three series with the two needles gives 0.936 for the horizontal intensity at Dublin to that at London as unity, while the mean of the determinations of the experimenters just referred to is 0.940, the two extremes being 0.946 and 0.934.*

EDINBURGH.

The following observations were made at CANAAN PARK, near Edinburgh. The instrument was much out of order, and required much time and pains to obtain the results, which, after all, are not as accordant as usual: their number probably makes up for the want of close agreement. The numbers in the column of corrected results are reduced for the rate of the chronometer,† as well as for temperature.

Observations for Horizontal Intensity at Edinburgh.

Needle.	Date.				Temp.	Number of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Coeffic't of Correction for Loss of Magnet'm.	Hor. Intensity.
	Year.	Month.	D.	H.	Fah. °		Secs.	Secs.	Secs.		Lond. 1.
Cylinder.	1837	Feb.	4	$2\frac{1}{2}$	46	250	37.05				
"	"	"	"	$2\frac{3}{4}$	"	270	.11				
"	"	"	"	3	45	250	.11				
"	"	"	"	$3\frac{1}{2}$	"	"	.08	37.107	37.107	0.986	0.895
Bar.	1837	Feb.	2	4	34	248	40.70				
"	"	"	"	$4\frac{1}{4}$	33	250	.68				
"	"	"	4	5	$44\frac{1}{2}$	330	.75	40.810	40.810	0.995	0.897

I do not find in either of Major SABINE's reports, already referred to, a comparison of the horizontal forces of magnetism at Edinburgh and London. Pro-

* See Report on the Magnetic Isoclinal and Isodynamic Lines in the British Islands. By Major Edward Sabine. From the Eighth Report of the British Association for the Advancement of Science. London, 1839. For the early receipt of a copy of this report I am indebted to the author.

† While at Edinburgh, the main spring of the chronometer gave way, and was replaced by Mr. Bryson. The watch had, subsequently, a very considerable losing rate, but I preferred to submit to this inconvenience to having frequent alterations made in it.

fessor Forbes has compared Edinburgh and Paris, and gives the intensity at the former place to that at the latter as 0.8402 to unity. My direct determination gives almost identically the same results; namely, 0.8405. Again, comparing Edinburgh and Paris through London, I find 0.841 for the horizontal intensity at the former city. Farther, using my results at Edinburgh in a comparison of Dublin and London through Edinburgh, I find 0.936 for the relative horizontal intensities at Dublin and London, agreeing within 0.004 of the mean result of Professor LLOYD and Major SABINE's observations. All these verifications go to show that my number for the relation of the horizontal intensities at Edinburgh and London is very nearly correct.

The dip was determined, at the same time and place with those of the foregoing observations, by Professor FORBES, with a small three inch circle, to be 71° 47'.5. This result differs but slightly from those of Major SABINE in September, 1836, and of Mr. Fox, in August, 1837, when reduced to this epoch, and I have employed it in determining the total intensity. Calculating this element from the mean of the horizontal intensities of the foregoing table, and using the dip observed by me at London, I find 1.013 for the total intensity at Edinburgh, that of London being unity. Major SABINE obtained, by the statical method, 1.023. I am at a loss to explain the difference between us. It does not, probably, depend upon an error in the dip used in my calculation, since, taking a mean of those which Major SABINE and Mr. Fox obtained at Edinburgh, and Major SABINE, Captain Ross, Professor PHILLIPS, Mr. FOX, and Professor LLOYD, at London, reduced to this same epoch, and using these means with my horizontal intensity, the total intensity appears to be 1.014. If my result is erroneous, the error must be in the determination of the horizontal intensity, the numerous verifications of which render it improbable that this is wrong to any considerable extent.

LONDON AND PARIS.

As these stations are of importance as references in connecting the magnetic intensity in the United States with that in Europe, I bestowed great care upon the observations, and multiplied them. They were, besides, points to which I intended to return a second time, and which, therefore, afforded the means of ascertaining the loss of magnetism of the needles. The number of needles employed, and of observations made, may, perhaps, farther entitle these results to be allowed some weight in the determination of the relative intensity of magnetism at these two important European stations. The instrument for measuring the horizontal intensity was put in excellent order by ROBINSON, who also furnished the dipping circle and needles. Besides the horizontal needles which I ordinarily used, I employed two others, and also observed by the statical method of Professor LLOYD. The observations were made in the summer of 1837, and again in 1838, the intervals between the respective series at London and Paris being quite short. The place of observation at London was near Captain Ross' former residence, at WESTBOURNE GREEN, and at Paris, in the garden of the observatory in the MAGNETIC CABINET of M. ARAGO. The chronometer was compared, before and after the observations, with the clock of the observatory at Paris, and with the standard of Messrs. ARNOLD and DENT, at London.

Observations for Horizontal Intensity at London and Paris.

Place.	Needle.	Date.					Temp.	No. of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.	
		Year.	Month.	D.	H.	M.	Fah. °		Secs.	Secs.	Secs.		Paris 1.	Lond. 1.
London	Cylinder	1837	June	24	12	06, P. M.	71	242	35.31	35.369				
	"	"	"	"	"	30,	76¼	280	.29	.349	35.359		1.069	1.000
	Bar	"	"	"	2	49,	73½	300	38.704	38.742				
	"	"	"	"	3	10,	"	"	"	"	38.742		1.066	1.000
	H. R.	"	"	"	1	36,	77	350	31.23	31.275				
	"	"	"	"	2	01,	"	"	.29	.335	31.305		1.066	1.000
	H. B't.	"	"	16	3	42,	72½	350	25.01	25.029				
	"	"	"	"	4	01,	72	400	.01	"	25.029		1.062	1.000
Paris	Cylinder	"	Aug.	4	10	58, A. M.	69	300	34.12	"				
	"	"	"	"	11	23,	"	"	.13	"	34.286	.9958	1.000	0.936
	Bar	"	"	"	12	42, P. M.	70½	300	37.42	"				
	"	"	"	"	1	02,	70	"	.40	"	37.560	.9980	1.000	0.938
	H. R.	"	July	13	12	04,	70½	350	30.18	30.305				
	"	"	"	"	"	34,	"	"	.16	.325	30.315		1.000	0.938
	H. B't.	"	"	"	10	53, A. M.	70	400	24.19	24.286				
	"	"	"	"	11	10,	69¼	"	"	"	24.286		1.000	0.942

Observations for Horizontal Intensity at London and Paris, continued.

Place.	Needle.	Date.					Temp.	No. of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.	
		Year.	Month.	D.	H.	M.	Fah. °		Secs.	Secs.	Secs.		Paris 1.	Lond. 1.
Paris	Cylinder.	1838	July	4	1	07, P. M.	73½	350	34.956	35.076				
	"	"	"	"	1	36,	"	326	.944	.066				
	"	"	"	17	12	04,	72	350	.903	.026				
	"	"	"	"	"	35,	73	"	.850	34.971				
	"	"	"	"	1	03,	74	"	.934	35.053				
	"	"	"	"	2	06,	82½	"	.934	.038				
	"	"	"	"	"	29,	83½	"	.931	.035	35.038		1.000	0.938
	Bar.	"	"	4	3	34,	73¼	350	37.714	37.812				
	"	"	"	"	"	56,	72½	"	.703	.805				
	"	"	"	17	"	16,	84½	300	.763	.811				
	"	"	"	"	"	36,	85¼	"	.792	.836	37.816		1.000	0.936
London	Cylinder.	"	Aug.	15	1	03,	65	350	36.232	36.271				
	"	"	"	"	"	25,	"	"	.239	.278	36.274	.9962	1.066	1.000
	Bar.	"	"	"	2	23,	"	350	39.032	39.064				
	"	"	"	"	"	49,	"	"	.030	.062	39.063	.9982	1.068	1.000

The final mean of these results gives the horizontal intensity at Paris 1.066, that at London being 1.000. By a series of observations with six needles, in 1827, Major Sabine found the same element to be 1.071: the highest result which any one of his needles gave was 1.073, and the lowest 1.0675.

The following observations of the dip were made at the same places with the foregoing. At Paris, in 1837, the observations with needle No. 2 were made at such a late hour as to be unsatisfactory, from a deficiency of light; I have, therefore substituted for them the dip given by the two needles used in the statical method, and corrected by a comparison of their results at London with those of the other two needles, the poles of which were reversed. Needle No. 2 was in the hands of Mr. Robinson, for alteration, in 1838, and I have again used the corrected results given by the statical needles. The total intensities are calculated from the mean horizontal intensity and the observed dips.

Dip and Total Intensity at London and Paris.

Place.	Date.			Needle.	Dip.		Mean Dip.		Total Intensity.	
	Year.	Month.	D.		Degs.	Min.	Degs.	Mins.	Lond. 1.	Paris 1.
London	1837	June	16	No. 1	69	18.3				
				2		17.4	69	17.8	1.000	1.020
Paris	"	Aug.	17	Lloyd No. 1	67	16.9				
				2		21.3				
				Mean,	67	19.6				
				No. 1		23.2	67	21.4	0.980	1.000
Paris	1838	July	10	No. 1	67	16.4				
				2		16.6	67	16.5	0.980	1.000
London	"	Aug.	15	Lloyd No. 1	69	12.9				
				No. 2		12.3				
				Mean,	69	12.6				
				No. 1		12.1	69	12.3	1.000	1.020

The report of Major SABINE on the magnetic survey of the British Islands affords ample authentic materials for putting these results to the test. Professor PHILLIPS, who observed the dip, in May, 1837, at the same place where my observations were made, found it 69° 20′.2; and again, in March, 1838, 69° 18′.2, which, reduced to the epoch of my observations, at the rate of a diminution of 0′.2 per month, would give (the correction being additive) 69° 20′.4. The dip observed by Major SABINE in Regent's Park, in July, 1837, reduced to the same epoch, is 69° 18′.9, and by an observation in November, 1837, 69° 25′.0. That found by Capt. JAMES Ross, at Westbourne Green, in August, 1837, similarly reduced, gives 69° 20′.8; in June and July, 1838, 69° 17′.0; and in December, 1838, 69° 17′.4. That of Professor LLOYD, in 1836, also, reduced, is 69° 20′.8; and of Mr. Fox, in May and June, 1838, 69° 20′.5. The mean of all these determinations, omitting the dip of 69° 25′.0, is 69° 19′.5. I am not acquainted with any series of determinations, at the same place, by different observers, and with different instruments, which agree so closely, and consider it, therefore, as an important point in verifying my results, that the dip observed in 1837 agrees within 1′.7 of the mean of those just referred to. The second determination of 69° 12′.3, in 1838, is in defect 4′.8, supposing the annual decrease of dip to be 2′.4, a difference which is admissible, since nearly as great a one is to be found among the foregoing results. The determinations of the dip at Paris agree very well with that given by Professor Forbes, on the authority of M. Arago, in July, 1835,* namely, 67° 24'.0. An annual diminution of dip of 2'.8 would give, in August, 1837, 67° 18'.2, while I found 67° 21'.4; and in July, 1838, 67° 15'.6, while my result was 67° 16'.5.

It is obvious, then, that my value of the total intensity is correct or not, according as the horizontal intensity has or has not been accurately determined. I shall return to this, after stating the results obtained by the statical method of Professor Lloyd. As the observations in 1837, by this method, were made at the short interval of a month from each other, I have not thought it necessary to apply a correction to them, the whole loss of magnetism, during the year, by either needle, having amounted to less than 0.01.

Observations for Total Intensity at London and Paris, by the Statical Method.

Place.	Date.		Needle.	Temp.	Dip when loaded, or Angle θ.		Dip reduced to August, or Angle δ.		Total Intensity, or Cor. θ
	Month.	Year.		Fah. °					$\frac{\text{Cor. } \theta}{\sin(\delta - \theta)}$
London	June	1837.	No. 1,	74½	21°	59'.0	69°	17'.5	
Paris	Aug.	"	"	72⅓	24	47 .3	67	21 .0	0.979
London	June	"	No. 2,	74½	19	13 .5			
Paris	Aug.	"	"	72½	22	48 .2			0.976
London	Aug.	1838.	No. 1,	65	22	31 .3	69	12 .3	
Paris	July	"	"	75	25	41 .7	67	16 .2	0.979†
London	Aug.	"	No. 2,	65	19	59 .4			
Paris	July	"	"	77	23	12 .5			0.980†

The horizontal intensity deduced from these results by using the dip already given, is 1.065, agreeing closely with the determination by the method of vibrations. This latter determination rests upon 4072 oscillations at one station, and 6426 at the other, besides the verification by the statical method. The foregoing results are collected in the following table.

* See the paper of Professor Forbes before referred to, in the Edinburgh Transactions, vol. xiv. p. 27.

† A small correction has been applied for the effect of temperature, amounting to 0.003 and 0.002 in the two cases respectively.

Horizontal and Total Intensities and Dip at London and Paris.

Date.	Needle.	Horizontal Intensity.		Total Intensity.		Magnetic Dip.	
		Paris.	London.	Paris.	London.	Paris.	London.
1837. June, July, Aug.	Cylinder.	1.069	1.000	0.982	1.000	67° 21′.4*	69° 17′.8†
	Bar.	1.066		0.980			
	H. R.	1.066		0.980			
	H. B.	1.062		0.976			
	Lloyd No. 1.	1.067		0.980			
	" " 2.	1.063		0.976			
1838. July, Aug.	Cylinder.	1.066		0.980		67° 16′.5	69° 12′.3
	Bar.	1.068		0.981			
	Lloyd No. 1.	1.067		0.981			
	" " 2,	1.066		0.980			
	Mean,	1.066	1.000	0.979	1.000		
		1.000	0.938	1.000	1.021		

BRUSSELS.

The horizontal intensity at Brussels compared with that at Paris being well known through the observations of M. Quetelet and others, it is important to me as a verification of my results, and as connecting stations in the United States with those in Europe, to compare my determinations with those already on record. The dip at Brussels is also, no doubt, accurately known from the regular observations of M. Quetelet since 1827; and I regretted that an accident which had happened to my dipping circle at Paris prevented me from farther putting its accuracy to the test. The observations for horizontal intensity were made in the garden of the Observatory. The chronometer was compared with the observatory clock before and after the observations.

* The mean of this result and that obtained in 1838, reduced to August 16th, 1837, allowing a diminution of dip yearly of 2′.8, is 67° 20′.8.

† The mean of this result and that in 1838, reduced to June 16th, allowing an annual decrease of dip of 2′.4, (see Major Sabine's Report on the Magnetic Survey of the British Islands,) is 69° 16′.0.

Observations for Horizontal Intensity at Brussels.

Needle.	Date.				Temp.	Number of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Mean.	Correction for Loss of Magnetism.	Hor. Intensity.
	Year.	Month.	D.	H.	Fah. °		Secs.	Secs.	Secs.		Paris 1.
Cylinder.	1838	July	25	$2\frac{1}{4}$, P. M.	62	300	35.596	35.640			
"	"	"	"	$2\frac{1}{2}$, "	61	300	.599	.644	35.642	1.0026	0.968
Bar.	"	"	"	$3\frac{1}{2}$, "	60	350	38.366	38.417			
"	"	"	"	$5\frac{1}{2}$, "	57	350	.334	.398	38.407	1.0002	0.970

The mean of these results, 0.969*, is in close accordance with the results before referred to as given by M. QUETELET, the mean of the several series of observations made at Brussels between 1828 and 1838 being nearly 0.964.

BERLIN.

I am indebted for an opportunity to make this set of observations to the kindness of Professor ENCKE, who put his convenient MAGNETIC OBSERVATORY at my disposal, and removed from it the variation magnetometer and dipping needle which it contained: without this, I could not have observed at this season of the year. In my first attempts to obtain the dip I was unsuccessful, owing to the great loss of force which my magnets for reversing the poles of the dipping needle had sustained during a circuitous journey from Switzerland to this capital. The magnets were retrenched by ŒRTEL, and the results then obtained appear worthy of confidence. Since this time I have taken the precaution to oscillate the dipping needles before observing with them after the reversion of the poles, to ascertain that they are charged nearly, or quite, to saturation. As the periods which elapsed between these observations and those which preceded and succeeded them, at Paris, were not very different, I have calculated the intensity at Berlin in reference to both the series at Paris, applying the correction for the loss of magnetism by the needles, deduced as

* This number differs by 0.001 from the result given by M. Quetelet in the Bulletin of the Brussels Academy, vol. v. p. 481. In the numbers communicated to him I had applied a correction for the loss of magnetism of the needles which was too high by nearly this difference; which is, however, entirely unimportant.

already stated. The coincidence of the two results shows strikingly the accuracy with which the curve already described supplies the data for the correction of the loss of force by the horizontal needles.

The chronometer was compared with the observatory clock.

Observations at Berlin.

For Horizontal Intensity.											
Needle.	Date.				Temp.	No. of Series.	No. of Oscill'ns.	Time of Ten Oscill'ns.	Corrected Time of Ten Oscill'ns.	Correction for Loss of Magnet'm.	Horizontal Intensity.
	Year.	Month.	D.	H.	Fah. °			Secs.	Secs.		Paris 1.
Cylinder	1837	Dec.	16	2, P. M.	$37\frac{1}{2}$	2	690	34.966	35.006	1837. 1.015	0.974
										1838. 0.975	0.977
Bar	1837	"	"	$2\frac{1}{4}$ "	35	2	660	37.886	37.993	1837. 1.005	0.983
										1838. 0.993	0.984
										Mean, . .	0.979

For Dip.
1837, Dec. 29, Needle No. 1, 68° 06'.5 No. 2, 68 10 .6 Mean, 68° 08'.5.
Total Intensity compared with Paris as unity, 1.0145.

The horizontal intensities of Berlin and Paris were compared by M. Rudberg, who made the relation 0.974, and by M. Quetelet,* who gave 0.975 for the relative intensities. My result differs but slightly from these.

The dip at Berlin is very well known from a series of observations extending from 1806 to 1837, and my result can add nothing to the knowledge of this element, but as obtained with the same instrument which was used at Paris, the total intensity will be, probably, a nearer approximation by using it than

* Annuaire de l'Observatoire de Bruxelles pour l'an 1834, p. 266. On the next page M. Quetelet gives 0.9886 for the relative intensities, but this is doubtless a mistake.

by employing in the calculation the more accurate determination of the long series just referred to.

Professor ENCKE has determined from this series a formula by which the dip may be calculated for any epoch, namely, $\delta = 68° 7'.3 - 3'.52 (t - 1836,)$ in which δ is the dip and t the year or fraction of a year. The dip in December, 1837, calculated from this formula, is 68° 00'.4, from which my result differs about eight minutes.

MM. HUMBOLDT and GAY LUSSAC determined, in 1809, the relative intensities at Berlin and Paris to be 1.014; M. ERMAN, in 1828, and M. QUETELET in 1829, 1.0165.* My determination is 1.0145.

VIENNA.

These observations were made in the BOTANIC GARDEN, upon the upper platform. The chronometer was compared, before and after the observations, with the observatory clock. The time of ten oscillations and the dip are compared with the mean of the observations at Paris in 1837 and 1838, in calculating the horizontal and total intensities.

Observations at Vienna.

FOR HORIZONTAL INTENSITY.

Needle.	Date. Year.	Month.	D.	H.	Temp. Fah. °	No. of Series.	No. of Oscill'ns.	Time of Ten Oscill'ns. Secs.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity. Paris 1.000.
Cylinder.	1838	March	23	$3\frac{3}{4}$, P. M.	58.3	2	700	33.436	1.0076	1.084
Bar.	"	"	"	$4\frac{1}{2}$, "	57.8	2	700	36.043	1.0023	1.096
									Mean,	1.090

FOR DIP.

1838, March 21, Needle No. 1, 64° 45'.8.
No. 2, 53 .7. Mean, 64° 49'.7.

Total Intensity compared with Paris as unity, 0.989.

The only published observations of magnetic intensity at Vienna with which I am acquainted are those quoted by Major SABINE, in his recent report, as

* Major Sabine's Report on the Magnetic Intensity of the Earth.

made by KEILHAU and BOECK, and which give the total intensity at Vienna, as compared with Paris, 0.983, differing from the above only 0.006.

The numbers for the horizontal intensity furnished by the two needles sometimes, as in this particular case, differ; and, in general, the greater relative intensity is given by the bar needle. After an examination of various causes which suggested themselves as likely to produce this result, I am still at a loss to explain it. It is not due to an ill-ascertained correction for the loss of magnetic force, nor for temperature, nor to a want of horizontality in the magnetic axis of the needle. The mode of observing renders the limits of error in the separate sets of observations much below these differences. It was my practice in observing to employ the cylinder needle which has a very small correction for temperature first, and, mean while, to place the other in the shade, so as to avoid an error from its not having acquired the temperature of the surrounding air.

TRIESTE AND VENICE.

The observations at Trieste were made in the BOTANICAL GARDEN, and those at Venice in the garden of the ARMENIAN CONVENT, on the Island of St. Lazarus.

Observations at Trieste and Venice.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscill'ns.	Time of Ten Oscill'ns at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Trieste	Cylinder	1838	April	4	$10\frac{3}{4}$, A. M.	54.0	2	700	32.889	1.0091	1.121
	Bar	"	"	"	$11\frac{3}{4}$, "	54.5	2	580	35.426	1.0024	1.135
										Mean,	1.128
Venice	Cylinder	1838	April	11	$12\frac{1}{4}$, P. M.	67.5	2	700	32.876	1.0097	1.122
	Bar	"	"	"	$1\frac{1}{2}$, "	67.6	2	700	35.393	1.0029	1.137
										Mean,	1.129

FOR DIP.

Trieste, 1838, April 4th, Needle No. 1, 63° 19′.1
No. 2, " 22 .5 Mean, 63° 20′.5

Venice, 1838, April 11th, Needle No. 1, 63° 18′.9
No. 2, " 24 .9 Mean, 63° 21′.9

Total Intensity at Trieste, compared with Paris as unity, 0.970.
" " Venice, " " " " 0.9715.

In this table the mean time of the oscillations at Paris and the mean of the observed dips in 1837 and 1838, is taken as the unit of reference in calculating the relative horizontal and total intensities.

The total intensity at Trieste, compared with Paris, is given by Major SABINE, in his report before referred to, as determined by Messrs. KEILHAU and BOECK, in 1826, as 0.977; differing from the mean of my results 0.007, the difference between us having a contrary sign from that at Vienna. M. QUETELET* gives the horizontal intensity at Venice as 1.1566, which is much greater than my number.

ROME AND NAPLES.

The observations at Rome were made at two different stations; one out of the region of the volcanic tufa upon which the city is built, upon the calcareous formation of MONTE MARIO, in the garden of the Villa Mellini, the other in the temple of Venus and Rome, opposite to the Colosseum. At the latter station a curious instance of local attraction occurred: I had selected a block of marble, apparently free from iron fastenings of any sort, as the resting place for the instrument, and finding results very discordant from those obtained on the Monte Mario, I next placed the instrument in a brick niche, to examine if the local attraction were common to the whole station. The results obtained when the instrument was in the niche were so different from the former that I placed it again upon the block, to ascertain if any mistake had occurred, but found again the same anomaly as at first. There was, probably, some iron beneath the pavement upon which the block of marble rested, suggesting the necessity for caution in the selection of these places of observation.

Fearing the influence of the ferruginous nature of the volcanic tufa upon which Naples is built,† I went to AVERSA, about eight miles to the north of the city. The place of observation was in the large garden attached to the Asylum for the Insane.

* Annuaire de l'Observatoire de Bruxelles pour l'an 1834.

† I certainly did not at that time remember that M. QUETELET had expressed his opinion that there was no local disturbance from this cause, or I should have deferred to his authority. Nevertheless, the precaution, though attended with some inconvenience, was not amiss.

At Rome the chronometer was compared, before and after the observations, with the observatory clock of the Roman College, and, at Naples, with that of the Royal Observatory.

The horizontal intensity observed at Paris, for 1838, is taken as unity in the calculations, the correction for loss of force in the needles being applied for the same epoch. The dip which is used in calculating the total intensity is a mean of that actually observed at Paris in 1838, and of that which would result from applying the yearly diminution of 2′.8 to the dip observed in 1837.

Observations at Rome and Naples.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscill'ns.	Time of Ten Oscill'ns. at 60°.	Coeffic't of Correction for Loss of Magnet'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Rome*	Cylinder	1838	May	18	8½, A. M.	67.3	2	650	31.574	0.9935	1.223
	Bar	"	"	"	9½, "	67.0	2	600	34.122	0.9981	1.226
Rome†	Cylinder§	"	"	"	P. M.	65.0	1	350	31.539	0.9935	1.226
		"	"	"	"	66.2	1	350	31.777		Rejected.
										Mean,	1.225
Naples‡	Cylinder	1838	May	7	8, A. M.	76.2	2	700	31.290	0.9921	1.244
	Bar	"	"	"	11¾ "	75.2	1	350	33.674	0.9977	1.258
										Mean,	1.249

FOR DIP.

Rome,‖ 1838, May 15, Needle No. 1, 60° 13′.1
18, " No. 2, " 14 .9 Mean, 60° 14′.0.

Naples,¶ 1838, May 7, Needle No. 1, 59° 04′.8
" " No. 2, " 05 .5 Mean, 59° 05′.1.

Total Intensity at Rome, compared with Paris as unity, 0.9525.
" " Naples, " " " " 0.9380.

In taking the means for the horizontal intensity, weight is allowed in proportion to the number of oscillations observed.

The observations at Rome confirm the statement of M. QUETELET, that no effect is produced upon the needle by the volcanic tufa.

* Monte Mario. † Temple of Venus and Rome. ‡ Aversa.
§ In niche, on stone. ‖ Monte Mario. ¶ Aversa.

The numbers assigned for the horizontal intensities at Rome and Naples, by M. QUETELET, are, respectively, 1.2471 and 1.2869, differing very considerably from my results. My total intensities agree, however, very nearly with those found by HUMBOLDT and GAY LUSSAC, which were, for Rome, 0.945, and for Naples, 0.938.

FLORENCE AND MILAN.

The observations at Florence were made in the BOBOLI GARDENS; those at Milan in the garden of M. KRAMER, near the PORTA NUOVA. The chronometer was compared, at both places, with the observatory clock.

The same data at Paris, which were referred to under the the head of Rome and Naples, were used in the calculations in the following table.

Observations at Florence and Milan.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Florence	Cylinder	1838	May	28	$2\frac{3}{4}$, P. M.	68.2	2	700	32.395	.9947	1.164
	Bar	"	"	"	$3\frac{3}{4}$, "	67.0	2	"	34.838	.9985	1.176
										Mean,	1.170
Milan	Cylinder	1838	June	10	1, P. M.	73.7	2	600	33.269	.9964	1.106
	Bar	"	"	"	2, "	72.1	2	"	35.765	.9989	1.117
										Mean,	1.112

FOR DIP.

Florence, 1838, May 28th, Needle No. 1, 62° 06′.5
No. 2, " 04 .5 Mean, 62° 05′.5

Milan, 1838, June 10th, Needle No. 1, 63° 54′.1
No. 2, " 55 .4 Mean, 63° 54′.7

Total Intensity at Florence, compared with Paris as unity, 0.965.
" " Milan, " " " " 0.972.

The same numbers for Paris being employed as in the preceding calculations, and referring to 1838, I thought it might be satisfactory to ascertain if any part of the differences of horizontal intensity, as shown by the two needles, (amounting, in the results at Florence and Milan, to .012 and .011,) could be explained by an erroneous correction for loss of magnetism. Referring the horizontal intensities to 1837, however, when the correction has the contrary effect from that in the table, the same difference results.

Nor does this depend upon some peculiarity in the observations at Paris, since, referring to the observations at London, and taking the horizontal intensity there as unity, nearly the same difference appears.

The horizontal intensities determined by M. QUETELET at these two stations both exceed my results, his number for Florence being 1.1830, and for Milan 1.1335. The total intensities obtained by MM. HUMBOLDT and GAY LUSSAC were, for Florence, 0.9481, and for Milan 0.9733, both of which numbers are less than mine.*

TURIN AND CHAMBERI.

The place of observation at Turin was in the BOTANIC GARDEN; at Chamberi, in the PARK of the COUNT DE BOIGNES, a short distance only from the town. At Turin the chronometer was compared with the observatory clock, and the same rate was applied at Chamberi. The comparison is made with the observations at Paris in 1838.

Observations at Turin and Chamberi.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns. at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Turin	Cylinder	1838	June	17	11, A. M.	82.5	2	600	33.440	.9987	1.096
	Bar	"	"	"	12, M.	83.0	2	"	36.149	.9992	1.093
										Mean,	1.0945
Chamberi	Cylinder	1838	June	21	$12\frac{3}{4}$ P. M.	78.2	2	700	33.539	.9989	1.090
	Bar	"	"	"	2 "	77.5	2	"	36.235	.9993	1.088
										Mean,	1.089

FOR DIP.

Turin, 1838, June 17, Needle No. 1, 63° 48′.8
18, " No. 2, " 55 .6 Mean, 63° 52′.2.

Chamberi, 1838, June 21, Needle No. 1, 64° 31′.5
No. 2, " 37 .5 Mean, 64° 35′.0.

Total Intensity at Turin, compared with Paris as unity, 0.959.
" " Chamberi, " " " " 0.979.

* The authorities for these numbers are the same as previously quoted. In the remainder of the paper, unless the contrary is stated, the numbers are derived from the same sources, namely, the Annual of the Brussels Observatory for 1834, or the Transactions of the Brussels Academy of Sciences, vol. vi., and the Report of Major Sabine on the Magnetic Intensity.

M. Quetelet assigns 1.112 as the horizontal intensity at Turin, and MM. Humboldt and Gay Lussac give 0.9911 as the total intensity. The latter number exceeds my determination very considerably.

LYONS.

These observations were made in a meadow to the south-east of Lyons, and across the Rhone from the city. In reducing the time of ten oscillations for the rate of the chronometer, the mean of the rates at Turin and Paris, which differed very slightly, has been employed.

Observations at Lyons.

For Horizontal Intensity.											
Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Lyons	Cylinder Bar	1838	June	25	$12\frac{1}{4}$, P. M.	75.7	2	700	33.739	.9991	1.077
		"	"	"	$2\frac{1}{2}$, "	74.1	2	750	36.391	.9995	1.079
										Mean,	1.078
For Dip.											
Lyons, 1838, June 24, Needle No. 1, 64° 49′.5. No. 2, 48 .6. Mean, 64° 49′.0.											
Total Intensity at Lyons, compared with Paris as unity, 0.978.											

According to MM. Humboldt and Gay Lussac, the total intensity at Lyons is .9889.

CHAMOUNI AND THE FLÉGIÈRE.

The place of observation which appeared to me most suitable, at the time of my visit to Chamouni, was in a field in rear of, and at some distance from, the Union Hotel. On the Flégière the observations were made not far from, and about thirty feet above, the point where the cross is placed. The height of this point above the Valley of Chamouni is, in round numbers, about 3500 feet, and the valley itself is 3400 feet above the level of the sea.

These observations having been made in August, 1837, are compared with those at Paris in 1837, the dip being obtained, however, as in the similar case of 1838, by using both series of observations. The rate of the chronometer determined at Geneva was used in the reduction.

Observations at Chamouni and the Flégière.

For Horizontal Intensity.											
Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Chamouni	Cylinder	1837	Aug.	26	$9\frac{1}{2}$, P. M.	53.0	1	150	32.902	1.002	1.088
	Bar	"	"	"	10, "	50.0	2	300	36.006	1.001	1.089
										Mean,	1.0885
The Flégière	Cylinder	1837	Aug.	26	12, M.	68.0	2	650	32.768	1.002	1.097
	Bar	"	"	"	$12\frac{3}{4}$, P. M.	69.5	1	300	35.945	1.001	1.101
										Mean,	1.099

For Dip.

Chamouni, 1837, Aug. 26, Needle No. 1, 64° 38′.7
No. 2, 64 37 .7 Mean, 64° 38′.2.

The Flégière, 1837, Aug. 26, Needle No. 1, 64° 35′.8.

Total Intensity at Chamouni, compared with Paris as unity, 0.979
" " on the Flégière, " " " " 0.987

The horizontal intensity in the Valley of Chamouni, according to Professor Forbes, is 1.076,* and to M. Quetelet, 1.0935.† My result agrees nearly with the latter. The higher station presents a greater horizontal and total intensity than the lower, contrary to the general deduction from the laboured and ingenious memoir of Professor Forbes on this subject. It is worthy of remark, however, that the number given by Professor Forbes for the horizontal intensity at the Jardin is greater than that for the valley. M. Quetelet, on the contrary, found a less horizontal intensity on the Mer de Glace than at Chamouni. The anomaly is probably real, and adds another to the instances presented by Professor Forbes, of the difficulties of the problem of which he has

* Edinburgh Transactions, vol. xiv., part I.

† Annuaire de l'Observatoire de Bruxelles pour l'an 1834.

successfully undertaken the solution. The dip given by Professor FORBES, at Chamouni, is 65° 00′, and at the Jardin, 64° 58′, both differing considerably from my results.

GENEVA.

These observations were made in the garden of M. PREVOST-MARTIN, not far from the city; those with the cylindrical needle on the 24th of August and 1st of September, those with the bar on the first occasion; the dip was measured on the second. The observations at Chamouni intervened between the two sets at Geneva. The loss of the chronometer was ascertained from the standard near the Church of St. Peter, which is rated for the use of the watchmakers.

The numbers for Paris used in the reductions were obtained as stated under the head of Chamouni.

Observations at Geneva.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date. Year.	Month.	D.	H.	Temp. Fah. °	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns at 60°. Secs.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity. Paris 1.
Geneva	Cylinder	1837	Aug.	24	1, P. M.	81.2	2	662	32.904	1.0023	1.088
	"	"	Sept.	1	1½, "	68.5	1	300	33.033	1.0032	1.081
	Bar	"	Aug.	24	1¾, "	82.0	2	650	36.048	1.0008	1.086
										Mean,	1.086

FOR DIP.

Geneva, 1837, Sept. 1, Needle No. 1, 64° 52′.4.
No. 2, 47 .3. Mean, 64° 49′.8.

Total Intensity at Geneva, compared with Paris as unity, 0.984.

The horizontal intensity at Geneva, compared with that at Paris, is stated by M. QUETELET* to be 1.0805, and by Professor FORBES†, 1.071; my own result agrees best with the former. Professor FORBES determined the dip, in August, 1832, to be 65° 05′, and states that it was found, in 1825, by M. ARAGO,

* Annuaire de l'Observatoire de Bruxelles, &c., 1834.

† Edinburgh Transactions, vol. xiv.

to be 65° 48′.5. Adopting 2′.8 as the annual decrease of the dip at Geneva, the observations of Professor FORBES would give, for the epoch 1837, 64° 51′.0, and those of M. ARAGO, 65° 14′.9.

BRIENTZ AND THE FAULHORN.

These observations were made at places only about fourteen miles apart, but differing in elevation 6800 feet: the lower station itself (Brientz) is about 8900 feet above the level of the sea. The Faulhorn was one of the stations of Professor FORBES in his Alpine observations; and Brientz is about twelve miles W. N. W. of another of his stations, Meyringen.

The observations at Brientz were made in a field in rear of, and about a hundred yards from the White Cross Hotel; those at the Faulhorn nearly on the very summit, and as far from the chalet as the ground would permit.

The chronometer was rated at Zurich, and the rate, which differed but little from that found at Geneva, has been applied in the following table. The numbers already referred to for Paris, in 1837, have been used in the calculations.

Observations at Brientz and the Faulhorn.

FOR HORIZONTAL INTENSITY.

Place.	Needle.	Date.				Temp.	No. of Series.	No. of Oscillations.	Time of Ten Oscill'ns. at 60°.	Coeffic't of Corr'n for Loss of Magn'm.	Horizontal Intensity.
		Year.	Month.	D.	H.	Fah. °			Secs.		Paris 1.
Brientz	Cylinder	1837	Sept.	22	11, A. M.	65.0	2	700	33.162	1.0056	1.075
	Bar	"	"	"	12½, P. M.	64.8	2	600	36.141	1.0020	1.082
										Mean,	1.078
The Faulhorn	Cylinder	1837	Sept.	20	3 P. M.	50.5	2	700	33.078	1.0054	1.080
	Bar	"	"	"	4 "	43.7	2	600	36.082	1.0017	1.085
										Mean,	1.082

FOR DIP.

Brientz, 1837, Sept. 22, Needle No. 1, 64° 59′.5
No. 2, 65 15 .0 Mean, 65° 06′.7.

The Faulhorn, 1837, Sept. 20, Needle No. 1, 65° 01′.5
No. 2, " 01 .9 Mean, 65° 01′.7.

Total Intensity at Brientz, compared with Paris as unity, 0.9869.
" " Summit of the Faulhorn, " " 0.9874.

The difference in the dip at Brientz, as shown by the two needles, (No. 1 and No. 2,) is very considerable, and, from the separate observed quantities, the results by No. 2 would appear more worthy of confidence than that by No. 1.

The two horizontal needles, oscillated by Professor FORBES, on the Faulhorn, gave 1.071 and 1.060, mean 1.065 for the horizontal intensity compared with Paris, and the needle oscillated at the lower station, Meyringen, for comparison, 1.075. My results, both at the upper and lower stations, exceed these, being 1.082 and 1.078. The difference of the horizontal intensities at the upper and lower stations appears equally from my series and that of Professor FORBES to have been very small; less, in fact, than the differences between two needles at the same station.

I am not aware that Professor FORBES determined the dip at his two corresponding stations. Using the mean dip for Brientz, the total intensity at the lower station appears very nearly the same with that at the upper; using the dip given by needle No. 1, it would, of course, be less; and using that shown by needle No. 2, it would exceed the total intensity at the upper station by only .0046.

The details given in the preceding pages appear to me essential, in order to a just conclusion as to the character of the results, and for reference in regard to the localities and circumstances of the observations. The comparisons of my conclusions with those of others, as far as I am acquainted with them, will probably be found convenient, and, in some cases, had a specific object in reference to these observations themselves. The results being thus unavoidably scattered, I have thought it best, in conclusion, to present them in a single table, divested of particulars.

The results are arranged in the order of the total intensities and columns are inserted for the latitude and longitude of the places.

No.	Place.	Latitude.		Longitude from Paris.		Date.	Horizontal Intensity.	Dip.		Total Intensity.
		°	'	°	'		Paris = 1.	°	'	Paris = 1.
1	Edinburgh.	55	57 N.	5	32 W.	Feb. 3, 1837.	0.841	*	*	
2	Dublin.	53	23 "	8	41 "	Nov. 20, 1836.	0.879	*	*	
3	London.	51	31 "	2	26 "	June 16, 1837.	0.939†	69	16.0	1.021
4	Brussels.	50	51 "	2	02 E	July 25, 1838.	0.969	*	*	
5	Berlin.	52	32 "	11	02 "	Dec. 16, 1837.	0.979	68	08.5	1.014
6	Paris.	48	50 "	0	00 "	Aug. 17, 1837.	1.000	67	20.8	1.000
7	Vienna.	48	13 "	14	02 E.	March 23, 1838.	1.090	64	49.7	0.989
8	The Flégierè.					Aug. 26, 1837.	1.099	64	35.8	0.987
9	Brientz.					Sept. 22, "	1.078	65	06.7	0.987
10	The Faulhorn.					Sept. 20, "	1.082	65	01.7	0.987
11	Geneva.	46	12 "	3	49 "	Aug. 25, "	1.086	64	49.8	0.984
12	Chamberi.					June 21, 1838.	1.089	64	35.0	0.979
13	Chamouni.					Aug. 26, 1837.	1.088	64	38.2	0.979
14	Lyons.	45	46 "	2	29 "	June 25, 1838.	1.078	64	49.0	0.978
15	Milan.	45	28 "	6	51 "	June 10, "	1.111	63	54.7	0.972
16	Venice.	45	26 "	10	01 "	April 11, "	1.129	63	21.9	0.971
17	Trieste.	45	38 "	11	27 "	April 4, "	1.128	63	20.5	0.970
18	Florence.	43	47 "	8	55 "	May 28, "	1.170	62	05.5	0.965
19	Turin.	45	04 "	5	20 "	June 17, "	1.094	63	52.2	0.959
20	Rome.	41		10	10 "	May 18, "	1.225	60	14.0	0.952
21	Naples.	40	52 "	11	57 "	May 7, "	1.249	59	05.1	0.938

* Dip not observed. † Mean of results in June, July, and August, 1837, and in July and August, 1838.

ERRATUM.

Page 96, (in table,) column headed "No. of Oscillations," first line, for 150, read 350.

ARTICLE X.

Additional Observations of the Magnetic Dip in the United States. By Elias Loomis, Professor of Mathematics and Natural Philosophy in Western Reserve College. Read October 14, 1839.

The following observations were made with the same instrument, and the mode of observing adopted was the same as described in a former paper. In needle No. 1, I have continued to find the magnetic axis to coincide very nearly with the geometrical. The inclination has never exceeded a few minutes. In needle No. 2, on the contrary, this inclination has seldom been less than one degree, and, in a few instances, has exceeded two degrees. Yet, although the magnetic axis of this needle never coincides with the geometrical, it does not maintain a constant position with respect to it. If the reading of the needle is at one time too great, when its polarity is reversed, in the same position of the instrument and needle, the reading is invariably too small, showing that the magnetic pole has passed to the other side of the geometrical. In other words, the magnetic axis, instead of revolving 180° from a reversal of the poles, revolves only 175° or 178°. That this anomaly is not to be ascribed to the mode of magnetising employed is, I think, evident from the uniformity of the effect, and from the fact that in needle No. 1, though magnetised in the same way, nothing similar is observed. I can only ascribe it to some peculiarity in the material or temper of the needle. In the transportation of the instrument from place to place by public conveyances, the level was, in several instances, slightly deranged. This was always verified by reversal, previous to commencing the observations, and the level readjusted when necessary. It is believed that the instrument has sustained no injury from transportation, and that it is susceptible of as great accuracy now as formerly. The observations made at Hudson, October 7th, 1839, afford presumptive evidence of this. In order to obviate all danger of mistake in reversing the poles, a small dot of ink was placed upon each needle, and the position of this mark, whether *up* or *down*, was always entered at the head of the observations. The following observations are arranged in the order of their dates:—

Magnetic Dip at Hudson, Ohio, Latitude 41° 15′ *N.; Longitude* 5*h.* 26*m. W.*

Place of observation the same as formerly described.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Aug. 16th,	7—9, A. M.	No. 1,	40	72° 54′.4
" " "	" "	No. 1, poles reversed,	40	42 .9
" " "	" "	Mean of No. 1,	80	48 .6
" " "	" "	No. 2,	40	22 .2
" " "	" "	No. 2, poles reversed,	40	69 .6
" " "	" "	Mean of No. 2,	80	45 .9
" " "	" "	Mean of two needles,	160	72 47 .3

The mean of the observations with the two needles is nearly the same, yet the observations with No. 2, in its two magnetic states, differs by 47′, indicating an inequality in the arms of the needle. If the needle could always be magnetised with the same intensity, the effect of this inequality would be eliminated by reversing the poles; yet, as this condition is not easily fulfilled, it is better to make the arms of the needle of equal weight. The heaviest end of No. 2 was therefore rubbed on a hone, and the observations repeated.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Aug. 18th,	8—9, A. M.	No. 2,	40	72° 36′.8
" " "	" "	No. 2, poles reversed,	40	51 .9
" " "	" "	Mean of No. 2,	80	72 44 .4

Here the inequality is reduced to 15′. The heavy end was again applied to the hone, and the following observations made:—

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Aug. 19th,	9—10, A. M.	No. 2,	40	72° 51′.9
" " "	" "	No. 2, poles reversed,	40	57 .7
" " "	" "	Mean of No. 2,	80	72 54 .8

The inequality is here reduced to 5′.8, and no farther change was made in the needle during the whole of the subsequent observations. The mean of the last 160 observations of No. 2 is 72° 49′.6, and *the mean of the* 320 *readings*, Aug. 16th—19th, is 72° 48′.4.

Magnetic Dip at Buffalo, New York, Latitude 42° 53′ *N.; Longitude* 5*h.* 16*m. W.*

Place of observation a few rods east of the American House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839. Aug. 31st,	8—10, A. M.	No. 1,	40	74° 36′.3
" " "	" "	No. 1, poles reversed,	40	43 .1
" " "	" "	Mean of No. 1,	80	39 .7
" " "	" "	No. 2,	40	37 .4
" " "	" "	No. 2, poles reversed,	40	46 .2
" " "	" "	Mean of No. 2,	80	41 .8
" " "	" "	Mean of both needles,	160	74 40 .8

Magnetic Dip at Oswego, New York. Latitude 43° 26′ *N.; Longitude* 5*h.* 6*m. W.*

Place of observation a few rods west of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 1st,	7½—9½, A. M.	No. 1,	40	75° 17′.3
" " "	" "	No. 1, poles reversed,	40	4 .8
" " "	" "	Mean of No. 1,	80	11 .1
" " "	" "	No. 2,	40	13 .2
" " "	" "	No. 2, poles reversed,	40	9 .7
" " "	" "	Mean of No. 2,	80	11 .5
" " "	" "	Mean of both needles,	160	75 11 .3

Magnetic Dip at Syracuse, New York. Latitude 43° 0′ *N.; Longitude* 5*h.* 5*m. W.*

Place of observation a grove, a few rods north-east of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 2d,	8—10, A. M.	No. 1,	40	74° 47′.8
" " "	" "	No. 1, poles reversed,	40	51 .6
" " "	" "	Mean of No. 1,	80	49 .7
" " "	" "	No. 2,	40	50 .2
" " "	" "	No. 2, poles reversed,	40	54 .0
" " "	" "	Mean of No. 2,	80	52 .1
" " "	" "	Mean of both needles,	160	74 50 .9

Magnetic Dip at Utica, New York. Latitude 43° 7′ *N.; Longitude* 5*h.* 1*m. W.*

Place of observation a few rods north-east of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 3d,	5½—7½, A. M.	No. 1,	40	74° 54′.0
" " "	" "	No. 1, poles reversed,	40	52 .6
" " "	" "	Mean of No. 1,	80	53 .3
" " "	" "	No. 2,	40	59 .5
" " "	" "	No. 2, poles reversed,	40	62 .6
" " "	" "	Mean of No. 2,	80	61 .0
" " "	" "	Mean of both needles,	160	74 57 .2

Magnetic dip at Schenectady, New York. Latitude 42° 48′ *N.; Longitude* 4*h.* 56*m. W.*

Place of observation a few rods south of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 3d,	4½—6½, P. M.	No. 1,	40	74° 40′.7
" " "	" "	No. 1, poles reversed,	40	40 .9
" " "	" "	Mean of No. 1,	80	40 .8
" " "	" "	No. 2,	40	24 .6
" " "	" "	No. 2, poles reversed,	40	38 .1
" " "	" "	Mean of No. 2,	80	31 .3
" " "	" "	Mean of both needles,	160	74 36 .1

Magnetic Dip at Albany, New York. Latitude 42° 39′ *N.; Longitude* 4*h.* 55*m. W.*

Place of observation a few rods north-west of the capitol.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 4th,	11, A.M.—1, P.M.	No. 1,	40	74° 55′.6
" " "	" "	No. 1, poles reversed,	40	45 .5
" " "	" "	Mean of No. 1,	80	50 .5
" " "	" "	No. 2,	40	53 .7
" " "	" "	No. 2, poles reversed,	40	50 .5
" " "	" "	Mean of No. 2,	80	52 .1
" " "	" "	Mean of both needles,	160	74 51 .3

Magnetic Dip at West Point, New York. Latitude 41° 25′ *N.; Longitude* 4*h.* 56*m. W.*

Place of observation on the bank of the river, near the steam-boat landing.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 5th,	3—5, P. M.	No. 1,	40	73° 28′.9
" " "	" "	No. 1, poles reversed,	40	27 .7
" " "	" "	Mean of No. 1,	80	28 .3
" " "	" "	No. 2,	40	22 .8
" " "	" "	No. 2, poles reversed,	40	30 .0
" " "	" "	Mean of No. 2,	80	26 .4
" " "	" "	Mean of both needles,	160	73 27 .4

Magnetic Dip at New York City. Latitude 40° 43′ *N.; Longitude* 4*h.* 56*m. W.*

Place of observation the yard in front of Columbia College.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 9th,	8—10½, A. M.	No. 1,	40	72° 54′.8
" " "	" "	No. 1, poles reversed,	40	47 .1
" " "	" "	Mean of No. 1,	80	50 .9
" " "	" "	No. 2,	40	47 .1
" " "	" "	No. 2, poles reversed,	40	59 .9
" " "	" "	Mean of No. 2,	80	53 .5
" " "	" "	Mean of both needles,	160	72 52 .2

Magnetic Dip at New Haven, Connecticut. Latitude 41° 18′ *N.; Longitude* 4*h.* 52*m. W.*

Place of observation the burial ground.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 11th,	7—9, A. M.	No. 1,	40	73° 24′.0
" " "	" "	No. 1, poles reversed,	40	34 .6
" " "	" "	Mean of No. 1,	80	29 .3
" " "	" "	No. 2,	40	14 .4
" " "	" "	No. 2, poles reversed,	40	33 .9
" " "	" "	Mean of No. 2,	80	24 .1
" " "	" "	Mean of both needles,	160	73 26 .7

Magnetic Dip at Hartford, Connecticut. Latitude 41° 46′ *N.; Longitude* 4*h.* 51*m. W.*

Place of observation a short distance north-west of the State House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 13th,	9½—11½, A. M.	No. 1,	40	73° 58′.2
" " "	" "	No. 1, poles reversed,	40	52 .4
" " "	" "	Mean of No. 1,	80	55 .3
" " "	" "	No. 2,	40	61 .0
" " "	" "	No. 2, poles reversed,	40	60 .8
" " "	" "	Mean of No. 2,	80	60 .9
" " "	" "	Mean of both needles,	160	73 58 .1

Magnetic Dip at Springfield, Massachusetts. Latitude 42° 6′ *N.; Longitude* 8*h.* 50*m. W.*

Place of observation a few rods east of Hampton Coffee House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 14th,	8—10, A. M.	No. 1,	40	74° 7′.6
" " "	" "	No. 1, poles reversed,	40	8 .1
" " "	" "	Mean of No. 1,	80	7 .8
" " "	" "	No. 2,	40	7 .0
" " "	" "	No. 2, poles reversed,	40	5 .0
" " "	" "	Mean of No. 2,	80	6 .0
" " "	" "	Mean of both needles,	160	74 6 .9

Magnetic Dip at Longmeadow, Massachusetts. Latitude 42° 2′ *N.; Longitude* 4*h.* 50*m. W.*

Place of observation a few rods west of the village church.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 14th,	3¼—5, P.M.	No. 1,	40	74° 6′.4
" " "	" "	No. 1, poles reversed,	40	4 .0
" " "	" "	Mean of No. 1,	80	5 .2
" " "	" "	No. 2,	40	11 .7
" " "	" "	No. 2, poles reversed,	40	73 59 .0
" " "	" "	Mean of No. 2,	80	74 5 .4
" " "	" "	Mean of both needles,	160	74 5 .3

Magnetic Dip at Worcester, Massachusetts. Latitude 42° 16′ *N.; Longitude* 4*h.* 47*m. W.*

Place of observation a few rods west of Worcester House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 16th,	4—6, P. M.	No. 1,	40	74° 19′.6
" " "	" "	No. 1, poles reversed,	40	26 .0
" " "	" "	Mean of No. 1,	80	22 .8
" " "	" "	No. 2,	40	11 .1
" " "	" "	No. 2, poles reversed,	40	25 .5
" " "	" "	Mean of No. 2,	80	18 .3
" " "	" "	Mean of both needles,	160	74 20 .6

Magnetic Dip at Cambridge, Massachusetts. Latitude 42° 22′ *N.; Longitude* 4*h.* 44*m. W.*

Place of observation a few rods south-west of the colleges.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 17th,	3—5, P. M.	No. 1,	40	74° 19′.2
" " "	" "	No. 1, poles reversed,	40	18 .9
" " "	" "	Mean of No. 1,	80	19 .1
" " "	" "	No. 2,	40	19 .4
" " "	" "	No. 2, poles reversed,	40	22 .7
" " "	" "	Mean of No. 2,	80	21 .0
" " "	" "	Mean of both needles,	160	74 20 .1

Magnetic Dip at Providence, Rhode Island. Latitude 41° 50′ *N.; Longitude* 4*h.* 46*m. W.*

Place of observation near the steam-boat landing.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 19th,	11½, A.M.—1, P.M.	No. 1,	40	73° 57′.0
" " "	" "	No. 1, poles reversed,	40	60 .6
" " "	" "	Mean of No. 1,	80	58 .8
" " "	" "	No. 2,	40	62 .8
" " "	" "	No. 2, poles reversed,	40	57 .9
" " "	" "	Mean of No. 2,	80	60 .3
" " "	" "	Mean of both needles,	160	73 59 .6

Magnetic Dip at Princeton, New Jersey. Latitude 40° 22′ *N.; Longitude,* 4*h.* 58*m. W.*

Place of observation an open field, one hundred rods south of the colleges.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 21st,	10—12, A. M.	No. 1,	40	72° 47′.4
" " "	" "	No. 1, poles reversed,	40	47 .4
" " "	" "	Mean of No. 1,	80	47 .4
" " "	" "	No. 2,	40	52 .9
" " "	" "	No. 2, poles reversed,	40	40 .8
" " "	" "	Mean of No. 2,	80	46 .8
" " "	" "	Mean of both needles,	160	72 47 .1

Magnetic Dip at Philadelphia, Pennsylvania. Latitude 39° 57′ *N.; Longitude* 5*h.* 1*m. W.*

Place of observation the yard in front of President Bache's house.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 23d,	10½—12, M.	No. 1,	40	72° 8′.6
" " "	" "	No. 1, poles reversed,	40	11 .3
" " "	" "	Mean of No. 1,	80	10 .0
" " "	" "	No. 2,	40	71 58 .9
" " "	" "	No. 2, poles reversed,	40	72 9 .6
" " "	" "	Mean of No. 2,	80	4 .2
" " "	" "	Mean of both needles,	160	72 7 .1

Magnetic Dip at Baltimore, Maryland. Latitude 39° 17′ *N.; Longitude* 5*h.* 7*m. W.*

Place of observation the grove north of Washington Monument.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 25th,	7—8, A. M.	No. 1,	40	71° 54′.3
" " "	" "	No. 1, poles reversed,	40	46 .3
" " "	" "	Mean of No. 1,	80	71 50 .3

Magnetic Dip at Washington City. Latitude 38° 53′ *N.; Longitude* 5*h.* 8*m. W.*

Place of observation the yard in front of the capitol.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 25th,	3—5, P. M.	No. 1,	40	71° 20′.9
" " "	" "	No. 1, poles reversed,	40	14 .5
" " "	" "	Mean of No. 1,	80	17 .7
" " "	" "	No. 2,	40	26 .4
" " "	" "	No. 2, poles reversed,	40	23 .7
" " "	" "	Mean of No. 2,	80	25 .1
" " "	" "	Mean of both needles,	160	71 21 .4

Magnetic Dip at Pittsburgh, Pennsylvania. Latitude 40° 32′ *N.; Longitude* 5*h.* 20*m. W.*

Place of observation an open yard on the opposite side of Alleghany river.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 30th,	9—11, A. M.	No. 1,	40	72° 44′.5
" " "	" "	No. 1, poles reversed,	40	39 .3
" " "	" "	Mean of No. 1,	80	41 .9
" " "	" "	No. 2,	40	34 .3
" " "	" "	No. 2, poles reversed,	40	37 .6
" " "	" "	Mean of No. 2,	80	35 .9
" " "	" "	Mean of both needles,	160	72 38 .9

Magnetic Dip at Beaver, Pennsylvania. Latitude 40° 44′ *N.; Longitude* 5*h.* 22*m. W.*

Place of observation on the bank of the Ohio, near Beaver bridge.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Oct. 1st,	$8\frac{3}{4}$—$10\frac{1}{4}$, A. M.	No. 1,	40	72° 34′.9
" " "	" "	No. 1, poles reversed,	40	40 .6
" " "	" "	Mean of No. 1,	80	37 .8
" " "	" "	No. 2,	40	40 .0
" " "	" "	No. 2, poles reversed,	40	45 .6
" " "	" "	Mean of No. 2,	80	42 .8
" " "	" "	Mean of both needles,	160	72 40 .3

Magnetic Dip at Hudson, Ohio. Latitude 41° 15′ *N.; Longitude* 5*h.* 26*m. W.*

Place of observation the same as formerly.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Oct. 7th,	1—3, P. M.	No. 1,	40	72° 49′.1
" " "	" "	No. 1, poles reversed,	40	45 .0
" " "	" "	Mean of No. 1,	80	47 .0
" " "	" "	No. 2,	40	43 .8
" " "	" "	No. 2, poles reversed,	40	46 .0
" " "	" "	Mean of No. 2,	80	44 .9
" " "	" "	Mean of both needles,	160	72 45 .9

In comparing the preceding observations, some discordances will be perceived. The difference of the readings in the two magnetic states of the needles is, by no means, constant. When the marked end of needle No. 1 was a north pole, the average observed dip was 4′.4 greater than when it was a south pole, showing a small but real inequality in the weight of the arms. Correcting the differences for this constant effect, the remainders are quite anomalous, and are subject to no obvious law. Their mean value is a little less than four minutes, and the greatest amounts to ten minutes. These anomalies may be ascribed to various causes, such as errors of observation; erroneous entries of readings; influence of currents of air, which, although the observations were all made under a glass cover, are quite appreciable when the wind is fresh; dust and moisture, and, perhaps, loose ferruginous particles collecting upon the needle, and producing a temporary inequality in the weight of the arms: this source of error I always endeavoured to guard against by carefully wiping each needle before the observations, yet it is doubtful if, even with this precaution, its effect was wholly eliminated. Dust and moisture, adhering to the pivots of the needles and to the agate supports, might also have a sensible influence; and, finally, it is, perhaps, credible that there may have been an appreciable diurnal change in the dip during the interval of the observations. Similar remarks apply to the observations with needle No. 2 in its different magnetic states. The mean results of the two needles at a single locality usually differ somewhat; and in one instance, at Schenectady, the difference amounts to 9'.5; yet, for the entire series of observations, the average excess of the results with one needle above those with the other is only the tenth part of a minute, showing that the differences in the partial results are accidental; and as these differences are not very large, it is believed that the preceding observations furnish a tolerable approximation to the true magnetic dip at the places designated.

ARTICLE XI.

On a new Principle in regard to the Power of Fluids in Motion to produce Rupture of the Vessels which contain them; and on the Distinction between accumulative and instantaneous Pressure. By Charles Bonnycastle, Professor of Mathematics in the University of Virginia. Read November 15, 1840.

In a paper published by Dr. Hare in the Transactions of the American Philosophical Society, of which paper he was polite enough to send me a copy, is a description of a singular phenomenon that was observed in the destruction of an air-vessel, under circumstances which at first appear to contradict the known laws that regulate the motion and pressure of fluids.

The subject of the paper is "The collapse of a reservoir whilst apparently subject within to great pressure from a head of water;" and in treating it, Dr. Hare points out the attendant circumstances, and ingeniously shows how the vessel may have been momentarily relieved from the pressure of the water within, so as to make the pressure of the surrounding air efficient in producing the collapse. He does not, however, push his inquiries to a point essential to the full explanation. An investigation into the nature and degree of the forces brought into action leads to results, according, indeed, with the theory of resilience, but presenting, in the laws of instantaneous pressure, and in the effects of that pressure when produced by an abrupt check given to a fluid in motion, a branch of the subject in some degree intermediate between statics and dynamics, and which has not yet been fully developed.

At the period when I first deduced the results contained in this paper, very little attention had been paid to any of the class of phenomena to which they belong; something further has since been done in England, but I have not seen any investigations that bear directly on the subject in question. My own remarks were drawn up immediately after the publication of the memoir above noticed, but were laid by and neglected until my attention was again drawn towards them by an instance of the great effect of such pressures that fell under my notice a few months since. I had occasion to trace the laws of sound propagated through water, and with the view of readily discharging a pistol at various depths below the surface, contrived the apparatus in Fig. 1. I had directed the box to be formed of cast iron, but the maker, providing a strong support for the breech of the pistol, and meeting with delay in the casting, persuaded himself that thick tin plate, strengthened with ribs, would give abundant strength to the remaining sides of the box. A covering of sheet brass, an eighth of an inch thick, was subsequently added, and yet such is the nature of the action in question, that farther security was necessary before this little case, which did not exceed eight inches by five, could resist the powerful strains that tended to burst it inward when exposed to the action of an ordinary pistol, exploded at a depth of five or six feet below water.

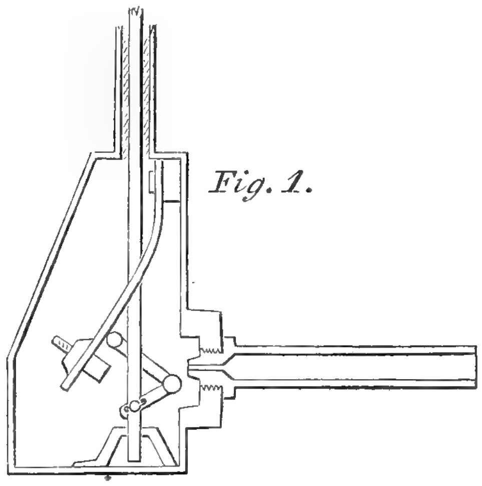


Fig. 1.

This additional instance of the occurrence of those destructive and apparently paradoxical strains that had attracted the attention of the eminent chemist above mentioned, induced me to re-examine the paper I formerly showed to you,* and to make public, with some slight addition, the results it contained.

I had shown, in a former paper, that many problems which appear purely questions of statics, cannot be resolved without employing the elementary motions which connect such problems with those of dynamics.† The problem before us is one of this class, and, when treated practically, is most conveniently arranged as a question of statical pressures.

Practical mechanics and engineers are accustomed to view the forces with which they have to deal, under the twofold division of the *loads* which their engines or structures bear, and the *strains* such loads occasion.

* This paper was addressed to Dr. Patterson.

† On the pressures produced by a heavy body when sustained by more than three supports. Read before the R. Society of London, 1819. An. Philos., April, 1819.

The pressures that maintain the equilibrium between the load and strain may vary incessantly from the operation of those minute vibrations that every where render absolute rest impossible; nearly all the cases that are practically regarded as states of rest, or uniform motion, are really examples of periodic vibrations which escape the senses. Motions so small are often sufficient to make the pressures pass through all degrees of intensity, and even to become negative; but the practical mathematician, who only looks to ultimate results, cannot take notice of this delicate and hidden machinery, and finds it convenient to regard the load as invariable, and to estimate the strain, not by its mean, but its greatest amount. These remarks will sufficiently explain the necessity of the distinction which I have made between the pressure and the mean pressure, or load: and I have only to add one or two farther observations, in order to render the terms I have employed sufficiently clear and precise. The first of these regards a species of action that occurs frequently in the strains we are discussing, or rather, which forms a convenient limit to the mixed strains that are met with in nature. To understand this action, let us suppose a fluid of finite mass, as water or mercury, to be contained in a tube of some very flexible and imponderable material; a sudden tremor propagated in the fluid would then cause, at the point where the wave passed, a pulsation of very limited extent, compared with the expansive power of the tube; and which would have its single advance and single regression regulated by laws proper to the fluid, and little involving the inconsiderable resistance of the conduit. Such an action we shall describe as "an exterior, or interior, vibration of immense momentum and infinitely little extent, compared with the motions and mass of the support."

A clear idea of this species of force will be necessary to what follows; and the only further observation for which we shall have occasion has reference, not to the forces exerted, but to the nature of the structure which sustains them; and chiefly to the distinction that must be made between elastic supports and those which unite with this quality a large degree of flexibility. Every material, it is well known, when wrought into rods or plates sufficiently thin, loses its tendency to return to a primary, or unloaded position, and must be regarded as flexible. Flexibility itself is merely an elasticity, more or less perfect, acting according to a single axe; and flexible bodies may be allied to the elastic by regarding them as secured at each end and drawn into an initial position by the action of an evanescent stretching force.

From which observations it is evident that if we consider the several cases of perfect and imperfect elasticity in the directions of all the axes, and of perfectly flexible bodies, drawn into an initial state by the action of an initial and evanescent force, we shall obtain the limits of the results that can practically happen.

The several conclusions to which I have arrived for these cases may be stated as follows:—

1. It is convenient to distinguish between accumulative and instantaneous loads, or between those which are gradually increased until the deflection due to the ultimate load is obtained, and those which commence in their full efficacy from the initial position of the support.

2. Within the limits of perfect elasticity, instantaneous pressure produces twice the effect of that which is accumulative, whether the result be to produce deflection or fracture.

3. In regard to supports perfectly elastic in one direction and perfectly flexible in the other, instantaneous action at right angles to the axis of elasticity produces a deflection which is to that of accumulative action as $\sqrt{4}$ to 1, whilst the tendencies of fracture are as 4 to 1. But, should any case occur where the law of elasticity follows an extremely high power of the deflection, then the singular result will follow, that the deflections are the same whether the force be exerted from the initial state or the state of load, but that the tendency to fracture will be immensely greater in the former case than in the latter.

4. In producing the fracture of natural substances, which all depart from the law of perfect elasticity as we approach the limit of fracture, the ratio of the effects of instantaneous and accumulative action will vary with the nature of the substances, never being less, for elastic bodies, than 2 to 1, nor, for flexible, than 4 to 1, and more usually approaching 3 or 4 to 1 for the former case, and 5 or 6 to 1 for the latter.

5. Let a vase or conduit be acted upon by a load which is alone insufficient to break it; and let this load be partly balanced by a small exterior force. Should the great interior force suddenly cease, the small exterior action may crush the vase or conduit inward, its energy in such case being the sum of the interior and exterior forces.

6. Should the interior force be a vibration of the kind already explained, and should the exterior action be extremely feeble, and act on a very great mass, this extremely feeble action may crush the vase inward, with a power that shall exceed, in any degree, the enormous action of the interior and explosive vibrations. The comparison of the interior and exterior actions is best effected, in this case, by finding the modulus of elasticity of a material spring that shall coincide most nearly in effect with the interior tremor. For, putting e and e' respectively for the modulus of the spring and of the support, and σ and σ' for the deflections resulting from the tremor acting alone, and the reaction as it does act, we have $\frac{s'}{\sigma} = \sqrt{\frac{e}{e'}}$, or, in other words, the deflection produced by the reaction, is to the deflection that would be produced by the interior tremor alone, in the inverse proportion of the square roots of the moduli of tremor and support.

7. Combining what is here said with the known laws of fluids moving in pipes, and whereby they necessarily produce hydraulic shocks, it follows that any vessel connected with such a train of pipes, and plunged at some little depth in a considerable mass of water, or other heavy fluid, will occasionally be subject to a crushing and exterior force vastly greater than the interior strain due to the constant head of fluid.

To investigate these results, let us commence with the very simple case of a mass m, urged by two moving forces f and $-f'$, which tend to deflect it from a point of initial repose. The vis viva in this case will be $\int_0^s \{fds - f'ds\}$, where s is the distance through which the mass has moved; and as this vis viva must be zero when the mass has attained its limit of deflection, we have for that case

$$\int_0^s \{fds\} = \int_0^s \{f'ds\} \qquad (1)$$

Now it is clear that if the forces f and $-f'$ acted only at the position of load, we should have simply

$$f = f'; \qquad (2)$$

and consequently if we express by σ and σ' the deflections occasioned by an instantaneous and an accumulated load, resulting from the action of $f - f'$ when commencing at the initial position, and the position of load, we must determine the first from equation (1), and the second from equation (2).

The case that we have first to consider, is when the force $-f'$ arises from the resistance es of an elastic support, whilst f, as ordinarily happens, is a constant load. The equations (1 and 2) then become

$$2f\sigma = e\sigma^2$$
$$f = e\sigma'$$

whence we deduce the second of the results already mentioned, namely that $\sigma = 2\sigma'$.

When the elasticity is imperfect, we may reason by observing, first, that s represents the abscissa, and $e\,s$ the ordinate y, of the curve of elasticity, or the curve which expresses the relation between the deflection and resistance; and, secondly, that the integral $\int f ds$ is equivalent to the area of this curve. Now an area corresponding to an abscissa s is equal to s multiplied into the mean ordinate y'; and when the curve deflects inward from the tangent, and turns towards the abscissa, as the curve in question does when the elasticity is imperfect, it is manifest that the mean ordinate does not stand in the middle of the total abscissa, but at a point which is nearer to the origin: in other words σ being the total abscissa, and σ' that belonging to the mean ordinate, we shall have in the equation $\sigma = m\sigma'$, m exceeding 2. But referring to our equations (1) and (2), we observe them to become in this case

$$f\sigma = y'\sigma$$

and

$$f = y'';$$

which gives $y' = y''$, or the mean ordinate of force to the deflection σ, equal to the extreme ordinate of force to the deflection σ'. And we have already seen that in the equation $\sigma = m\,\sigma'$, m exceeds 2; whence we conclude so much of the fourth proposition as relates to bodies imperfectly elastic in the direction of the load.

To demonstrate the third proposition, let a cord of inconsiderable mass, half length l, and modulus e, be drawn into a horizontal position by the action of an inconsiderable stretching force. Applying to the centre of this cord a force that deflects it through a space s, the half length after deflection will be $\sqrt{l^2 + s^2}$; the extension $\frac{1}{2}\frac{s^2}{l}$; and the tension in the direction of each branch of the cord, equal to $\frac{1}{2}\frac{es^2}{l}$. The resistance opposed to the deflecting force is therefore $\frac{es^3}{l^2}$; or f must be regarded as constant, and f' as equal to $\frac{es^3}{l^2}$; assumptions that reduce the equations (1) and (2) to

$$f\sigma = \frac{1}{4}\frac{e\sigma^4}{l^2}$$

$$f = \frac{e\sigma'^3}{l^2};$$

which give $\sigma = \sigma'\sqrt[3]{4}$, or the deflection from the initial position to the deflection of load, as $\sqrt[3]{4}$ to 1.

When the deflection, produced in either way, attains the limit of rupture σ'', we have $\sigma = \sigma' = \sigma''$; and denoting by $f_\backslash$ the force that would produce this deflection when acting from the initial position, and by f the force that would produce the same as a deflection of load, the equation $\sigma = \sigma'$ gives

$$\frac{4f_\backslash}{f} = 1$$

or $f = 4f_\backslash$; or, the force which produces rupture when acting from the position of load, is to the force which produces fracture when acting from the initial position, as 4 to 1; an imperfection in the elasticity increasing this proportion, as in the former case.

And observing that when the law of elasticity is as the m^{th} power of the deflection, these equations become

$$f\sigma = \frac{1}{m}\frac{e\sigma^{m+1}}{l^2}$$

$$f = \frac{e\sigma'^m}{l^2}$$

$$\frac{mf_\backslash}{f} = 1,$$

we deduce for the case when m is infinite, the conclusion of the third proposition in regard to that case.

The application of this theory to the strains occasioned by a column of fluid moving through a pipe, and subject to checks, and separation into distinct columns, will be immediately seen. The most powerful of the interior strains of this class must be due to those blows of the hydraulic ram which occur, both on the first letting on of the water, and on the suddenly closing a stop-cock when the fluid is in one of those pulses of attenuation which occur in the motion of fluids through long pipes, obstructed by enclosed air, and rendered irregular by branches.

How very powerful these blows are is well known to the engineer, and we have now only to show under what circumstances they may be reversed in direction, and vastly increased in intensity.

The inverted direction will occur whenever the pipe, pressed from without by the atmosphere, and any large mass of fluid, as the water of a well or pit through which it may pass, is left unsupported within by the sudden separation and contraction of the fluid which follows an hydraulic blow. Such inversion will always occasion a strain from without, more powerful than the internal strain that produced it, but the severest strains of this kind will occur when the original force is such as we have termed an interior vibration of immense momentum and infinitely little extent, compared with the motions and mass of the support.

It is true that such a case is never practically attained, and that it far more usually happens that the internal strain has an extent of motion approaching to, or equalling that of the support; in which case the reversed pressure becomes the sum of the interior and exterior forces; but as this forms one limit of the practical action, so may the explosive forces that we have described be said to form the other; and I shall therefore consider it proper to give their theory as connected with the subject under discussion. The very instance, indeed, which Dr. Hare describes, and that which fell under my own observation, approach this class, as will be evident in the former case, from considering that a pipe passing through a large metal reservoir, or chamber, might have the lateral pulses propagated in the water it conveyed, small with regard to the expansion which the chamber was capable of enduring; and this to the greater extent, as we speak not of the total lateral motion of the pulse, but of that lateral expansion which it would undergo during its extremely rapid transit through the chamber.

Such forces would nearly resemble those internal explosions that we assume; and as the sides of the reservoir in the case alluded to were of copper, and of no great thickness, they will approach the remaining conditions of the problem, partaking of the nature both of flexible and of elastic bodies, and having little mass compared with the column of fluid within the pipe, or the body of fluid without.

The instance of explosive forces on which I shall found their theory will be readily understood. Conceive an elastic lamina a, of inconsiderable mass, and small modulus e' to be placed between two masses m and m', both large compared to a, but of which m' infinitely exceeds m. Let m be attached to a spring b that is retained at a distance s' from the point of repose, very inconsiderable with regard to the deflections of a, but which, from the amount of the modulus e of this second elastic body, will occasion, when the retaining power is removed, an immense pressure on m, a, and m'. Further, conceive m' subject to a small constant force that urges it in a contrary direction to this pressure.

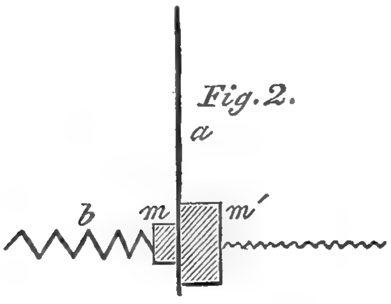


Fig. 2.

The magnitude of e's and m' will allow us to consider these as the only elements concerned in the generation of the first motions, and thus when b has attained the position of repose, or that where it has no elastic power, the vis viva generated will be $e\,\sigma^2$; and as the motion of the mass m', attached to b, is now retarded, m' and m will separate; and the latter, after being urged to a distance which, on account of the minuteness of the resisting force, is considerable, will return to impinge on a, with the vis viva $e\,\sigma^2$; and if b has been removed in the interval, this force must be destroyed by the sole resistance of a. But the vis viva generated by a in traversing a distance σ' is equal to $e'\,\sigma'^2$; from which it follows that when the returning strain occasioned by m' has been wholly destroyed, we have

$$e\,\sigma^2 = e'\,\sigma'^2$$

or

$$\frac{\sigma'}{\sigma} = \sqrt{\frac{e}{e'}}$$

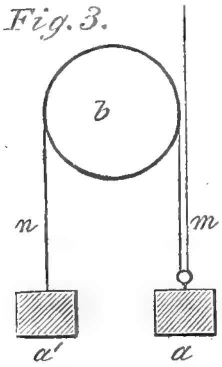
as asserted in the sixth proposition. The use of the mass m' in this investigation will be readily seen by observing that it makes the velocity of the motion, when b acts against a alone, quite independent of the mass of the latter; so that a will stop when b has expanded through the extent of a vibration, and the deflection thus attained will be σ; or, in other words, the case assumed is that of a heavy and powerful spring, acting against a light and weak one.

I shall conclude these remarks with illustrations derived from two obvious and simple experiments.

Thus an examination of the relative power which different filaments possess in resisting instantaneous and accumulative loads may be conducted as follows:—

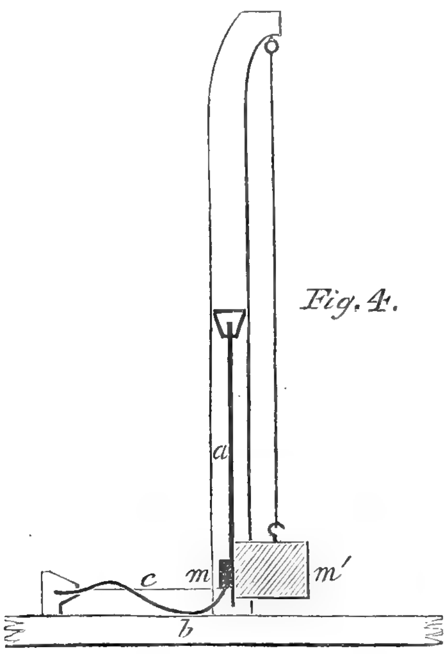
Suspend from a thread (*m*) of the substance examined, a weight (*a*) that is insufficient to cause rupture: let a weight (*a'*) exceedingly nearly equal to (*a*) support the latter through the medium afforded by the fine thread (*n*) that passes over the very delicate pulley (*b*). In this state of things it is evident that (*m*) will merely sustain such tension as suffices to draw it into a rectilinear position; or, in other words, to bring it into the state where elasticity begins to be exerted. Now, by the rapid lateral motion of some sharp edge, as that of a razor, divide (*n*); and thus transfer, instantaneously, the whole tension of (*a*) upon the thread (*m*). The load, in this case, is that which we have termed instantaneous, and, in consequence, rupture will take place under the action of a weight considerably less than if the pressure had been made accumulative, as, by gradually raising (*a'*) until (*m*) had obtained the deflection of load. In the instance of a thread of fine cotton, the proportion of the weights that caused rupture in the two cases was as 1 to 3.

Fig. 3.



Experiments on the restricted vibrations which we termed explosive, and which last occupied our attention, may be conducted by means of the very case that we chose for investigating the theory of such forces. A massive body (*m'*), suspended by a thread of considerable length, and allowed to rest in its state of equilibrium against the elastic rod that is to be broken, will supply both the mass (*m'*) of the theory, and the weak and nearly constant force that urged it; whilst the smaller mass (*m*), set into motion by suddenly cutting the cord (*c*), will continue to press against (*a*) until the spring (*b*) has nearly attained its point of repose, when, no longer supported by

Fig. 4.



friction, the weight of (m) will detach it from (a), and bring (b) into such a position as to prevent its impeding the reaction by which (a) is broken.

The sides of the reservoir, in the case which led to this investigation, we have assimilated to (a); the brief but powerful hydraulic concussions of the internal fluid, to the action of the spring (b), and the effect of the external water in which we suppose the reservoir plunged, to that of the mass (m'); and I need merely add, that were the cases perfectly parallel, our formula proves that the tendency to rupture by the reaction may amount to a very large multiple of that resulting from the mere explosive strain when the exterior pressure is removed.

ARTICLE XII.

On the Storm which was experienced throughout the United States about the 20th of December, 1836. By Elias Loomis, Professor of Mathematics and Natural Philosophy in Western Reserve College. Read March 20, 1840.

Being well convinced that meteorology is to be promoted, not so much by taking the mean of long-continued observations, as by studying the phenomena of particular storms developed over a widely extended country, I resolved to select some single storm of strongly marked characteristics, and trace its progress as extensively and minutely as possible. For this investigation I made choice of the storm which occurred in the United States about the 20th of December, 1836; not only because it seems well suited to my purpose, but because I found ready furnished for my use a considerable number of most valuable observations. In the eastern states this storm occurred within the period recommended by Sir John Herschel for hourly meteorological observations, and all the phenomena of the storm were most carefully and minutely recorded at eight different stations, namely, at Baltimore, New York, Albany, Flushing, New Haven and Gardiner, in the United States; as, also, at Montreal and Quebec, in Lower Canada. These observations, with the exception of those at Baltimore, are published in the Report of the New York University Register for 1837. I addressed a letter to each individual who, so far as I could ascertain, kept a meteorological register, requesting an extract from the same for the period in question. The result is that I have obtained barometric observations from twenty-seven different stations within the United States and the neighbouring British possessions. The situation of these stations, and the authority upon which the observations rest, are shown in the following table:

Station.	Latitude.	Longitude.	Authority.
Natches, Miss., ...	31° 34′ N.	91° 24′ W.	Henry Tooley.
Pensacola, Florida, ...	30 28	87 12	William W. Valk, M. D.
Lexington, Kentucky, ...	38 6	84 18	Robert Peter, M. D.
Springfield, Ohio, ...	39 53	83 48	M. G. Williams.
Marietta, Ohio, ...	39 25	81 36	S. P. Hildreth.
Twinsburgh, Ohio, ...	41 20	81 26	Rev. Samuel Bissel.
Savannah, Georgia, ...	32 5	81 7	W. H. Williams.
Indian Key, Florida, ...	24 48	80 55	Charles Howe.
Rochester, New York, ...	43 8	77 51	James W. Russell.
Washington City, ...	38 53	77 2	J. M. Foltz.
Sunbury, Pennsylvania, ...	40 53	76 50	Hugh Bellas.
Baltimore, Maryland, ...	39 17	76 36	Maryland Academy.
Syracuse, New York, ...	43 1	76 16	V. W. Smith.
Philadelphia, Pennsylvania, . .	39 57	75 11	Franklin Journal.
New York City, ...	40 43	74 1	William C. Redfield.
Flushing, New York, ...	40 45	73 52	Prof. C. Gill.
Albany, New York, ...	42 39	73 45	Albany Institute.
Montreal, Lower Canada, . . .	45 31	73 35	John S. M'Cord.
New Haven, Connecticut, . . .	41 18	72 58	Edward C. Herrick.
Hanover, New Hampshire, . . .	43 41	72 22	Prof. Ira Young.
Quebec, Lower Canada, ...	46 49	71 16	J. Watt.
Boston, Massachusetts, ...	42 21	71 4	Dr. Hale.
New Bedford, Massachusetts, . .	41 38	70 56	Joseph Congdon.
" "	" "	" "	Mr. Rodman.
Gardiner, Maine, ...	44 10	69 50	R. H. Gardiner.
Halifax, Nova Scotia, ...	44 39	63 36	John Morrow, U. S. Consul.
Bermuda, ...	32 34	63 28	Col. A. Emmett.
St. Johns, Newfoundland, . . .	47 34	52 38	Joseph Templeman.

I have been more successful in obtaining meteorological registers which did not comprise observations of the barometer. Through the politeness of Hon. Elisha Whittlesey, late Representative in Congress, I have obtained a copy of the observations made at the different military stations of the United States; and through Mr. M. H. Webster, of Albany, N. Y., I have obtained a copy of the observations made at the several academies in the State of New York. To Messrs. S. C. Walker, E. C. Herrick, and S. F. Plimpton, I am under particular obligations for their assistance in obtaining for me meteorological journals.

The following table shows the names and situations of the military posts from which observations have been received.

Posts.	Latitude.	Longitude.
Fort Gibson, Arkansas,	35° 47′ N.	95° 19′ W.
Fort Leavenworth, Missouri,	39 28	95 14
Fort Towson, Arkansas,	33 36	95 4
Fort Jesup, Louisiana,	31 35	93 42
Fort Snelling, Iowa,	44 53	93 12
Fort Des Moines, Iowa,	40 21	91 38
Fort Crawford, Wisconsin,	43 4	91 7
Jefferson Barracks, Missouri,	38 32	90 25
St. Louis, Missouri,	38 37	90 21
Fort Winnebago, Wisconsin,	43 32	88 53
Fort Howard, Wisconsin,	44 46	87 13
Fort Mitchell, Alabama,	32 20	85 16
Fort Mackinac, Michigan,	45 46	84 40
Fort Brady, Michigan,	46 29	84 18
Dearbornville Arsenal, Michigan,	42 24	83 2
Fort Gratiot, Michigan,	42 54	82 25
Picolata, Florida,	29 59	81 56
Fort Marion, Florida,	29 48	81 35
Alleghany Arsenal, Pennsylvania,	40 28	80 7
Fort M'Henry, Maryland,	39 18	76 35
Fort Monroe, Virginia,	36 50	76 22
Fort Columbus, New York,	40 41	74 1
Fort Wood, New York,	40 42	74 1
West Point, New York,	41 25	74 0
Watertown Arsenal, Massachusetts,	42 23	71 7
Fort Independence, Massachusetts,	42 16	71 0
Fort Constitution, New Hampshire,	43 4	70 45
Hancock Barracks, Maine,	46 8	67 51

The following table shows the situation of the academies in New York from which observations have been obtained.

	Latitude.	Longitude.		Latitude.	Longitude.
Pomfret,	42° 25′ N.	79° 24′ W.	Potsdam,	44° 40′ N.	75° 1′ W.
Lewiston,	43 9	79 10	Delhi,	42 16	74 58
Concord,	42 31	78 50	Fairfield,	43 5	74 55
Rochester,	43 8	77 51	Cherry Valley,	42 48	74 47
Henrietta,	43 6	77 39	Poughkeepsie,	41 41	74 45
Palmyra,	43 5	77 16	Canajoharie,	42 53	74 35
Canandaigua,	42 50	77 15	Johnstown,	43 0	74 23
Ithaca,	42 27	76 30	Goshen,	41 20	74 11
Auburn,	42 55	76 28	Newburgh,	41 30	74 5
Homer,	42 38	76 11	Kingston,	41 55	74 2
Ellisburgh,	43 45	76 10	Montgomery,	41 32	74 0
Onondaga,	42 59	76 6	Flatbush,	40 37	73 58
Pompey,	42 56	76 5	Redhook,	42 2	73 56
Casinovia,	42 55	75 51	Jamaica,	40 41	73 56
Genornem,	44 25	75 35	Schenectady,	42 48	73 55
Hamilton,	42 49	75 34	Mount Pleasant,	41 9	73 47
Oxford,	42 28	75 32	Lansinburgh,	42 49	73 43
Bridgewater,	42 55	75 17	Kinderhook,	42 22	73 43
Whitestown,	43 7	75 14	Cambridge,	43 1	73 23
Utica,	43 6	75 13	Granville,	42 23	73 16
Hartwick,	42 37	75 4	East Hampton,	41 0	70 19

The following are the additional stations from which meteorological registers have been received.

	Latitude.	Longitude.	Authority.
Baton Rouge, ...	30° 28′ N.	91° 28′ W.	Surgeon of Penitentiary.
Augusta, Illinois, ...	40 15	91 6	Samuel B. Mead, M. D.
St. Louis, Missouri, ...	38 37	90 21	George Engelmann, M. D.
St. Augustine, Florida, ...	29 48	81 35	Surgeon of Military Hospital.
Charleston, South Carolina, . .	32 46	79 57	Prof. C. U. Shepard.

I have also collected a great variety of observations from stations beyond the probable limits of the storm, to which reference will be made in the sequel. I think it unnecessary to transcribe all the above mentioned observations at large, because they would occupy a great space, and the substance of them will presently be presented in a condensed form.

In discussing these observations, four distinct subjects of inquiry present themselves.

I. A remarkable oscillation of the barometer.

II. A sudden depression of the thermometer.

III. Rain—amount—with time of beginning and end.

IV. Wind—its duration and velocity.

I. The oscillation of the barometer.

A bare inspection of the meteorological registers is sufficient to show that, during the period in question there was every where throughout the United States a sudden depression of the barometer, immediately succeeded by an equally sudden rise; that the barometric minimum occurred first in the western states, and later in the eastern, passing like a wave over the entire country, from west to east. In order to present this fact in the most striking light, I have projected on Plate I., Fig. 1, curves representing this oscillation of the barometer at each station. The abscissas represent the times of observation, and the ordinates the barometric heights on a scale reduced one-third; that is, a difference of two-thirds of an inch in the ordinates of a curve is intended to show an absolute oscillation of the barometer to the amount of an inch. It will be observed that at most of the stations there is a striking resemblance in the curve described, so that we need not hesitate to call it the *same wave*; just as an elevation or depression of the surface of the ocean which arrives successively at distant stations, we call one wave, understanding, of course, that the same wave, at successive instants, may be formed by entirely different particles of water. The same atmospheric wave, then, passed over the continent from west to east, from the valley of the Mississippi to the Bermudas and Newfoundland. We wish now to be able to assign the *rate* of progress of this wave, and in order to institute the comparison, we must fix upon some particular *phase* of the wave. We might make the comparison for the times of either the barometric maximum or minimum. The latter, however, is much the best suited to our purpose, as the barometer remained much longer near the high than the low extreme. There is a difficulty, however, in ascertaining the precise instant of even the barometric minimum. When observations are taken but two or three times a day, it is highly improbable that the minimum should occur at the precise instant of either observation. There may, therefore, be an uncertainty in the time to the amount of twelve hours, or more. Fortunately, however, this uncertainty is, in a measure, obviated in the present instance. The hourly observations made at Baltimore, Montreal, Albany, Flushing, New Haven and Gardiner, exhibit the precise form of the barometric curve described, and the instant of greatest depression. Moreover, as will appear in the sequel, this minimum was contemporaneous with a remarkable change of wind, and the time of this change was noted at several stations; as, for example, at Springfield, Syracuse, Philadelphia, New York, and Hanover. At nearly half of the stations, then, the time of minimum is certainly known; and the form of the curve at these stations will guide us in completing the curve at the remaining stations. This conjectural completion of the curves is represented on the chart by dotted lines. We are then enabled to trace the progress of this wave with very considerable precision. I accordingly drew upon a map of the United States lines connecting all those places where the barometer attained its minimum at the same instant. The result is shown on the accompanying chart, which exhibits the lines of greatest depression for every six hours from the morning of December 20th to the noon of the 23d. The velocity of the wave appears not to have been uniform. Thus, on the southern border of the United States its velocity varied from seventeen to twenty-nine statute miles per hour; and on the northern borders from seventeen to thirty-seven miles per hour. No allowance is here made for difference of longitude, which would increase this velocity by about one twenty-fifth part. The form of these curves for the north-west part of the United States rests mainly upon the thermometric observations to be described presently. The front of this wave appears, in many places, decidedly convex, to an amount much beyond the possible errors of observation.

Having thus discovered the form and velocity of the wave, let us attend to the *amount* of the depression of the barometer. The following table exhibits the difference between the barometric minimum and the subsequent maximum, the observations being arranged in the order of latitude.

	Latitude.	Bar. Range.		Latitude.	Bar. Range.
Indian Key, . .	24° 48′ N.	.26 nich.	Twinsburgh, . .	41 18	.68 nich.
Pensacola, . . .	30 28	.46	New Haven, . .	41 18	.98
Natches, . . .	31 34	.79	New Bedford, .	41 38	1.02
Savannah, . . .	32 5	.65	Do.	" "	.97
Bermuda, . . .	32 34	.41	Boston, . . .	42 21	.92
Lexington, . .	38 6	.96	Albany, . . .	42 39	1.173
Washington, . .	38 53	.98	Syracuse, . . .	43 1	.95
Baltimore, . . .	39 17	1.02	Rochester, . .	43 8	1.03
Marietta, . . .	39 25	.98	Hanover, . . .	43 41	1.14
Springfield, . .	39 53	1.00	Gardiner, . . .	44 10	1.00
Philadelphia, . .	39 57	.97	Halifax, . . .	44 39	.52
New York, . .	40 43	.97	Montreal, . . .	45 31	1.266
Flushing, . . .	40 45	1.042	Quebec, . . .	46 49	1.57
Sunbury, . . .	40 53	1.00	St. Johns, . . .	47 34	.85

It will be observed that the range of the barometer increases generally with the latitude. A more particular consideration of the subject, however, is deferred for the present. I come, therefore, to consider,

II. The movement of the thermometer.

The movement of the thermometer during the period in question was quite as remarkable as that of the barometer, and generally in the opposite direction. Thus, while the barometer was falling under the influence of the storm, the thermometer was every where rising; and as the barometer rose the thermometer fell with extraordinary rapidity. It is not thought necessary to insert here all the observations which have been collected. The following, being about half the whole number, are selected as being, from their distribution, a fair representative of the whole.

	December 19th.			December 20th.			December 21st.			December 22d.		
	Morn.	Noon.	Even.	Morn.	Noon.	Even.	Morn.	Noon.	Even.	Morn.	Noon.	Even.
Fort Leavenworth, .	32°	37°	33°	— 3°	— 3°	— 4°	— 7°	10°	8°	20°	32°	32°
Fort Gibson, . . .	44	50	36	26	12	10	10	22	20	26	42	46
Fort Snelling, . .	22	28	28	— 2	— 6	— 5	— 22	— 4	— 8	— 6	8	8
Fort Towson, . .	42	48	50	45	20	16	10	30	25	23	45	44
Fort Jesup, . . .	43	60	58	64	50	34	17	36	28	21	48	41
Fort Crawford, . .	22	30	35	34	1	— 4	— 16	— 8	— 6	— 4	15	22
Augusta, ...	23	40	39	38	0	— 3	— 12	— 1	— 4	7	29	28
St. Louis, . . .	33	41	40	39	14	6	— 1	13	10	13	33	31
Natches, ...	38	57		59	55		21	32		25	40	
Baton Rouge, . .	30	53	50	60	60	55	21	36	30			
Fort Winnebago, .	17	25	30	32	17	— 4	— 17	— 11	— 16	— 8	13	18
Fort Howard, . .	21	29	28	35	38	38	— 4	— 5	— 8	— 6	17	20
Pensacola, . . .	43	49	54	63	65	62	31	37	29	22	33	35
Fort Mitchell, . .	23	56	58	48	69	50	30	34	38	18	29	40
Lexington, . . .	21	46	38	43	46	50	19	16	10	18	28	21
Springfield, . . .	10	40	34	38	43	47	6	11	7	1	18	17
Fort Brady, . . .	17	25	25	32	36	36	8	10	0	— 10	12	10
Fort Machinac, . .	21	23	26	32	35	39	4	8	2	— 2	10	10
Dearbornville Arsenal,	14	30	32	31	38	41	— 1	4	— 4	— 9	13	13
Fort Gratiot, . . .	15	31	33	34	38	43	4	7	1	— 1	14	15
Twinsburgh, . . .	8	38		36	48		12	10		0	30	
Marietta, ...	7	41	27	38	52	50	16	16	11	6	22	14
Alleghany Arsenal, .	2	29	20	17	38	21	18	19	10	3	16	10
Pomfret, ...				27	40	41	18	11	10	10	14	13
Rochester, . . .				30		38	20		10	9		10
Savannah, . . .				56	64	64	60	50	48	38	42	40
Sunbury, ...				16	28	32	40		18	6		18
Syracuse, ...				25	41	45	36	23	10	7	20	9
St. Augustine, . .				60	68	68	64	56	48	34	50	50
Charleston, . . .				51	51	64	54	48	34	26	43	33
Washington, . . .				33	39		37	30		13	30	
Potsdam, ...							36	26	10	4	12	8
Montreal, ...				26		35	44		15	9		9
Philadelphia, . .				23	36		54	32		11	18	
Albany, ...							49	29	15	11	20	13

	December 20th.			December 21st.			December 22d.			December 23d.		
	Morn.	Noon.	Even.	Morn.	Noon.	Even.	Morn.	Noon.	Even.	Morn.	Noon.	Even
Fort Monroe, . .	42	53	53	63	56	52	22°	24°	22°			
New York, . . .	26	35	45	51	40	24	17	20	19			
Quebec, ...		27	21	33	29	14	— 2	3				
New Haven, . . .				53	43	28	15	20	16			
Hanover, ...	7	29	34	42	47	15	8	14	3	3°	16°	16°
Indian Key, . . .	74	76	74	74	76	66	62	66	68	68	71	69
New Bedford, . .	28	45	42	46	50	27	15	21	14	11	25	30
Boston, ...	25	38	44	48	52	22	16	19	15	12	22	31
Gardiner, ...				40	47	32	12	18	10	3		
Hancock Barracks, .	— 1	42	20	36	41	35	7	10	6			
Halifax, ...	18	30	30	38	40	40	28	30	26	4	10	12
Bermuda, ...	min. 58°	max. 62.5.		Min. 58°	Max. 63.5		Min. 61.5	Max. 66		Min. 53	Max. 61	
St. Johns, . . .	min. 16	max. 29		Min. 14	Max. 25		Min. 26	Max. 33		Min. 2	Max. 26	

The fall of the thermometer is very sensible in all of the observations, and the instant of change I have indicated by a dark line drawn across the table. The observations at the military posts were made at 7, A. M.; 2 and 9, P. M.; and the others were generally made about the same hours. It is not easy to compare, with entire precision, the rate or amount of the depression of the thermometer at the several stations, because the change occurring at different hours is variously affected by the diurnal change of temperature. A correction needs to be applied for this inequality before the observations are comparable, and this correction it is difficult to apply with entire satisfaction. It requires, however, but a hasty inspection of the table to perceive that the depression of the thermometer was greater in the northern than the southern states, and greater in the western than the eastern; that is, the fall was most remarkable of all in the north-western states. Thus, for example, at Fort Crawford, from the morning of the 20th to that of the 21st, at the same hour, the thermometer fell 50°; at Augusta the same, and at Fort Winnebago 49°. At Augusta, on the 20th, the thermometer fell 38° from sunrise to 2, P. M., that is, against the diurnal variation, which, according to observations made at the same place for the entire month, amounts to ten degrees; making the real depression of the thermometer *forty-eight degrees in six and a half hours*, the most remarkable fluctuation I recollect ever to have heard of; and this, too, in a latitude south of Naples.

The commencement of this depression coincided sensibly with the minimum of the barometer. This is very satisfactorily shown by the hourly observations. In a few instances the thermometer fell a degree or two before the barometric minimum; but in all cases the fall of the thermometer became very rapid after the barometer began to rise. This appears to be a well established feature of the storm, and I have availed myself of it in tracing the progress of the storm in regions where barometric observations could not be obtained. This was particularly true of the north-west part of the United States, and I have projected on Plate I., Fig. 2, the observations made in this region in the same manner as the curves on Plate I., Fig. 1, were constructed. The observations were first corrected for the diurnal inequality. The curves exhibit to some extent the effect of local causes; although, on the whole, the resemblance is quite striking, and probably would have been still more so if the observations had been made at shorter intervals.

In order to determine the dependence of the temperature upon latitude and longitude, I classified the observations as below, placing the most western observations on the left and the eastern on the right, and arranging each in the order of latitude. The table shows the greatest heat observed during the storm, and the greatest cold immediately succeeding it.

	Latitude.	Max.	Min.		Latitude.	Max.	Min.
Pensacola, . . .	30° 28′ N.	65°	22°	Indian Key, . . .	24° 48′ N.	76°	62°
Baton Rouge, . .	30 28	60	21	St. Augustine, . .	29 48	68	34
Natches, ...	31 34	59	21	Savannah, . . .	32 5	64	38
Fort Jesup, . . .	31 35	64	17	Bermuda, ...	32 34	66	53
Fort Mitchell, . .	32 20	69	18	Charleston, . . .	32 46	64	26
Fort Towson, . .	33 36	50	10	Fort Monroe, . .	36 50	56	22
Fort Gibson, . .	35 47	50	10	Washington, . . .	38 53	39	13
Lexington, . . .	38 6	50	10	Philadelphia, . .	39 57	54	11
St. Louis, . . .	38 37	41	— 1	New York, . . .	40 43	51	17
Marietta, ...	39 25	52	6	Sunbury, ...	40 53	40	6
Fort Leavenworth, .	39 28	37	— 7	New Haven, . . .	41 18	53	15
Springfield, . . .	39 53	47	1	New Bedford, . .	41 38	50	15
Augusta, ...	40 15	40	—12	Boston, ...	42 16	52	16
Alleghany Arsenal, .	40 28	38	3	Albany, ...	42 39	49	11
Twinsburgh, . .	41 18	48	0	Syracuse, . . .	43 1	45	7
Dearbornville Arsenal,	42 24	41	— 9	Rochester, . . .	43 8	38	9
Pomfret, ...	42 25	41	10	Hanover, ...	43 41	47	3
Fort Crawford, . .	43 4	35	—16	Gardiner, ...	44 10	47	3
Fort Gratiot, . .	42 54	43	— 1	Halifax, ...	44 39	40	4
Fort Winnebago, .	43 32	32	—17	Potsdam, ...	44 40	36	4
Fort Howard, . .	44 46	38	— 8	Montreal, . . .	45 31	44	9
Fort Snelling, . .	44 53	28	—22	Hancock Barracks, .	46 8	41	6
Fort Machinac, . .	45 46	39	— 2	Quebec, ...	46 49	33	— 2
Fort Brady, . . .	46 29	36	—10	St. Johns, . . .	47 34	33	2

The average of the maxima at the eastern stations is about three and a half degrees greater than at the western; and the average of the minima fourteen degrees greater. It is remarkable that, with the exception of Quebec, the only stations where the thermometer fell below zero were in the north-west quarter of the United States, and would be cut off by a line joining Detroit and St. Louis.

III. Rain—amount, &c.

The following table shows the amount of rain which fell at the different stations, with the time of commencement and termination, so far as the same could be collected from the registers.

Stations.	Rain Began.	Rain Ceased.	Duration.	Amount.
Fort Leavenworth,	Snow morning of 20th.			.06 inch.
Fort Gibson,	Snow morning of 20th.			2.10
Fort Snelling,	.03 inch snow on the 19th;	.1 inch snow on the 20th.		.13
Fort Towson,	Rain all day of 19th.	Light snow morning of 20th.		1.10
Fort Jesup,	Rain morning of 20th.			
Fort Crawford,	Snow on the 20th.			.90
Fort Des Moines,	Snow on the 20th.			2.00
Augusta,	Rain in torrents 10 A. M. of 20th;	Noon commenced snowing; lasted to 4, P. M.	6 hours.	
Jefferson Barracks,	19th, snow and rain;	20th, rain.		
St. Louis,	19th, 3 P. M. to 20th 11 A. M.;	Light snow and hail, P. M.	24 "	2 00
Do., (another register)	19th, P. M.; 20th 10 A. M. hail and snow till 3 P. M.		24 "	
Natches,	20th, A. M. showers, thunder and rain.			
Baton Rouge,	20th all day.			
Fort Winnebago,	.20 inch snow on the 19th;	.70 inch snow on the 20th.		.90
New Orleans,	20th, 2 P. M heavy rain.			
Fort Howard,	Snow on 19th; rain and snow night of 20th.			.50
Mobile,	Rain on 20th.			
Pensacola,	20th, 8 A. M. or earlier;	20th, 6 P. M., or later.	at least 10 hours.	
Fort Mitchell,	20th, rain during night.			.38
Lexington,	20th, 7 A. M.	20th, 9 P. M.	14 hours.	1.10
Springfield,	20th, 9 A. M.	20th, 8 P.M.; at 11 P.M. snow.	14 "	1.52
Cincinnati,	20th, 11 A. M.	20th, 9 P. M., followed by snow.	12 "	above 1.00
Fort Brady,	.15 snow on 19th;	.95 snow on 20th, and heavy rain at night.		1.10
Fort Machinac,	.02 snow on 19th;	.35 rain and snow 20th.		.37
Dearbornville Arsenal,	Snow and rain on 20th.			.70
Fort Gratiot,	20th, rain during the day.			1.28
Twinsburgh,	20th, rain;	21st, snow.		
Marietta,	20th, morning cloudy; day rainy; evening rainy.			
Alleghany Arsenal,	Rain morning of 21st.			.48
Pomfret,	20th, rain all day; snow all day of 21st, and A. M. of 22d.			
Lewiston,	20th, P. M. rain.			
Greendale, Pa.,	20th, 8 P. M.	21st, 5½ A.M.; snow till 10 A. M.	14 "	
Batavia, N. Y.,	20th, 9½ P. M. turned to snow;	Ceased 21st, 5 P. M.	19½ "	
Rochester,	20th, 5 P. M.	20th, 10 or 11 P. M.	6 "	.30
Picolata,	20th, some rain through the day;	21st, rain A. M.		
Henrietta,	21st, A. M. rain.			.01
Ithaca,	20th, rain at night.			.50
Savannah,	20th, heavy rain all night.			1.00
Sea, near Savannah,	Rain on 21st.			
Sunbury,	All night of 20th; rain and snow morning of 21st.			
Syracuse,	Latter part of night of 20th;	Slight snow 10 A. M. of 21st.		
Homer,	21st, rain and snow.			1.20
Ellisburgh,	20th, P. M., snow;	21st, all day, snow.		.50
Onondaga,	21st, A. M., snow.			
Casenovia,	21st, A. M. rain; P. M. snow.			.25
Hamilton,	20th, P. M., snow.	21st, all day, rain.		.50
Oxford,	21st, A. M., rain and snow; P. M., snow.			
Bridgewater,	Rain morning of 21st.			
Whitestown,	21st, P. M., snow.			
Utica,	21st, rain and snow in the morning.			
Fort Marion,	Rain not mentioned.			
St. Augustine,	21st, 4 A. M.	21st, 10 A. M.	6 "	
Charleston,	20th, drizzling.			
Washington,	Rain morning of 21st.			.80

Stations.	Rain Began.	Rain Ceased.	Duration.	Amount.
Fort M'Henry,	Night of 20th 1.50; morning of 21st .20.			1.70 inch.
Baltimore,	Night of 20th;	21st, 9 A. M.		.98
Hartwick,	21st, A. M., snow and rain; P. M., snow.			
Potsdam,	21st, A. M., snow.			
Montreal,	Rain 21st, A. M., to noon; $12\frac{3}{4}$ hail; snow to 3 P. M.		9 hours.	
Delhi,	21st, all day, rain and snow.			1.20
Fairfield,	21st, A. M., rain; P. M., snow.			
Cherry Valley,	21st, A. M., rain and snow; P. M., snow.			1.53
Philadelphia,	20th, P. M.;	21st, 11 A. M.		.63
Albany,	20th, 10 P. M.;	Ceased raining 21st at 11, A. M.; hail and snow to 1, P. M.	15 "	1.235
Poughkeepsie,	21st, rain all day,			.46
Canajoharie,	21st, A. M., snow and rain;	P. M., rain.		
Johnstown,	20th, P. M., rain; 21st, A. M., rain and snow; P. M. snow.			1.03
Goshen,	21st, rain all day.			.45
Newburgh,	20th, P. M., rain; 21st, A. M., rain; P. M., snow.			.73
Kingston,	21st, A. M., rain.			.85
Montgomery,	21st, rain all day.			1.04
Flatbush,	21st, 4 A. M., rain; drizzling rain late in the evening of the 20th.	21st, noon.	8 "	.30
Redhook,	21st, all day rain and snow.			.50
Jamaica,	21st, 4 A. M.	21st, 1 P. M.	9 "	.32
Schenectady,	21st, A. M., rain.			.45
Mount Pleasant,	21st, A. M., rain.			
Lansinburgh,	21st, A.M., rain; P. M., snow.			.97
Kinderhook,	21st, rain and snow all day.			1.11
Cambridge,	21st, rain A. M.; snow P. M.			
Granville,	21st, rain A. M.; snow P. M.			
Fort Monroe,	20th, P. M.			.70
West Point,	20th, P. M.	21st, noon.		3.40
New York,	20th, 10 P. M.;	21st, noon.	22 "	
Fort Columbus,	20th, night;	21st, morning.		.10
Fort Wood,	Rain on the 21st.			1.00
Flushing,	21st, $4\frac{1}{2}$ A. M.;	21st, $12\frac{1}{2}$ P. M.	8 "	.34
Quebec,	21st, 6 A. M.; noon sleet;	Snow till midnight.	18 "	
New Haven,	21st, morning;	21st, 3 P.M.; 7 to 8 P.M. snow.	14 "	
Hanover,	21st, 2 A. M.;	21st, 1 P. M.	11 "	1.04
Indian Key,				none.
East Hampton,	21st, A. M., rain.			
New Bedford,	21st, all day to evening.			.94
Do.	20th, evening;	21st, P. M.		.80
Watertown Arsenal,	21st, rain all day.			1.05
Gardiner,	21st, A. M., soon after midnight;	21st, 5 P. M.	17 "	.80
Fort Independence,	21st, rain all day.			
Boston,	20th, evening;	21st, P. M.		.77
Fort Constitution,	21st, P. M.			.01
Hancock Barracks,	21st, P. M.			1.20
Halifax,	21st, 6 to 8 P. M.			
Bermuda,	22d, sunset;	23d, evening, light rain.		.95
St. Johns,	23d, A. M., snow.			

It will be observed that rain or snow fell at every one of the above stations except Indian Key, an island south of Florida. The rain, then, extended from about latitude 28° to latitude 48°, and from longitude 52° to 96°. How much farther it extended will be a subject of future inquiry. Throughout all this region the rain was very abundant. The average at the fifty-nine stations where the amount is given is about seven-eighths of an inch. This, then, may be taken as the probable average depth of the rain throughout the United States. This amount, however, was far from being the same at all places. The greatest amount fell at West Point; and at three other stations, Fort Gibson, Fort Des Moines, and St. Louis, the amount was two inches, or more. On the other hand, at a few stations, the amount given is exceedingly small. Thus, at Henrietta and Fort Constitution, it is stated at 0.01 inch. I think it probable there is here a mistake in the decimal point, and that the numbers should read one-tenth inch, or, perhaps, even one inch. I have myself consulted the copy of the observations preserved at Washington, and find that the total of rain for the month, at Fort Constitution, is greater than the sum of all the items shown in the register. Some mistake was probably committed in transcribing.

It may, also, fairly be presumed there was some defect in the rain-gauge used at West Point. According to the register, the amount of rain for nine months of the year 1836 was 73.27 inches. During the other three months the gauge was not observed. Making, however, a proportionate allowance for this period, we have the annual amount of rain 97.69 inches. The average amount of rain for the state of New York, as appears by the Regent's Reports, is 36 inches.

The stations at which much or little rain fell appear scattered indiscriminately over the country, so that it is difficult to say in what district rain was most abundant. The amount at stations moderately removed from each other was very unequal. Thus, while at West Point the amount is stated at 3.40 inches, at Montgomery, seventeen miles north-west, it was 1.04; at Newburgh, eight miles north, it was .73 inch; at Poughkeepsie, twenty-two miles north, .46 inch; and at Goshen, eighteen miles west, .45 inch. So, also, at Fort Wood, in New York harbour, the amount was one inch, while, at Fort Columbus, in the same harbour, it was 0.10 inch; and at Flushing, Jamaica, and Flatbush, (all within fifteen miles,) the amount at each place was about one-third of an inch. Also at Fort Brady the amount was 1.10 inch, while, at Fort Mackinac, not fifty miles distant, it was but .37 inch. These inequalities may probably, in part, be ascribed to errors of observation, to defective gauges, or improper exposure, yet the differences are too considerable and numerous to be wholly disposed of in this summary way.

Most of the registers are very defective in not naming the hour when the rain commenced or ceased. Some of the accounts, however, are sufficiently precise; and by comparing all the observations, it is believed that the limits of the rain for any particular instant may be determined with considerable confidence. I have drawn upon the accompanying chart a line representing the limit of rain for midnight of the 20th—21st. The curve representing the western limit corresponds closely to the curve of barometric minimum, but the curve of the eastern limit differs sensibly from it. It will be observed I make no distinction here between rain and snow. At the southern stations only rain fell; at some of the northern only snow; while, at the intermediate points, there fell both rain and snow. Both are probably to be ascribed to the same cause.

IV. Wind—direction and force.

The following table shows the direction of the wind at each station of observation. The letters underlined indicate strong winds. A double line indicates a gale. At but a few of the stations was the strength of the wind noted.

Stations.	December 18.			December 19.			December 20.			December 21.			December 22.		
ort Leavenworth, .	S.W.		S.W.	S.		S.	N.		N.	S.W.		S.W.	S.		S.
ort Gibson, . . .	N.		S.W.	S.E.		S	N.		N.W.	N.		E	S.E.		S.E.
ort Snelling, . . .	W.		S.	S.		S.	N.W.		N.	N.W.		S.W.	S.W.		S.W.
ort Towson, . . .	S.		S.	S.E.		S.E.	N.W.		N.W.	N.W.		N.W.	S.		S.
ort Jesup, ...	N.		N.	S.E.						N.E.		N.E.	S.		W.
ort Crawford, . . .	N.		N.	S.		S.	N.W.		N.W.	W.		W.	N.		N.
ort Des Moines, . .	N.W.		S.W.	S.E.		S.E.	N.E.		N.	W.		W.	W.		S.
ugusta, ...	S.W.		S.E.	S.E.		S.E.	S.E.		N.W.	S.W.		S.W.	S.		S.
fferson Barracks, .	S.E.		S.E.	S.		S.	S.W.		N.W.	N.E.		S.E	S.E.		S.E.
. Louis, ...	S.W.		S.W.	S.		S.	E.		N.W.	W.		W.	S.		S.
o., (another register)	S.W.			S.E.		S.E.	S.E.	W.		S.W.					S.E.
atches, ...	E.			S.E.			S.	S.W.; W.;	N.W.	N.			E.		S.E.
aton Rouge, . . .	E. by N.E.		N.E.	N. by N.E.		N.E.	E. by S.E.		S.	N. by N.E.		N.W.			
ort Winnebago, . .	W.		S	S.		S.	S.E.		N.	N.W.		W.	E.		S.
ew Orleans, . . .								S.	N.						
ort Howard, . . .	S.		S.	S.		S.E.	S.E.		S.E.	W.		W.	S.E.		S.E.
obile, ...								S.			N.			N.	
ensacola, ...	N.½E.; N.N.W.			N.E.;	N.E.;	N.E.	N.N.E.;	S.S.E.;	S.E.	N.W.	N.	N.	N.	N.E.	N.
ort Mitchell, . . .	N.E.		N.	N.		N.							E.		E.
incinnati, ...								S.E.;	S.W.						
exington, ...							S.E.		S.W.	N.W.		S.W.	S.E.		S.E.
pringfield, ...	W.		W.S.W.			S.W.	S.		S.E.	W.		S.W.		S.;	S.S.W.
ort Brady, ...	N.E.		N.W.	N.E.		S.E.	S.E.		S.E.	S.W.		S.W.	N.W.		N.E.
ort Machinac, . .	N.W.		W.	S.		S.W.	S.		S.	N.W.		N.W.	W.		W.
earbornville Arsenal,	S.W.		W.	S.E.		S.E.	S.E.		S.E.	W.		W	S.W.		S.E.

Stations.	December 18.			December 19.			December 20.			December 21.			December 22.		
Fort Gratiot,	S.E.		S.E.	S.W.		S.W.									
Twinsburgh,		N.W.			S.E.			S.E.			N.W.			N.W.	
Marietta,		S.W.			S.			S.E.			W.S.W.			N.W.	
Alleghany Arsenal,	N.		N.				S.W.		S.W.	N.		N.	N.		N.
Pomfret,							S.		S.	S.		S.	S.W.		W.
Lewiston,							S.E.		S.	W.		W.	S.		S.
Greendale, Pa.,							S.		S.W.	W.					
Batavia, N. Y.,								S.E.							
Rochester,	W.		W.	S.W.		S.	S.		S S.W.	W.		W.	W.		W.
Picolata,	N.W.		N.W.	E.		E.	S.E.		S.E.	W.		W.	N.		N.
Henrietta,							S.		S.	S.		S.W.	S.W.		S.
Palmyra,							S.		S.	W.		W.	S.W.		S.W.
Canandaigua,							W.		W.	N.		N.	N.		N.E.
Ithaca,							S.		S.	S.		N.W.	W.		W.
Savannah,							N.E.	S.E.	S.E.	N.W.;	N.W.;	N.W.	N.E.;	N.E.;	N.E.
Sea, near Savannah,							N.N.E.		E.S.E.	S.S.E.;	W.;	W.N.W.	N.W.;	N.N.W.	
Sunbury,	W.	W.	W.	S.			E.					W.			W.
Syracuse,	N.W.		N.W.	N.W.;	S.S.E.;	S.	S.		S.	W.;	N.W.;	N.W.	W.;	W.;	S.
Auburn,							S.		S.	W.		N.W.	S.W.		S.W.
Homer,							S.		W.	W.		N.W.	S.W.		W.
Ellisburgh,							S.		S.	W.		W.	N.W.		N.W.
Onondaga,							S.		S.	W.		N.W.	W.		W.
Pompey,							S.		S.	N.W.		N.W.	N.W.		N.W.
Casenovia,							S.		S.	S.W.		N.W.	W.		S.W.
Gouverneur,							S.W.		S.W.	S.W.		S.W.	N.W.		N.W.
Hamilton,							S.W.		S.W.	S.W.		N.W.	N.W.		N.W.
Oxford,							N.W.		S.	S.		N.W.	N.W.		N.W.
Bridgewater,							S.		S.	S.		W.	S.W.		S.
Whitestown,							E.		E.	S.		W.	W.		W.
Utica,							E.		E.		W.	N.W.	W.		W.
Fort Marion,	N.		N.	N.		N.E.	N.E.		S.E.	S.E.		N.	N.		N.E.
St. Augustine,							S.E.		S.E.		N.E.	N.	N.		N.E.
Charleston,		N.W.			N.			S.E.			N.W.			N.	
Washington,		N.W.									N.W.			N.W.	
Fort M'Henry,	N.W.		N.W.	W.		W.	S.W.		S.		N.W.	N.W.	N.		N.
Baltimore,	N.N.W.		W.	N.W.		S.E.	E.	S.E.	S.E.		N.W.			N.W.	
Hartwick,							S.		S.	S.		N.W.	N.W.		N.W.
Potsdam,											W.	S.W.	W.		S.
Montreal,		W.			W.			S.		S.	S.W.	S.W.	W.;	W.N.W.;	W.N.W.
Delhi,							S.		W.	W.		N.W.	S.W.		W.
Fairfield,							S.E.		S.E.	S.E.		N.W.	N.W.		N.W.
Cherry Valley,							S.W.		S.	S.		N.W.	W.		W.
Philadelphia,		W.			W.S.W.			S.E.			S.W.	N.W.		W.	
Albany,				S.		S.	S.		S.E.	S.E.	S.; N.W.;	N.W.	N.W.		N.W.
Poughkeepsie,							S.W.		S.W.	S.E.		S.W.	S.W.		N.W.
Canajoharie,							S.E.		S.E.	S.E.		N.W.	N.W.		N.W.
Johnstown,							N.E.		N.E.		N.W.	W.	N.W.		W.
Goshen,							S.E.		W.		N.	W.	W.		S.W.
Newburgh,							S.W.		S.W.	S.		W.	W.		W.
Kingston,							S.W.		S.W.	S.W.		N.W.	N.W.		N.W.
Montgomery,							S.W.		S.W.	S.W.		S.W.	W.		W.
Flatbush,							W.		S.W.	S.		W.	N.W.		N.W.
Redhook,							S.E.		S.E.	S.W.		N.	N.		N.
Jamaica,							E.		E.	S.		W.	N.W.		N.W.
Schenectady,							S.		S.		N.W.	N.W.	N.W.		N.W.
Mount Pleasant,							S.		S.W.	S.		S.W.	N.W.		N.W.
Lansinburgh,							S.		S.	S.		N.W.	W.		W.
Kinderhook,							S.		S.	S.		N.W.	N.W.		S.W.
Cambridge,							W.		S.	S.		N.W.	N.		N.
Granville,							S.		S.W.	S.W.		S.	S.W.		N.
Fort Monroe,	W.		W.	S.		S.	S.W.		S.		N.	S.W.	N.		N.
West Point,	N.W.		N.W.	N.W.		N.W.	S.	S.	E.	S.		N.W.	N.W.		N.W.

Stations.	December 18.			December 19.			December 20.			December 21.			December 22.		
v York, ...	W.;	W. by S.;	W.	W.N.W.;	S.W.;	S.W.	N.E.;	E.N.E.;	S.S.E.	S.	N.W.	W.	W.		W.
t Columbus, . .	N.W.		N.W.	N.W.		N.W.	N.E.		E	S.E.		N.W.	N.W.		N.W.
t Wood, ...				S.W.		S.W.	N.E.		N.E	S.W.		W.	N.W.		N.W.
shing, ...										S ;	S S.W.	N.W.	N.W.;	N.N.W.	
ebec, ...								E.N.E.;	N.E.	S.W. by W.;	S.	W. by S.	W. by N.		
v Haven, . . .										S.;	S.W.	W.N.W.	N.W.		N.W.
nover, ...	S.W.;	N.W.;	N.W.	S.W.;	S.;	W.	S.W.;	S.W.;	S.	S.E.;	S.	N.W.	W.;	N.W.;	N.W.
ian Key, ...	N.		N.	N.E.		N.E	N.E.		E.	N.W.		N.	N.		N.E.
t Hampton, . . .							N.W.		S.W.	S.E.;	S.W.		N.W.		N.W.
v Bedford, . . .	W.S.W.;	W.N.W.;	N.W.	W.;	S.S.E.;	W.	N.;	S.S.E.;	S.	S S.E.;	S.	N.W.	N.W.;	N.W.;	N.W.
Do.							N.E.;	S.E.;	S.	S E.;	S.	W. by N.	N.W.;	N.W.;	N.W.
tertown Arsenal, .				S.W.		W.	S.W.		S.	S E.;	E.		S.W.		N.W.
diner, ...										S E ;	S.	N.W.	N.		N.W.
t Independence, .				S.W.		S.W.	S.W.		S.W.	S.E.		S.W.	N.W.		N.W.
ton, ...							S.W.;	S.E.;	S.E.	S.E.;	S.W.;	W.	W.;	W.;	N.W.
t Constitution, . .				W.		N.W.	S.W.		S.	S.		S.	W.		N.W.
acock Barracks, .				W.		N.W	S.		S.E.	S.E.		S.E.	N.W.		N.W.
ifax, ...	W.		W.	N.W.		N.W.	N.;	S.;	S.	S.;	S.;	S	N.;	N.;	N.
muda, ...	S.S.W.;	S.S.W.;	N.	N E.;	N.E.;	N.E	E.;	S E.;	S.E.	S.E.;	S.E.;	S.W.	N.;	N ;	S.W.
Johns, ...	S.E.		W.		W.N.W.			W.N.W.			N.N.E.			S.S.E.	

At Bermuda, on the 23d, the wind was N.; N. N. E.; E. N. E.; and at St. Johns, N. N. W. I have drawn a dark line across the preceding table, representing the time of the barometric minimum. It will be observed that this crisis was marked by an extraordinary change of wind. Thus, at almost every station in the table, the wind, for nearly a day before the crisis, blew from the southern quarter, generally for several hours from the south-east. This south-east wind is believed to have been more general than the table would seem to indicate; because, not being of long continuance, it did not, at every station, happen to blow at either of the fixed hours of observation. This crisis was as uniformly followed by a wind from nearly the opposite quarter; commonly the north-west. This sudden change of wind, then, was every where one of the most prominent features of the storm. The wind, before the change, is characterized by the terms high—strong—windy—brisk—fresh—very high—violent—gale—severe gale. It would seem to have been most severe at New York, and places farther east. After the change, it is characterized by the terms high—very windy—violent—blustering—hard violent—strong gusts—strong gale—tremendous gale—one of the most violent gales ever experienced. From which it would appear that the wind was generally more violent after than before the change; though, perhaps, the reverse was the case at New York City, and throughout New England.

I have now presented the most important facts which I have been able to collect respecting the storm in question. Its principal characteristics were as follow:—After a cold and clear interval, with barometer high, the wind commenced blowing from the south. The barometer fell rapidly, the thermometer rose—rain descended in abundance. The wind veered suddenly to north-west, and blew with great violence; the rain is succeeded by hail or snow, which continues but a short time; the barometer rises rapidly; the thermometer sinks as rapidly. These changes are experienced not every where simultaneously, but progressively from west to east.

Before proceeding to analyze these facts more particularly, it may be well to inquire for the probable *limits* of the storm. This question is not merely curious, but will be seen to be intimately connected with the rationale of the phenomena. By inspecting Plate I., Fig. 1, it will be seen that the oscillation of the barometer was every where quite marked, except at Indian Key. It should be stated that the observations at this place were made with a sympiesometer, an instrument far less satisfactory than the mercurial barometer. Here the range was only a quarter of an inch, and the curve described bears very little resemblance to those at the other stations. I am inclined, however, to consider this slight change of pressure as due to the same causes as the greater oscillation in higher latitudes. No rain fell at this station. This, then, was beyond the limit of rain, and the barometer and thermometer were but slightly affected. In Senate Documents, No. 300, 1838, are given observations of the thermometer at Santa Cruz, Latitude 17° 45′ N., Longitude 64° 35′ W., for December, 1836. The mean of observations taken six times a day gave, December 15th, 76°.2; 16th, 77°.5; 17th, 78°.1; 18th, 78°.7; 19th, 77°.9; 20th, 77°.2; 21st, 77°.4; 22d, 76°.6; 23d, 75°.2; 24th, 75°.9; 25th, 74°.7; 26th, 75°.0; 27th, 74°.4; 28th, 75°.6; 29th, 75°.1.

The temperature was exceedingly uniform during this whole period, yet it will be observed there was a slight fall of the thermometer on the 23d. This is about the time that the cold wave which passed over the United States might be expected to be felt there, if felt at all. No other particulars respecting the weather are stated, except the general remark that "frequent small showers fell during the month, but no one which continued longer than from five to ten minutes." Santa Cruz, then, may be considered as beyond the limits of the storm, though, perhaps, not wholly beyond its sensible influence.

The following is extracted from the journal of the ships Mary and Susan, bound from Calcutta to New York:—

	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.
Dec. 22,	8° 56′ N.	44° 36′ W.	28.58	79°	N. E., light and variable.
23,	9 43	45 41	.59	78	N. E., " " "
24,	10 41	47 57	.60	78	N., light and steady.
25,	11 11	49 19	.60	79	N. W. by W.
26,	11 12	50 8	.50	79	Variable—calm.
27,	11 34	50 22	.56	78	Variable—calm.
28,	12 28	50 49	.60	77	Variable—calm.

It will be observed that the barometer was lowest on the 26th; and this is about the time that the wave which passed over the United States might be expected here, if felt at all.

I have obtained from the navy department at Washington a copy of the Meteorological Journal of the United States ship Peacock, for December, 1836. The greatest height of the barometer during the month was, on the 7th, 30.00 inches. Greatest depression, on the 18th, 29.88. Total range for the month, .12 inch. The ship was on the eastern coast of the Pacific, between latitude 16° 50′ N. and latitude 2° 19′ S. The preceding range is little, if any, greater than the diurnal oscillation at the equator. The hour of observation is not stated, so that we cannot decide whether the observations are affected by the diurnal inequality. The following is an extract from the register:—

	Latitude.	Longitude.	Thermometer.			Barometer.	Wind.	Remarks.
			8, A. M.	2, P. M.	6, P. M.			
Dec. 16,	8° 52′ N.	96° 34′ W.	78	79	77	29.90	N. E. and East.	Moderate and pleasant.
17,	7 40	96 49	79	80	79	90	" " "	" " "
18,	5 42	96 59	79	81	78	88	North and East.	" " "
19,	" "	97 3	76	80	77	90	South and East.	Squally, with rain.
20,	" "	97 16	74	75	75	90	Variable and calms.	Cloudy, with rain.
21,	4 45	97 4	77	78	76	90	" " "	
22,	" "	96 3	77	80	78	90	" " "	Showers, pleasant
23,	3 11	94 23	76	77	75	90	" " "	" squally.
24,	1 56	91 54	74	77	76	93	S. E. and South.	Pleasant.

Here is exhibited no oscillation of the barometer; but a mean depression of the thermometer, on the 20th, of three degrees from the 19th, and 4°.7 from the 18th. This was simultaneous with the depression of the thermometer at the most western stations of the United States. It should be remembered, also, that although this fall of temperature was slight, it was considerable for the latitude. On the 19th the wind was south-east, with rain. The coincidence is certainly remarkable. Although, then, it seems not improbable that the causes which, in the United States, were operating with such energy, were sensible even in the vicinity of the equator, still, as there was no fall of the barometer, and the depression of the thermometer was but slight, we shall hesitate to call it the same storm, and shall fix upon the parallel of 25° N. latitude as being not far from the southern limit of our storm. I have received a copy of the observations made on board the United States ship Erie, at Buenos Ayres, during the month of December, 1836, but it is impossible to identify any movement of the barometer from observations at a single station so remote.

The boundary on the west must be somewhat conjectural. At the rate with which the storm moved across the western states, it would have travelled from the Rocky Mountains to Fort Leavenworth in sixteen hours. The depression of the thermometer was more sudden and greater in amount at the western stations than in any other part of its observed course. No reason, then, can be seen why the storm should not have extended to the Rocky Mountains. But could it pass them? These mountains, in connexion with the Cordilleras, are understood to form a continuous range from the Frozen Ocean to the interior of Mexico, every where several thousand feet in elevation, and presenting insulated peaks, which, according to Professor Renwick, attain the height of twenty-five thousand feet above the sea. Suppose the warm south-east wind which was felt in the United States to blow over this wall covered with perpetual snow. The temperature of those elevated peaks during the month of December can hardly be supposed equal to zero of Fahrenheit. This warm current would then be suddenly cooled down to the temperature of that elevation, and its moisture be precipitated. The eastern side of the mountain would be buried in snow. Suppose the same air to continue its course and descend upon the other side of the range. It now comes into a warmer region; it brings with it only the moisture proper to an exceedingly low temperature; it is therefore a cold and dry wind, instead of a moist and warm one. Its character is wholly changed. It would seem, then, that even if the south-east wind could continue its course over this mountain barrier, it could carry no rain with it. So far, then, as rain, at least, is concerned, the Rocky Mountains must be supposed the western boundary of the storm.

I am unable even to conjecture a probable limit of the storm on the north. By inspecting the table on page 130 it will be seen that, with certain exceptions to be hereafter considered, the oscillation of the barometer increased pretty uniformly from the most southern to the most northern station. The range was greatest of all at Quebec. It would seem natural to infer that Quebec could not have been south of the centre of the storm. Why should not the storm have extended as far to the north as it did to the south of this station? On this supposition the northern limit would be found near the arctic circle. I have been unable to obtain observations of this date from any higher latitude in North America. As some guide, however, to my conjectures, I have instituted a comparison between the barometric observations made by Capt. Parry, at Melville Island in 1819–20, and similar observations made at New Haven. The following table exhibits the times and amount of all the barometric maxima observed at Melville Island which reached the height of 30.2 inches. Opposite these times I have given all the instances in which the barometer at New Haven rose to 30.1 inches within the ten days subsequent. I have also added another column, giving all the instances in which the barometer at London, by Professor Daniell's register, rose above 30 inches within the fifteen days subsequent.

Melville Island.	New Haven.		London.	
April 27, 30.86	April 29, 30.27.	Interval 2 days.	May 1, 30.33.	Interval 4 days.
	* May 5, .35.	" 8 "	May 12, .05.	" 15 "
Jan. 16, .77	Jan. 21, .22.	" 5 "	Jan. 22, .07.	" 6 "
	Jan. 23, .13.	" 7 "	Jan. 29, .09.	" 13 "
Dec. 30, .75	* Jan. 7, .32.	" 8 "	** Jan. 9, .59.	" 10 "
			Jan. 14, .12.	" 15 "
Sept. 3, .42	Sept. 6, .12.	" 3 "	Sept. 9, .05.	" 6 "
	* Sept. 12, .43.	" 9 "	Sept. 13, .23.	" 10 "
May 14, .41	May 16, .10.	" 2 "	May 21, .32.	" 7 "
	May 19, .10.	" 5 "		
	May 21, .10.	" 7 "		
Dec. 14, .40	Dec. 18, .25.	" 4 "		
	Dec. 22, .20.	" 8 "		
Jan. 10, .35	Jan. 16, .30.	" 6 "	Jan 14, .12.	" 4 "
			Jan. 22, .07.	" 12 "

Melville Island.	New Haven.		London.	
Oct. 22, 30.32	* Oct. 27, 30.40.	Interval 5 days.		
Nov. 6, .32	Nov. 8, .30.	" 2 "	* Nov. 18, 30.01.	Interval 12 days.
	Nov. 11, .42.	" 5 "		
	Nov. 16, .15.	" 10 "		
April 18, .32	April 22, .25.	" 4 "	* April 24, .54.	" 6 "
	April 25, .33.	" 7 "	* May 1, .33.	" 13 "
May 23, .30	May 30, .15.	" 7 "	June 6, .13.	" 14 "
March 28, .26	March 31, .45.	" 3 "	March 29, .03.	" 1 "
	April 2, .30.	" 5 "	April 3, .21.	" 6 "
	April 4, .40.	" 7 "	April 12, .02.	" 15 "
Jan. 4, .24	* Jan. 7, .32.	" 3 "	** Jan. 9, .59.	" 5 "
			Jan. 14, .12.	" 10 "
Oct. 18, .22	Oct. 27, .40.	" 9 "		
Nov. 17, .21	Nov. 22, .70.	" 5 "	* Nov. 18, .01.	" 1 "
	Nov. 24, .52.	" 7 "		
Nov. 19, .20	Nov. 22, .70.	" 3 "	* Dec. 3, .09.	" 14 "
	Nov. 24, .52.	" 5 "		
	** Nov. 29, .75.	" 10 "		
Nov. 23, .20	** Nov. 29, .75.	" 6 "	* Dec. 3, .09.	" 10 "
May 26, .20	May 30, .15.	" 4 "	June 6, .13.	" 11 "
	June 1, .15.	" 6 "		

The observations distinguished by an asterisk were the highest of their respective months; those with a double asterisk the highest of the year. It will be observed that the principal New Haven maxima follow the Melville maxima generally at intervals of five or six days; and the London maxima follow at intervals of from five to ten days. To identify certainly a single wave would require simultaneous observations at numerous intermediate points; yet the preceding facts, taken in connexion with the increase of the barometric oscillation for December 20, 1836, from the southern part of the United States to the most northern station, seem to render it not improbable that the storm in question might have been experienced within the arctic circle.

By reference to the table on page 130 it will be seen that, with the exception of Twinsburgh, Bermuda, Halifax, and St. Johns, the barometric oscillation increased pretty regularly with the latitude. The observations at Twinsburgh being made with a wheel barometer, which, from the nature of the instrument, is susceptible of very little accuracy, I do not hesitate to reject them from this comparison. It will be seen that the oscillation at the three remaining stations was only about one-half what it was at the corresponding latitudes in the United States. This must be considered as evidence that the causes, whatever they were, which produced the oscillation, were now acting with diminished energy. The diminution was about one-half in less than two days. It might naturally be expected that the wave would go on diminishing until, by its insignificance, it should become insensible. What law this diminution would observe we are unable to say. For the sake of an estimate, however, let us take a simple supposition. The loss was one-half in two days. In two days more the last range might be reduced one-half; and again one-half in two days more. That is, in four days from St. Johns, the range would be in latitude 32°, 0.11 inch; and in latitude 47°, 0.22 inch, a fluctuation too small to be traced with confidence. At the rate with which the wave travelled from Halifax to St. Johns, in four days more it would have passed somewhat beyond the Azores. But it will be observed that the velocity of the wave was sensibly reduced in travelling eastward. It had even become reduced to about one-half in two days in the latitude of Quebec. We might then expect the wave would become insensible before it reached the middle of the Atlantic.

But a remarkable storm was experienced over nearly the whole continent of Europe, about the 25th of December, and the opinion has been repeatedly expressed that this storm was identically the same with the one whose phenomena I am investigating. With the view of prosecuting this inquiry, I have collected all the European meteorological registers of this period in my power. Observations made at St. Petersburgh and Catherinenburgh were obtained from the library of the American Philosophical Society, by the politeness of Mr. Vaughan, and copied for me by Mr. S. C. Walker. The latter place is in latitude 56° 50′ N., and longitude 60° 35′ E., and is eight hundred and thirteen English feet above the level of the sea. Observations for Brussels and Milan were furnished me by Mr. S. C. Walker, the latter being from the library of the High School Observatory in Philadelphia. The observations for Geneva, Zurich, and St. Bernard, were from the Bibliotheque Universelle, and copied by Mr. E. C. Herrick: those for London, Chiswick, and Boston, are from the London and Edinburgh Philosophical Magazine: those for Paris, from the Comptes Rendues des Séances de l'Academie; and those for Cadiz, in Spain, I obtained through our consul, Mr. Burton. The barometric observations I have projected in curves on Plate 2, a difference of an inch in the ordinates of the curves representing an oscillation of the barometer to the same amount. A bare inspection of this chart is sufficient to show that there were, at this period, two distinct oscillations travelling in nearly opposite directions. One of these minima occurred at Cadiz, in Spain, on the 24th; passed Geneva on the afternoon of the 25th; London on the afternoon of the 26th; Boston by the morning of the 27th; St. Petersburgh and Catherinenburgh about midnight of the same day. The progress of this wave was almost due north, and at the rate of about twenty statute miles per hour. This certainly was not the same wave which passed over the United States, for the front of the latter was nearly north and south, while the front of the European wave was directed to the east and west, and was travelling northward.

The other barometric minimum was first experienced at St. Petersburgh on the 21st; at Catherinenburgh on the 22d; at Boston on the 23d; at Paris, Geneva, Zurich and Milan on the 24th; although at the latter place this oscillation is almost merged in the one before described. At Cadiz the wave is well nigh lost, but is, perhaps, barely discernible on the 27th and 28th. This wave, then, travelled nearly from north to south, inclining, however, to the west, and at the rate of about seventeen miles per hour. It is not, perhaps, equally clear that this wave cannot be identified with that of the United States. If we draw upon the globe lines representing the fronts of these waves, as I have done upon the accompanying chart, we shall find that they may be joined by a line of no very great curvature. Nevertheless, the fronts of both of the waves are curved, particularly the European wave, and when joined they make a curve with at least two points of inflection, as in the annexed diagram; the black line on the left

hand representing the American, and the other the European wave. The appearances of the curves seems very clearly to indicate two distinct waves. If further confirmation were needed, it may be found in the course of the winds, which exhibited very different movements in Europe from what they did in the United States. As, however, I have not proposed to enter into any extended investigation of this European storm, and have only alluded to it for the sake of ascertaining whether it could be identified with that in America, believing that the evidence already presented will be conclusive to most minds, I think it unnecessary to adduce any further observations. I arrive, then, at the conclusion, that the storm of December 20th did not extend to the other side of the Atlantic.

I have made great inquiry for the log-books of vessels at this time on the

Atlantic, but with indifferent success. I have found no barometric observations, and few log-books of the common kind. The New York packet ship Hibernia left Liverpool December 20th. The following extract from her log-book gives some information of the weather which prevailed at that time on the Atlantic. For the sake of comparison I have placed by the side the winds as observed at Brussels.

Ship Hibernia.				Brussels.
	Latitude.	Longitude.	Wind.	
Dec. 23,	50° 28′	9° 9′	W.N.W.; N.W.; N.; showers.	N.; N.; N.; snow.
24,	48 36	14 36	N.E.; N.E.; showers of hail.	N.E.; N.E.; snow.
25,	47 58	19 58	N.E.; E.N.E	N.E.; N.E.; snow.
26,	47 23	23 40	N.E ; N.N.E.; showers.	N.E.; N.E.
27,	46 56	27 30	N.E.; E.N.E.; E.	N.E.; N.E.; snow.
28,	46 38	32 6	N.E.; E.N.E.; showers.	N.E.; E.N.E.; snow.
29,	46 20	33 27	N.E.; E.S.E.; S.E.	N.E.; N.E.; snow.
30,	45 55	34 3	Calm.	N.E.; N.E.

The uniformity in the direction of the winds shows that the Hibernia experienced the same kind of weather which prevailed in Europe up to the 29th of December, when she was in the middle of the Atlantic, and the American storm, if felt at all, ought already to have passed her. I have sought to procure some meteorological register from the Azores. The following extract, furnished by our consul, Mr. Dabney, is all I have been able to obtain. It exhibits the mean temperature of the respective days at Fayal.

Dec. 23	24	25	26	27	28	29	30	31
63°	64°	61°	63°	62°	67°	57°	57°	57°

Here is exhibited a striking depression of the thermometer on the 29th. This may, perhaps, be ascribed to the influence of the American storm, which had just reached the Azores. A like depression of the thermometer, however, accompanied the European storm; and from the above observations of the Hibernia, the latter influence would seem to have been the one chiefly, if not exclusively, felt. My conclusion, then, from this investigation is, that the eastern limit of the storm of December 20th cannot be placed beyond the middle of the Atlantic. The storm was probably sensible over seventy degrees of longitude and forty of latitude.

Having given all the information I have been able to collect respecting the storm, and assigned, as far as practicable, its limits, I proceed to analyze more minutely its phenomena. Let us take, then, first, the observations of the wind. In making this comparison, certain general principles should be borne in mind. One is, that the direction of the wind is liable to be sensibly influenced by the inequalities of the surface of the earth. In a shallow stream of water, flowing over a rocky bottom, the course of the particles of water is often very devious. An effect similar in kind, though much greater in degree, must be expected from an elastic fluid like air. This is strikingly exhibited in the narrow and straight streets of cities, with high buildings on each side. The wind must here blow in the direction of the streets, or not at all. So, also, a mountain gorge; the straight bed of a river with high banks; the shore of a lake, or the ocean; or a mountain ridge might be expected sensibly to influence the direction of the atmospheric current. To this cause is doubtless to be ascribed the fact, that at stations very moderately removed from each other, the prevalent winds often differ sensibly in direction.

Again, the direction of the wind is exceedingly variable. I mean that its direction varies not merely from day to day, and from hour to hour, but from minute to minute, and from second to second. When the wind is at all fresh, it is rare that it blows sensibly from the same direction for five successive seconds. I have been the more struck with this fact from having a vane attached to a revolving shaft, to which is secured a graduated circle. The precise amount of the oscillations is thus easily measured. I am accustomed, at each observation, to note the extreme excursions during an interval of about five minutes. This range of the vane may be termed a measure of the variableness of the wind, and from an average of the year, does not differ much from fifty degrees. In repeated instances it has amounted to ninety, and even more, degrees. Now, one who judges of the direction of the wind from a single glance at a vane, is liable to mistake the mean direction by twenty-five or thirty degrees, because the vane, at the instant observed, may point thus much aside of its mean position. To this add the probable error of judgment when angles are estimated entirely by the eye, and it will not appear strange if two individuals, neither of them particularly careless in observing, should, at the same place, and at the same hour, sometimes differ by forty-five degrees in their estimate of the wind's direction. Indeed, at five-sixths of the stations from which observations have been received, this appears to be the smallest fraction ever recorded. Add to this that the observations are generally taken but twice a day, and the precise hour to which the observation corresponds is seldom given, and we shall be prepared to expect considerable irregularity in comparing the observations at a hundred different stations. Finally, it is but reasonable to bear in mind that in the table of winds which I have given there may be actual errors of transcribing. The materials from which the table was prepared are copies, most of them at second hand, from the original records. In transcribing such a list of unmeaning letters, where the copyist can receive no assistance from the context to guide his judgment, slips of the pen are particularly liable to occur.

I trust it will not be inferred from these remarks that I have a theory of winds to which all the observations are to be made forcibly to conform, and that whatever seems obstinate is to be pronounced an error of observation. I wish merely to show that we should look at the general or average tendency of the winds at the several stations, and when one observation differs essentially from all the rest, it is not unphilosophical to regard it with distrust. That these remarks are not uncalled for will appear evident from comparing the different registers kept at almost identically the same station; for example, the two at St. Louis, and that at Jefferson Barracks; those at St. Augustine and Fort Marion; and those at New York, and its immediate vicinity.

It may be well to enumerate here the principal known causes of wind. It is believed that winds may commonly be referred to one of the three following causes, viz:

I. Inequality of atmospheric pressure.

II. Unequal specific gravity of air.

III. Rotation of the earth.

Conceive two vertical columns of air connected by a horizontal canal. If the weight of one column exceeds that of the other, it must preponderate. The wind, therefore, must blow *from* places where the barometer is highest, *towards* those where it is most depressed. Moreover, if the two columns of air supposed be of equal weight, but unequal specific gravity, there will be effected a new distribution of the particles of the two portions. The denser will flow under and displace the lighter. This inequality of specific gravity may arise either from a more elevated temperature or an excess of aqueous vapour. Even then, though the barometer may indicate every where the same pressure, the wind will blow, at the surface of the earth, from the colder to the warmer station; from the one where the dew point is lowest, to that where it is highest. In the upper regions of the air the current will, for the same reason, be reversed. The rotation of the earth is indirectly one of the most powerful causes of wind. Of itself it would produce no wind. When the earth first began to revolve upon its axis, the atmosphere, it may be supposed, would be left behind, and a wind would result, blowing with the velocity of the earth's motion. By friction upon the earth's surface, the air would, however, soon acquire the same motion with that part of the earth upon which it rested, and a universal calm would result as truly as if the earth were at rest. If authority is needed in support of this conclusion, we have that of Laplace. The earth's rotation, then, is not an independent cause of wind, although some have entertained a contrary opinion. But when one of the other named causes would alone produce a south wind in northern latitudes, the earth's rotation converts it into a south-west wind; and in like manner a north wind is converted into one from the north-east. Several other causes of wind might be enumerated, but it is believed that their action is comparatively feeble and unimportant.

Bearing in mind these preliminary principles, let us proceed to analyze the observations of the wind on pages 137—139. To do this the more conveniently, I furnish myself with a large number of small bits of paper, each having the figure of an arrow, and spreading out before me a map of the United States, I place at each station an arrow, representing the wind's direction for the period under comparison. I thus have a graphic representation of all the observations. Beginning, then, with the observations of the morning of December 18th, we find the barometer at an unusual height along the line of the Mississippi river, while, in the eastern states, it was quite low, but rapidly rising. The wind, at places east of Detroit, we find very uniformly blowing from the west. Where there is a deviation from this rule, it is usually to the north-west; and in one case only, Alleghany Arsenal, was the wind from the north. Near the southern border of the United States the wind was from some northern quarter, except at Natches, where it was east. The rise of the barometer which was experienced in the United States was nearly insensible south of the parallel of 28°, and hence a tendency of air in that direction. Along the valley of the Mississippi the barometer was at its maximum; the winds consequently were light, and their directions very various. More usually they were from the west, the quarter from which they had blown with great strength the day previous; but at a few stations they had already changed to the south and east, which was soon to become the prevalent direction; for it appears there was now a barometric minimum, not far to the west, towards which the whole atmosphere soon precipitated itself with great violence. In the afternoon of the 18th there was no change in the wind's direction at any station east of Detroit, nor any change of importance on the southern border. On the north-west the wind generally veered round more to the south, the cause which I have already assigned becoming now more sensible in its operation.

On the morning of the 19th, the wind, at places east of Baltimore, was still from the west. Albany furnishes the only exception to this remark, and here the wind is from the south. On the southern border the wind still blew from the north. At Picolata only was it from the east. In the western and north-western states it was from the south. To this there was but one exception, at Fort Brady, where the wind was north-east. The more general tendency was from the south-east. A very instructive phenomenon is here exhibited. The barometer was at its maximum height on a line passing north and south, nearly through the centre of the United States, and the wind accordingly blew *outward* from the centre every where upon the borders. I do not mean precisely in the direction of radii from one point, but still decidedly outward; and there is but one palpable exception to this remark, namely, at Alleghany Arsenal, where the wind is reported from the north. Thus, on the eastern border, the prevalent direction was westerly; on the southern, northerly; on the western, south-easterly; and on the northern, southerly. These currents could not be maintained without producing a rapid drainage of air from the United States, unless there were some means of compensation. In point of fact, the drainage was not very rapid, as is shown by the barometric observations, and the required compensation we shall find in the upper current of the atmosphere. The winds of which I have been speaking were surface winds, reaching to only a moderate elevation, and above them flowed the usual upper current from the west. This might have been safely presumed in the absence of all testimony. The fact was, however, observed at Springfield, Syracuse, and New York, the only journals which noted at this time the direction of the clouds. The drainage from the lower currents was, however, somewhat more rapid than the supply from the upper, and the barometer began slowly to descend. On the afternoon of the 19th the changes in the direction of the wind were very slight. At Fort Brady the wind changed from north-east to south-east, conforming now to the general direction of the winds in that quarter.

On the morning of the 20th the barometric maximum passed through the eastern extremity of Maine. The winds in the eastern states were accordingly light, and exceedingly variable. At about half of the stations, however, the wind was from the south, and at about one-half of the remainder it was south-west. The irregularity at the remaining stations I ascribe to the lightness of the wind, and to the fact that the influence of the barometric minimum at the west was just beginning to be felt, but had not yet had time to impress upon the winds any strong and steady impulse. On the southern border the winds generally continue to blow from the north. The barometric minimum now coincides nearly with the bed of the Mississippi river. Upon the west of this line, the wind blows from the north and north-west; upon the east side it blows from the east, south, and south-east. The winds in this section blow with great strength, and their directions, as might be expected, are far more regular and uniform. By the afternoon of the 20th the line of barometric minimum had advanced farther to the east. The number of stations west of this line at which the wind now blew from the north and north-west was increased. In the eastern states the general direction of the winds was substantially the same as in the morning. The wind at New Bedford and Halifax, the only stations in this section at which, in the morning, it blew from the north, now blows from the south. Oxford and East Hampton were the only stations, in the morning, at which the wind blew from the north-west. At the former of these it is now south, and at the latter south-west. On the eastern section of the storm the wind now every where, with but a few trifling exceptions, blows from some southern quarter.

On the morning of the 21st the barometric minimum had arrived nearly at New York city. In all the western and middle states the general direction of the winds is from the west and north-west. At a few places it is north, and at a few others south-west. But no where is it from the south, south-east, or east, and at only one station, Jefferson Barracks, from the north-east. Even this observation may be suspected to be a mistake, or must be ascribed to local situation, when it is found that at St. Louis the wind was from the west. The mean of all these directions is about N. 74° W. On the southern border, also, the prevalent direction is north-west, although at two stations it is represented as inclining to the east. On the east side of the line of barometric minimum, the prevalent direction is from the south-east. As the observations were not all made at the same hour, they are not strictly comparable; and it seems necessary to leave out of the account those which were made near the line of minimum, because we cannot know, except conjecturally, whether they were made before or after this line had passed. We thus obtain for the mean direction at the remaining stations about S. 5° E. At a certain distance, however, from the line of minimum the courses are very uniformly south-east. As this line approached, the wind veers to the south, south-west, west, and north-west. In the afternoon of the 21st, the line of barometric minimum had nearly reached Boston, and the north-west wind had become the prevalent one throughout almost the entire United States. In the extreme west the wind had begun to moderate its violence, and at Fort Jesup it blew from the north-east; at Fort Gibson from the east; and at Jefferson Barracks from the south-east. These are the only easterly winds recorded any where upon the west of the line of barometric minimum. The only south winds were at Pomfret and Granville, in New York. All the other winds, eighty-one in number, were from some point between the north and south-west; and their mean direction about N. 70° W.

On the 22d the north-west wind was almost every where the prevalent one, particularly in the eastern section of the United States, where it blew invariably from some point between the north and south-west. On the southern border it blew very uniformly from the north; and in the western states the winds were becoming more light and irregular, veering round to the south and south-east, as they had done three days previous.

From the preceding review it will be seen that, in the midst of much irregularity, there was a considerable degree of uniformity in the course of the winds throughout the entire period under examination. It blows, at first, fresh from the north-west; this wind moderates and veers to the southward; it changes by nearly a calm to some eastern quarter; blows fresh from the south-east, in some places a gale; veers rapidly to the south, south-west, west, and north-west, blowing all the time with great violence. After about a day, the north-west wind moderates into a calm, and is succeeded by a southerly wind. In order to present these changes more palpably to the eye, I have drawn upon the chart arrows, representing the direction of the wind for the forenoon of the 21st, the length of the arrow being intended to be proportioned to the strength of the wind. These observations were not all strictly cotemporaneous; and hence arises some confusion in the course of the winds near the line of barometric minimum, particularly in the state of New York. It cannot, however, fail to be perceived that, at places moderately removed from each other, the wind blew from quarters almost diametrically opposed. At a little distance from the line of barometric minimum, on the east, the wind was from the south-east, while, on the west, it blew from the north-west. These were both violent winds, whose velocity, probably, could not be estimated at less than forty miles per hour. But how is it possible for two winds, not far separated from each other, to blow violently towards each other for hours, and even days, in succession? Let us make a simple numerical estimate. The wind blew from the north-west at least forty miles per hour. This gives a progress due east of more than twenty-eight miles per hour, and is fully equal to the average progress of the barometric minimum. This atmospheric wave, then, progressed with not far from the velocity with which the wind was actually observed to blow. But, in order to allow an opportunity for this onward progress, the wind in advance of this wave must retire, and that with the same velocity with which the north-west wave approaches. There seems no other possible supposition, unless the north-west wind flowed *under* the opposing wind. But what was the motion of the air in advance of this wave? About six hours in advance, it blows from the south-east; then, for three or four hours, it blows nearly from the south, and the entire change from south to north-west occupies only from one to two hours. The whole body of air in advance of this wave is moving, then, in almost exactly an opposing direction; whereas, as I have already stated, it ought to move in the same direction, in order to allow the wave's onward progress. The conclusion is inevitable; the north-west wind displaces the south-east one by flowing under it. I can think of but one mode in which any one can imagine it possible to evade this conclusion. The wind changed from south-east to north-west by the south-west. Some might fancy, therefore, that this south-west wind might furnish the necessary vent for this surplus air. But this south-west wind seldom blew an hour at any one place. Now, the phenomena which I have described were occurring simultaneously throughout the entire length of the United States, a distance of at least twelve hundred miles, and probably much greater. In order, then, that the south-west wind might drain off this vast torrent from the south-east, it would need to blow continuously for at least thirty hours with the velocity observed. And even on this supposition the south-west wind would only drain off the south-east, so as to prevent its advancing. But we have already seen that it must recede with the same velocity as that with which the opposing wave advances. I might call to my aid here, if necessary, the observations of the thermometer, but it would be superfluous. The case, to my mind, is perfectly made out. This south-east current found its escape by *ascending* from the surface of the earth. Having quit the surface, it might either flow on in its first direction *over* the north-west current, or it might be entirely driven back over the south-east current; or both of these motions might exist simultaneously. When we come to consider the cause of the rain, we shall be able to judge of the probability of these several suppositions.

If a south-east current should pass a north-west one by blowing over it, the wind, to a stationary observer, would seem to change its direction by a calm. But if one were S. S. E. and the other W. N. W., as was nearly the case in the present instance, the wind would veer rapidly from one quarter to the other, passing through each of the intermediate points. The two currents must necessarily influence each other to some extent. As the north-west wind approached, the south-east would feel its influence, and begin to veer to the south. At a certain instant the two would exert equal power; and the direction of the particles of air would be precisely intermediate between those of the two great currents. Presently the second current would predominate, and, in a short time, the influence of the first would entirely disappear.

The question naturally arises, What produced this southerly wind throughout a territory so extended? The atmosphere is always warmer in the southern states than in the northern; why, then, should not a current always set from the north? There is no doubt, I think, that throughout this entire region the general progress of the atmosphere near the surface of the earth is towards the south. Not that the wind will necessarily blow a greater number of days in a year from the north than from the south, for the northerly winds are ordinarily far the most violent. One cause of southerly winds is found in the upper current, which, in these latitudes, blows from a point a little south of west. This wind, by friction upon the lower stratum, and by gradual subsidence into it, tends to impress upon the lower current its own direction. This accounts, in part, for our westerly and south-westerly winds, but would not explain the south-east wind of the storm in question. The true explanation of this phenomenon is, I think, found in the fact that the greatest depression of the barometer was at some point north of the United States. The greatest observed depression was at Quebec; and it is not improbable that the absolute minimum is to be found still farther north. We should expect a prevalent tendency of the winds towards this point of greatest depression; that is, in the United States, in front of the storm, we should expect a south-east wind, and to the north of the storm's centre, a north-east wind. I have been unable to obtain any observations for testing the truth of this last conclusion.

I come now to inquire for the cause of the rain. Rain is always owing to one cause, namely, a sudden reduction of the temperature of the atmosphere below the dew point. We run no risk in always assigning this as the immediate cause of rain. But how is this reduction of temperature effected? It may occur in a great variety of ways, among which are the following:—

I. Radiation.

II. Warm air coming in contact with cold earth or water.

III. A warm current coming in contact and mingling with a cold one.

IV. Air suddenly transported into elevated regions.

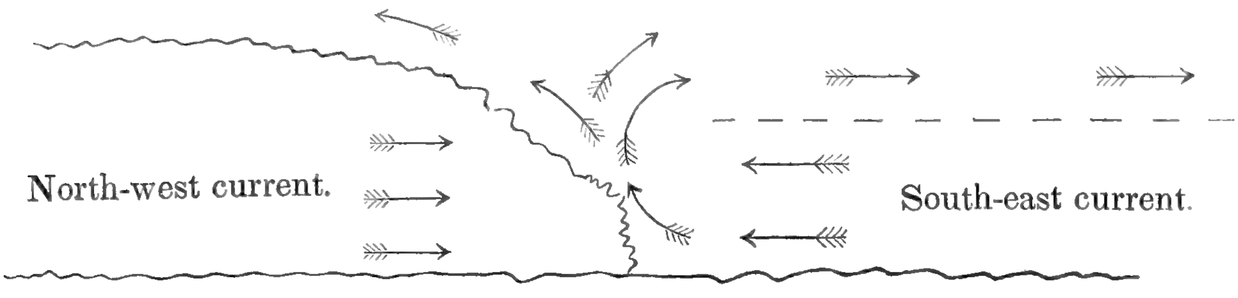
It is doubtful whether the first of these causes ever produces rain, for the reduction of temperature is too gradual. It is very common for the thermometer to sink during the night below the dew point of the preceding evening, and without any change of wind; yet not only no rain follows, but the atmosphere may remain perfectly transparent the whole time. Such circumstances produce a most copious dew, but seldom if ever rain.

The second cause is one which is often observed, but ordinarily produces merely a fog. Thus the warm air from the gulf stream rolling over the cold banks of Newfoundland produces the densest fogs; and in winter, the air from the sea flowing in upon the frozen earth has its moisture abundantly condensed. Yet the reduction of temperature effected in this way is also so gradual, it is believed never to produce any considerable rain.

The third cause, though very similar in principle to the second, is believed to be more efficient than either of the preceding, because it will produce a more sudden change of temperature. The phenomenon, moreover, of atmospheric currents flowing one over the other in different directions may be observed almost every day of the year. But the fourth cause named, admitting its existence, must be allowed to be by far the most efficient of all. For the reduction of temperature may be conceived to be effected with almost any degree of suddenness, and to any extent. Thus, in midsummer, air with a dew point of 80°, being suddenly elevated two or three miles above the earth's surface, would, from change of temperature, lose almost the totality of its vapour. By supposing some cause which should continually renew the operation over a limited locality, we could account for the most violent and abundant rains on record. This case, therefore, demands particular consideration. This effect might be produced, 1. By a horizontal current impinging upon the side of a mountain. The current might thus be forced up to an elevation, where it would experience a very great and sudden reduction of temperature, and a portion of its vapour be instantly precipitated. 2. A large body of air might be suddenly and mechanically elevated by a volcanic eruption. The direct effects of these two causes must, however, be quite local. If they ever influence distant stations, it must be indirectly, by means of currents here set in motion. 3. Air may be elevated by a whirlwind; for even in horizontal whirlwinds there is ordinarily, if not always, an upward motion in the centre of the vortex. 4. When a hot and cold current, moving in opposite directions, meet, the colder, having the greatest specific gravity, will displace the warmer, which is thus suddenly lifted from the surface of the earth, is cooled, and a part of its vapour precipitated. This is a cause which may operate in any locality, and with almost any degree of energy. It is believed, therefore, to be, at least in this latitude, the most common cause of rain. Let us now review the circumstances of the rain which fell during the period under examination. This occurred during the winter, and with a southerly wind. We have here, then, the second cause for the reduction of atmospheric temperature, operating under the most favourable circumstances. Yet the precipitation arising from this cause must begin at the surface of the earth, and proceed very gradually. But in the present case the rain came from a considerable elevation, and poured down in torrents. Although, then, this be admitted as a cause of rain, I cannot regard it as the main cause, nor any thing more than a very feeble auxiliary. Can the third cause be the true one? We have, in the present case, a warm current from the south, and, without doubt, a little above it, a cold current from the west. The consequence would be, a certain amount of precipitation from the partial mingling of these two currents where they came in contact. The whole amount of air which could be cooled in this way is very small, and the consequent precipitation would be only a small fraction of that which was observed. Let us, then, inquire if the fourth cause could be supposed to operate. We have already shown from the observations of the wind, without the aid of any hypothesis, that the southerly current must have disappeared by being elevated into the upper regions of the air. This I regard as a necessary deduction from the observations. We find, then, a warm current suddenly cooled, and its moisture must, of course, be in part precipitated. I find by computation, that if the entire atmosphere, saturated with moisture at the temperature of 70°, be cooled 5°

"	60	"	7	one inch of water will be precipitated.
"	50	"	10	
"	40	"	16	
"	30	"	25	

But the average amount of water which fell throughout the United States was somewhat less than one inch. The cause we have assigned, then, seems adequate to account for the phenomena. We have simply determined, as yet, that the south-east wind must have disappeared by being lifted from the earth's surface. But in what direction did it continue to move? It might be supposed to continue on its course towards the north-west, above the other current, or to return towards the south-east. Being a current of more than a thousand miles in breadth, we can hardly suppose it to escape either by the north-east or the south-west. Did it, then, continue its direction towards the north-west? We should then have a warm and moist current flowing at a great elevation over an exceedingly cold one. The consequence would be, that its moisture would not only be precipitated, but frozen, and would descend to the earth in the form of snow or hail. This is conformable to observation. Snow and hail did fall at nearly all of the northern stations, after the north-west wind set in. But the amount was small; much less than must necessarily result if this entire southerly wind had flowed over the northerly, and had its moisture precipitated by it. Still, it seems probable that a part of this southerly wind did continue on its course, and produce the snow which was observed to fall. I infer that the current was mainly turned back upon itself, so that the moisture, as fast as precipitated, fell through the lower current, still blowing from the south-east. My idea may, perhaps, be best illustrated by a diagram.



A part of the moisture of this south-east current might be frozen from the cold of elevation, even if it were driven back in the direction from which it came. But, falling through a warm stratum, before it reached the earth's surface it would be entirely melted. At several stations hail fell in small quantities very soon after the wind changed. This might be owing to the moisture of the warm current suddenly condensed by contact with the cold one, and sustained by this upward motion, until the frozen drops had acquired the size actually observed, which in no case was very great.

Why more rain fell at some stations than at others only moderately distant I cannot certainly say. The causes, doubtless, were local, and it would be unsafe to assign particular reasons without a good knowledge of the localities. Such an effect, however, might be produced by a hill of moderate elevation, which would raise the lower current, and, consequently, the returning upper current, to an unusual elevation, producing a corresponding depression of temperature.

The observations of the thermometer on pages 131—133 are believed to present nothing very difficult of explanation. That the temperature should rise under a southerly wind was to be anticipated. The wind blew from a southern quarter more than twelve hours, in which time it probably travelled nearly five hundred miles, or, making allowance for the obliquity of its course, between four and five degrees of latitude. The difference of temperature corresponding to this difference of latitude, for winter, in the United States, is about ten degrees. But the temperature of the air generally rose more than this number of degrees above the mean. Moreover, there prevailed in the northern states a vast body of snow and ice, which rapidly absorbed the caloric of this southern current. The explanation, then, is insufficient. We shall find an additional cause for this elevated temperature in the abundant precipitation of aqueous vapour. When vapour becomes reduced to the liquid state, it gives up a large amount of latent heat, which will, of course, be taken up by the surrounding air. The temperature of the eastern states was found to be a little greater than that of the western. At the former, the southerly wind came from the ocean, which, in winter, has a higher temperature than the land. It is not clear, however, that more rain fell in one section than the other.

That the north-west wind was cold is not remarkable. It came from a high latitude, where the prevalent temperature is, probably, far below zero. Its severity, however, became somewhat tempered in its progress, the mean of the minima at the eastern stations being fourteen degrees higher than at the western.

I come now to the phenomenon probably the most difficult of all to be explained, namely, the oscillation of the barometer. For the movements of this instrument various causes have been assigned, some of them so unphilosophical that it is really astonishing that they could ever have been seriously proposed by intelligent men.

1. The oscillations of the barometer have been ascribed to the destruction of large masses of air in the higher regions by electricity. The supposition is too gratuitous to deserve serious consideration.

2. They have been ascribed to the diminished pressure resulting from the loss of rain. But the amount of rain which fell in the case under consideration would be balanced by a column of mercury about one-fifteenth of an inch in height.

3. Heat, by expanding a column of air, causes it to ascend to a greater height, and thus changes its centrifugal force arising from the earth's rotation. This cause is too insignificant to produce the effect in question.

4. They have been ascribed to the attractions of the sun and moon. Laplace estimates the greatest oscillation of the barometer due to this cause to be, at the equator, 0.025 inch.

5. Leslie ascribes them to the centrifugal force arising from violent winds. But, in the case of a hurricane, this would not produce an oscillation of the barometer amounting to the thousandth part of an inch.

6. The opposition of winds. This might produce a small movement of the barometer. We shall presently inquire whether this cause operated in the case under consideration.

7. The barometer has frequently been observed to fall under the influence of a whirlwind. But in the present case there was no whirlwind.

8. These oscillations have been ascribed to sudden changes in temperature and in the amount of aqueous vapour. An elevation of temperature of the entire atmosphere could not directly affect its pressure, for, in proportion as its density is diminished, its height will be increased. But if, by any means, a portion of hot air can be made to displace an equal bulk of cold air, the weight of the column must be diminished. It is obvious that this cannot be a state of permanent equilibrium; yet it is worthy of inquiry whether it may not temporarily exist under the influence of winds. On the 20th of December, 1836, the air over nearly the whole of the United States became unusually heated, and its specific gravity was, of course, diminished. If, then, the height of the atmosphere remains invariable, a diminution of pressure ought to be the consequence. But, although a fall of the barometer is usually accompanied by an elevation of temperature, the reverse is sometimes the case. Thus the fall of the barometer in Europe, which I have represented on Plate 2, and which, at most places, amounted to more than an inch, was accompanied by a steady fall of the thermometer. The barometer, in this case, fell in spite of the increased specific gravity of the air. We may naturally presume, then, that a change in the specific gravity of the air produces only a secondary effect on the oscillations of the barometer.

9. A wind blowing upward or downward would affect the pressure of the air. This is a cause whose existence we have proved in the case in question. Its effect upon the mean pressure of the air in the equatorial regions is unequivocally maintained in the Instructions for the British Scientific Expedition to the Antarctic Regions, recently prepared by the President and Council of the Royal Society, causing the barometer at the equator to stand permanently lower than in latitude 30°, by about a quarter of an inch. The as-

cending current of December 20th could not, however, exert any direct influence upon the barometer, except near the centre of the storm. To account for the entire oscillation, I think, we must admit another principle quite distinct in its operation.

10. Let a wind blow ever so violently over the earth's surface, and the diminution of gravity arising from the centrifugal force must be inconsiderable. But, imagine the different parts of the current to travel with unequal velocity, and there will arise a mechanical condensation, or rarefaction. When air is at rest, or in motion, with a uniform velocity, its particles are maintained at a constant distance from each other. But let the velocity of one section be increased beyond that of the succeeding, and the same particles of air are forced to fill a greater space. Such is the principle of the undulations which produce the sensation of sound. It appears to me that a similar effect must have been produced in the storm of December 20th. The south-east wind which accompanied the rain moved with an accelerated velocity. The particles, therefore, of air at one extremity of the current must have left those of the other extremity at an increased distance. Hence a mechanical rarefaction, and, of course, diminished pressure. The reverse effect must have taken place after the storm had passed. A north-west wind sets in with great violence. A vast body of air is precipitated towards the south-east. The partial vacuum which at first existed is very soon supplied. Yet, though the first impelling cause has ceased to act, the momentum of the excited current still urges it onward. The front of the wave is impelled by the momentum of the mass in the rear, and a mechanical condensation results, bringing, of course, increased barometric pressure. The cause, however, which produces this extraordinary rise, being temporary in its nature, soon ceases, and the barometer falls. The causes which I have here assigned for the oscillation of the barometer appear to me to be such as are known to be true, and that they are sufficient to account for the phenomena.

I have thus analyzed the phenomena of this somewhat remarkable storm, and given such explanations of them as have appeared to me most satisfactory. It is a most interesting and important inquiry, how far the conclusions at which I have here arrived may be safely generalized. I have already made some progress in this investigation; but as the present paper has now grown to an unexpected length, I reserve my remarks upon that point to some future opportunity. I trust it will not be inferred from my silence with respect to the labours of others in this important field, that I am wholly ignorant of them, or am insensible of their value. I have availed myself of the labours of others as far as was in my power. To have credited every suggestion to its original author would have been inconvenient, and generally superfluous, being found in most treatises on meteorology. I am happy, however, to express my particular obligations to the labours of Messrs. Redfield, Espy, and Col. Reid, and shall esteem myself well repaid if the present communication shall contribute something to the progress of that science which they have done so much to promote.

ARTICLE XIII.

Observations on Nebulæ with a Fourteen Feet Reflector, made by H. L. Smith and E. P. Mason, during the year 1839. *By E. P. Mason. Read April* 17, 1840.

1. ALTHOUGH a period of nearly fifty years has now elapsed since the researches of the elder Herschel exposed to us the wide distribution of nebulous matter through the universe, we are still almost as ignorant as ever of its nature and intention. The same lapse of time that, among his extensive lists of double stars, has revealed to us the revolution of sun around sun, and given us a partial insight into the internal economy of those remote sidereal systems, has been apparently insufficient to discover any changes of a definite character in the nebulæ, and thereby to inform us at all of their past history, the form of their original creation, or their future destiny. At the same time, the detection of such changes is in the highest degree desirable, since no other sources of evidence can be safely relied upon in these inquiries. That the efforts of astronomers have thus far ended, at best, in vague and contradictory conjectures, is principally attributable to the great difficulty of originally observing, and of describing to future observers, bodies so shapeless and indeterminate in their forms, with the requisite precision. For, we cannot doubt, authorized as we are to extend the laws of gravitation far into the recesses of space, that these masses of diffused matter are actually undergoing vast revolutions in form and constitution. The main object of this paper is to inquire how far that minute accuracy which has achieved such signal discoveries in the allied department of "the double stars," may be introduced into the observation of nebulæ, by

modes of examination and description more peculiarly adapted to this end than such as can be employed in general reviews of the heavens. The observations which are detailed in this paper are brought forward in illustration of this inquiry.

2. It will conduce to a clearer understanding of our object to point out, generally and rapidly, the distinctions between our own theory of observation and that commonly adopted. It consists not in an extensive review, but in confining the attention to a few individuals; upon these exercising a long and minute scrutiny, during a succession of evenings; rendering even the slightest particulars of each nebula as precise as repeated observation and comparison, with varied precautions, can make them, and confirming each more doubtful and less legible of its features by a repetition of suspicions, which are of weight in proportion as they accumulate; and, lastly, when practicable, correcting by comparison of the judgments of different persons at the same time.

Thus much for observation—for rendering the idea of the object as perfect as may be in the mind of the observer. For the most unimpaired communication of this idea or perception, the theory of the process adopted is briefly, 1st. To form an accurate chart of all stars capable of micrometrical *measurement* in and around the nebula. 2d. From these, as the greater landmarks, to fill in with all the lesser stars, down to the *minimum visible* by *estimation*, which, with care, need not fall far short of ordinary measurement. 3d. On this, as a foundation, to lay down the nebula. After this preparation, subject to no material distortion, except such digression from the original perception of the observer as the difficulties of accurate representation by a shaded ground and subsequent copying and engraving may cause. Lastly, the process includes the adoption of a method of representing nebulæ, intended to remove the formidable and acknowledged difficulties just named, and at the same time to introduce a numerical precision in the manner of expressing on paper their various features; thereby transmitting the best impressions of observation with almost unimpaired fidelity, and entailing only the necessary defects of original vision. It is not supposed that this process, as more fully to be illustrated in its application, is the best adapted to meet the end in view, for greater experience and reflection would certainly suggest particular modifications, if not general alterations; nor is it intended as a description of what has been done in the present instance, but rather of what might be done, with more time, and under more favourable circumstances, by observers of greater skill and longer practice.

3. The observations presented in the following paper are a portion of a series undertaken in the summer of 1839. The range of objects which at that time passed under inspection was considerably more extensive than the present list; but many of these were examined in a desultory manner, and the rest of those excluded are not favourable specimens of the style of observation which it is intended to exemplify. The telescope employed was of the Herschelian construction, with an aperture of twelve inches and a focal length of fourteen feet. A short description of its construction and powers will not be uninteresting, and may serve to show what degree of confidence is warranted in results obtained by its aid. Although much inferior in size and light to some of the gigantic reflectors of the Herschels, it yet is entitled to some distinction as the largest telescope on this side of the Atlantic. The instrument was first planned and begun in the summer of 1838, by my friend and classmate, Mr. H. L. Smith. A tolerably good metal was cast, after several failures, and the speculum was finally polished near the close of the summer. Mr. Smith and Mr. Bradley shared the expenses attending the formation of the mirror and erection of the telescope, and divided the long labour of grinding the speculum, and I united with them in the less tedious task of giving the mirror its final polish and figure. An account of its performance in some of our first rough trials of its figure is furnished in a note on the 174th page of the XXXVth volume of Silliman's American Journal of Science. It has since been frequently and perseveringly repolished by Messrs. Smith and Bradley; the test objects mentioned in that note, however, have been about the limit of its separating power.

4. The mode of mounting the telescope was similar to Ramage's, but ruder. The base consisted of three beams, forming a triangle, which revolved on a circular ledge of plank, by means of rollers at the angles, and which was guided truly in its circuit by a cross-piece, through which rose a central bolt, firmly driven into the ground. From the angles of this base rose three beams, meeting at a height of sixteen or seventeen feet from the ground, and a rope passed through a pulley fixed at this height, and sustained the weight of the upper part of the telescope. The lower end, containing the speculum, rested on a small platform at one of the solid angles of the base, and revolved with the frame. The quick motion in altitude was by means of the rope just men-

tioned, which passed down to a windlass at the base, while a slow motion was gained by an apparatus very similar to that described and figured in Pearson's Astronomy as attached to Ramage's telescope—a combination of ropes within the immediate command of the observer. In azimuth the whole frame could be wheeled about by a single person, and a slower motion was obtained by simply swinging the telescope by the hand, which could be done by the observer, in following a star, with perfect steadiness. At very high altitudes, the system of ropes was not available; but the weight of the upper end of the telescope was then so little that the observer could grasp the tube in his arms, steadying them by contact with the converging beams, and carry on his work nearly as well as before. This method of directing a large telescope is much ruder in description than in practice.

A light frame-work of steps, detached from the main frame, served to support the observer in his elevated situation. Against this the tube of the telescope could be steadied at any moderate elevation, by means of a simple contrivance; this, however, was never necessary unless in high winds. The tube was, at first, of wood, but was afterwards replaced by sheet iron, on account of its superior lightness and portability; it was painted outside and inside, and protected, during bad weather, by oil-cloth, the speculum at such times being taken out.

5. It was our intention, at first, to have availed ourselves of the power and light of this instrument in a meridional review of a portion of the double stars of the younger Herschel's catalogue. But a short experience convinced us that its large surface was much better adapted to observations on the fainter nebulæ than its power of separation to the examination of close double stars. And an imperfection in the casting,* which, in spite of the most patient endeavours in renewed and frequent polishing, seemed to vitiate a portion of the

* It is exceedingly difficult to obtain a good casting of so large a speculum. The metal, in itself, is of a composition that presents obstacles of no ordinary difficulty, while, from the comparative ignorance and unskilfulness of many of our workmen in this department, those facilities are not afforded for overcoming these obstacles which scientific interest in Great Britain and the older countries of Europe has conferred. For a telescope considerably less in size I have had more than fifty specula cast before I could obtain one free from imperfections, and susceptible of a very excellent figure. In the present case, the general figure of the speculum, except in the neighbourhood of the flaw I have spoken of, seemed to be excellent.

speculum near it, although it did not prevent a very perfect definition of the discs of large stars, was yet apt to throw around them flitting rays and burrs of light, sometimes hiding very close or faint companions. By a skilful application of diaphragms, these might be so far annihilated as to afford a good separation of such stars as σ Coronæ Borealis, ζ Orionis, μ^2 Bootis, γ Virginis, λ Ophinchi, and others of less than $1''$ in distance, but the loss of light by this mode of proceeding was a serious inconvenience. On objects as ill-defined as nebulæ, however, the full light of the telescope could be employed to the utmost advantage. It was not long before a strict scrutiny revealed to us many particulars concerning the nebulæ of the elder and younger Herschels, which it was obvious that they had not noticed, and in some instances spaces of nebulous matter of great extent, connected with well known nebulæ, but altogether overlooked by former observers. These considerations decided the application of the instrumental power we had obtained to this interesting field of inquiry.

6. The nebulæ which are the subjects of the present paper are 1991, 2008, 2092 and 2093 of Sir J. F. W. Herschel's large catalogue, (Phil. Trans. 1833.) These are, in reality, but three, since 2092 and 2093, as will be shown in this paper, are but parts of one very extensive nebula, united by a long, irregular band of very faint nebulous matter. These three nebulæ are among the most interesting objects in the heavens; perhaps, with the exception of Nebula Orionis and Nebula Andromedæ, the most so. They are represented in Plates IV., VI., and VII., with the stars in and near them, visible in the fourteen feet telescope. The number of objects examined is small, in order that the utmost accuracy in the delineation of the peculiar features and minutiæ of these nebulæ, attainable by protracted scrutiny, might be aimed at. This must still be limited by the unavoidable errors of judgment and the power of the telescope. It is hoped, however, that by this means something has been done to supply, in the examination of these nebulæ, the place of measurement in that of double stars, and to put in our possession data by which future changes, if there be any, can be recognised and detected in at least a few of these wonderful sidereal systems.

7. The first intention was to intrust entirely to careful *estimation* the copying of the stars which were to form the ground-work of the nebula, since no means of measurement were then at hand. The following is a sketch of the course of procedure adopted in pursuance of this plan. The limits of the

nebula were traced as far as long and close examination could discern them, and a rough chart was made of the principal stars within it. This preparation was indispensable, because, in the consequent mapping down of all the visible stars in the nebula, it was necessary to use a light out of doors, and the object, of course, became invisible. The distance between any two conspicuous stars, favourably situated in the nebula, was then chosen as a standard of reference, and from this as a base, a kind of triangulation was carried out by the eye to all the stars in the neighbourhood, and these were successively marked on a sheet of paper at the time; their magnitudes were also affixed to each according to a fictitious scale, for which a few stars, conveniently situated, furnished standards of reference as to size. A lamp was close at hand, whose light could be cut off at pleasure; an almost direct comparison was thus instituted between the stars in the field of view and those on paper, and corrections made where any distortions in the latter were observable. As the work advanced from night to night, the reference to the lamp was necessarily less and less direct, since a longer exclusion of light was necessary to see the fainter stars. Finally, the nebula itself was drawn upon the map by the guidance of the stars already copied; and although only an occasional and unfrequent reference could be made to a lamp, the stars within it had become so familiar by their constant recurrence, that the memory could, as easily as before, retain its *estimations* of distance and direction, until mutual comparison could be made between the map and the heavens.

The assistance which is rendered to the faithful description of these remarkable objects by thus laying a groundwork of stars, may be well illustrated by the familiar expedient of artists, who divide any complicated engraving which they would copy, into a great number of squares, their intended sketch occupying a similar number. The stars, which are apparently interwoven throughout the whole extent of the nebulæ, furnish a set of thickly distributed natural points of reference, which, truly transferred to the paper, are as available as the cross-lines of the artist in limiting and fixing the appearance of the future drawing.

8. In nebulæ of great extent, however correctly estimated may be the stars immediately around the standard of reference, those in the distant parts of the nebula are liable to suffer from an accumulation of errors of nearly the same kind as that arising in an extended trigonometrical survey. But if the places

of the larger stars are well settled by fixed instruments, there will be far less room for error in *estimations* which spread, as from so many centres, over the remaining intervals. It was extremely desirable, in the present case, to ensure accuracy by such a course; although it would have been preferable, had the means existed, to have resorted to it in the first instance. The opportunity was, however, fortunately afforded at a late period of this research, by the unexpected arrival of an excellent micrometer from England, belonging to Yale College, and adaptable to the ten feet Clarke's telescope in the observatory of the institution. I was enabled, by the kindness of Professor Olmsted, to avail myself of this instrument, and, during the fall of 1839, took repeated measures in right ascension and declination of so many stars in each nebula as would serve to determine, within a very small quantity, the places of those which were utterly too faint for any measurement. An abstract of these measures is contained in this paper. By these means the places of all the stars were brought to such a degree of exactness that it was thought expedient to throw them into the form of catalogues, especially as a direct reference could thus be made to any particular star, and, through it, to any portion of each nebula, without the necessity of encumbering the map with multitudes of letters or numbers. These catalogues, which are contained in Articles 37, 38 and 39, will be referred to constantly in this paper, and from them the star corresponding to any number in the catalogues will be easily found on the maps.

9. There must be a very considerable, though partial dependence, after all, upon the eye of the observer and the delicacy of its judgments. And as, in the use of any instrument, we feel unsafe and distrustful until aware of its errors and their probable amount, so in this kind of *estimation* by the eye, a knowledge of its liability to error is necessary to command the confidence either of the observer or of others in the results obtained by this means. To ascertain the liability of these charts to error from this source, I frequently drew a set of triangles upon paper, and after estimating their angles and the comparative lengths of the sides, measured the same. From the mean of a great number of trials, I found my average error in such *estimations* to be less than two degrees upon angles, and $\frac{1}{20}$ or $\frac{1}{30}$ in comparative distances. A fairer allowance may, perhaps, result from estimated angles of position and distances of double stars. I have a record of a considerable number of such, observed on the meridian during the summer of 1838, thirty-six of which are comparable

with standard catalogues. The mean error of these estimations in position is 4°, in distance .09 of the whole. As these estimations were of absolute distance, and included stars ranging from ξ Libræ and λ Ophinchi to such as were several minutes asunder, it may be inferred that the errors of merely relative distance in the drawings will be considerably less.

A still better test is afforded by the comparison of the star-charts as first copied from the heavens by simple *estimation*, with the projections afforded by later micrometrical measurement. The latter were laid over the former, and the discordances between the two are given in numbers in Article 34. By taking from that table the mean of the errors of *estimation* on each star, we find that, where they were made in the most careful manner, their average error in right ascension is about $0.^s4$, and in declination about $6\frac{1}{2}''$. These were in a space of 20′ diameter; the spaces included between the settled, or standard stars, are generally much smaller than this, and, of course, diminish the liability to error. Although the mean errors named above show that careful *estimations* need not, in small spaces, be in error to so great an amount as 5″ or 6″, (an accuracy not very far from that of actual measurement,) yet it may be well to add, that some portions of the larger nebulæ were more hurriedly and less accurately observed, as explained in Article 34. From all these sources a tolerably correct idea of the probable error of judgment, so to speak, may be deduced.

10. I will here speak of a method that I hit upon for the exact representation of nebulæ, which has essentially contributed to the accuracy of the accompanying delineations; the one referred to in Article 2. It was first suggested by the method usually adopted for the representation of heights above the sea-level on geographical maps, by drawing curves which represent horizontal sections of hill and valley at successive elevations above the level of the sea, that is, by lines of equal height; and it is the same in its principle. It is obvious, that if lines be imagined in the field of view winding around through all those portions of a nebula which have exactly equal brightness, these lines, transferred to our chart of stars, will give a faithful representation of the nebula and its minutiæ, and of the suddenness as well as of the amount of transition from one degree of shade to another. I cannot better illustrate my idea than by a reference to Plate II., the lines of which were transferred directly from the field of view to the paper in this way, and will be immediately recognised as

identical with the nebula of Plate IV. The lines marked 5 were traced in the telescope among the stars, and imagined to surround all those portions of the nebula which are of uniform brightness, and brighter than any other part. The first perceptible gradation or diminution of light is bounded by the lines marked 4, and so on, successively, to the line $\frac{1}{2}$, which represents the utmost bounds of the visible nebula. All these lines were first traced carefully by the eye, in their windings among the stars in the field, retraced by the pencil upon a map of the stars at hand, and finally corrected by repeated and mutual comparison.

11. If we suppose in Plate V. the faintest perceptible tint to be laid over all the space included within the line $\frac{1}{2}$, and upon that, another layer of shade bounded by the line 1, such that the gradation shall be just perceptible, and so go on, increasing in depth of shade, till the last tint laid on within the lines 5 shall represent the brightest portions of the nebula, we have at once a representation of *h*.* 1991, giving, in its fullest perfection, the original idea of the observer, as formed with the object under his immediate and minute inspection. The great errors which are likely to arise in drawing and shading such delicate objects are done away. In the usual mode, a slight pressure of the pencil, or even the inequalities of the paper, may give a different impression of the particular features of the object from that which the observer intended; and where the gradations of shade to be represented are so extremely delicate, it cannot go through the process of engraving without still farther suffering in accuracy. In the method here proposed these sources of error are annihilated, for these lines can be drawn and corrected out of doors, with the native object in view, and can be transferred to the engraved plate without appreciable alteration.

12. In strictness, we should further suppose that these tints shade off into each other at their boundary lines, or that the lines should be drawn at infinitesimal intervals from each other, as exact theory must require, and conformity with the gradual decrease of light in the objects themselves. But, in practice, it is only necessary to draw the lines so that the spaces between them shall represent the least equal gradations of light visible to the eye, as has been

* The reference to Sir J. F. W. Herschel's catalogues is here, and elsewhere, by means of the small letter *h*, according to his own notation. So, also, *Sh* refers to "Herschel and South's Catalogue," 1824.

done in Plate V. Farther than this, of course, it would be useless to multiply lines; and these express the rate of condensation as well, and in much the same way as a series of points distributed at very small, equal intervals serve to determine the curve in which they are situated.

This method may be designated as a *method by lines of equal brightness*, in analogy with the terms "cotidal lines,"—"lines of equal magnetic intensity," &c., to which modes of expressing facts it is nearly allied.

13. In the double nebula, (Plate V.) the southern member of which is the very remarkable and well known nebula divided into three portions by dark rifts, and having a triple star in the centre, and the northern member, one hitherto overlooked, and surrounding the bright star in its neighbourhood, the *lines* of *equal brightness* enable us to recognise at once particulars such as these: that the portion of the *trifid* marked A suddenly shades off, almost to darkness, on the side towards the triple star, as is indicated by the closeness with which the lines succeed each other, while the transition outward is very slow and gradual; that the three nuclei of the southern portion, running up to shade 5, are perceptibly brighter than that of the northern, whose brightest portion is only within the line 4; and others of a similar description. It is evident, at once, that all such particulars concerning a nebula as are expressed, in the younger Herschel's nomenclature, by the terms "gradually," "suddenly," and "very suddenly—brighter in the middle," are indicated in this method by a greater and greater proximity and crowding of the lines; while the distinction between such terms as these, "suddenly brighter" and "suddenly much brighter—in the middle," are marked by a greater number of these lines intervening in the latter case than the former. It will be easy to conceive how all other particulars concerning a nebula, except, perhaps, its resolvability, and the like, can be at once embodied in the simplest form of diagram at the time of observation.

14. The half lines serve to show strongly suspected gradations of shade; for instance, within the space enclosed by the line $1\frac{1}{2}$, the nebula is suspected to brighten up a little, dividing the rift α into two branches. Many minute particulars are perfectly and readily distinguished at a glance in Plate V., but far less easily and definitely in Plate IV. And even Plate IV., as well as the other shaded drawings, owe much of their minute accuracy, in the hands of the engraver, to drawings similar in design to Plate V. They are, in fact, copied

from such, by the artist, in a way somewhat resembling the imaginary process I have described in Article 11, of laying upon them successive tints of shade.

15. It will be observed that but one nebula is represented in the figures by this method of lines. It was deemed expedient to adopt, at present, the common mode, that the drawings might be better understood. The originals by lines, however, are preserved, and are considered more accurate sources of reference.

16. I will now proceed to the immediate observations on the nebulæ, only premising that less care was taken to keep records of them in the form of a journal than to embody them in drawings. From these drawings the plates accompanying this paper have been principally compiled. I regret that I have at hand no notes of Mr. Smith's observations distinct from my own, and can, therefore, furnish only such scattered remarks of his as I have happened to record at the time. This deficiency is of little real consequence, since it was the constant practice for each of us to verify the observations of the other. Indeed, in all cases where there could be any doubt, no particular was considered as any thing more than a mere suspicion, whose existence had not been fully and independently corroborated by the other's testimony.

Observations with the Fourteen Feet Reflector.

17. *Nebula* h. 1991.

1839. *July* 12.—Saw the triple nebula in Sagittarius. The three clefts which divide it were made out without difficulty, although the whole nebula was extremely faint. Rather low in the horizon.

Aug. 1.—Observed the *trifid* nebula of Herschel. The double star is certainly not as figured in the Phil. Trans., 1833, but rather adhering to the left of the three divisions. (A diagram was made, exhibiting this peculiarity.) The star was not seen triple.

Aug. 7. Nebula IV. 41. The nebula much brighter than I have seen it before. Mr. Smith and myself both remarked that the large star (22) immediately adjoining was surrounded with a very distinct nebula, not far inferior in brightness to the trifid. It was scarcely to be overlooked, and was seen at the first glance into the field. Its limits are nearly as great as those of the trifid nebula, with which it is nearly, or quite, in contact. On looking over Herschel's observations on this nebula, it was very evident that this is to be classed among the *Novæ*, although immediately contiguous to one of the most remarkable and frequently observed nebulæ in the heavens.

Aug. 9.—Figured some half dozen of the stars of the trifid nebula. I see distinctly the star near its centre triple, but a ray or burr of light from the larger star nearly obscures the faint companion, so that I can scarcely tell whether the difficulty of the small star consists in its closeness or faintness. Estimated distance of AB 10″; of AC 5″, but the last may easily be in error from the cause just mentioned. The triple star is certainly not central, but involved in the skirts of the division marked A in the diagram, and also is north of the point where the three clefts meet, being in the cleft γ. The division B runs up at the junction towards, or into the opposite cleft β a little way, shading off, at the same time, so gradually that, at first sight, the rift α seems to proceed more directly from the triple star than it really does.

Aug. 10.—Finished figuring the stars in Nebula Trifid. There is scarcely a visible star in the nebula above the triple star.

Figured the nebula. There is a peculiarity about the cleft α which had been suspected on the night of the 9th. It shelves off suddenly to the north with a pretty well defined boundary, which I can trace nearly up to the star (2;) if I mistake not, it divides in two, leaving an extremely faint nebulosity, or fourth portion, isolated from the rest. Mr. S. saw the sudden turn of the cleft northwards, but could not satisfy himself as to its division into two, which must therefore remain uncertain.

Peculiarities of the lower nebula.—There is a large, but indistinct vacancy, or gap, north, or below its central star, where the nebula is decidedly less bright, while, on the left hand of this vacancy, is a small portion brighter than the rest of the nebula. "I think the vacancy runs up past the central star, though narrower there."—*S.* In my own observation, I think it does not quite reach the central star, so that it remains doubtful whether the star in the centre is not somewhat isolated from the surrounding nebula. I saw the same appearance described by Mr. Smith, but considered it the effect of the brightness of the star in effacing the impression of the nebula in its immediate neighbourhood. Our estimates of the utmost extent of the lower nebula nearly agreed, although its boundary was very indefinite.

Aug. 14.—The nebula IV. 41 again examined; the moon at first troublesome, but setting. I tried, this evening, a plan for better delineating this nebula by lines which represented equal gradations of shade. I find it more convenient and direct, and, I believe, much more accurate. I think I can thus take a copy of the nebula with as much exactness as I can see it. To settle the angles of position of the triple star, lines were drawn on the star-chart, representing their apparent directions as referred to other stars in the nebula. The nebula, as delineated by lines, was compared by Mr. Smith, and verified; some slight alterations were suggested by himself, nearly all of which a re-examination confirmed, and some others added, which are better expressed in the drawing than by description.

18. *Nebula* h. 2008.

1839. *Aug.* 1.—Observed nebula M. 17. Nearly all the parts figured by Herschel in the Phil. Trans. are distinctly and beautifully seen. The night has evidently improved.

The two knots which Herschel describes in the appendix to his paper are well seen, but the upper one not resolvable; the lower one is seen by Mr. Smith and myself oval, and extending downwards. I think there is a small branch at the angle of the nebula, in a downward direction towards a coarse collection of large stars just below. A careful diagram made of this and other particulars.

Aug. 3.—The curved part of this nebula is certainly smaller in proportion to the bright following branch than is represented in Herschel's figure. The extremely faint preceding branch neither of us are able to see, although guided by Herschel's figure.

Aug. 7.—There is a coarse collection of stars below this nebula, in which I have once or twice suspected faint nebulosity. The branch before spoken of as extending downwards from the smaller of the two knots, seems to pass to the right hand part of this cluster, and, perhaps, running through it, to rise again, returning to the bright arm of the nebula, near the star (29.) This is but a bare suspicion, for an assemblage of stars often gives a deceptive appearance of nebulosity among them.*

"There is, I think, a faint ray from the internal angle of the nebula, towards the upper star of Herschel's figure (25 of Plate VI.)"—*S.* This observation of Mr. Smith's it was too late for me to verify.

Aug. 10.—Messier 17. Figured the stars in this nebula, amounting to upwards of thirty; also the principal features of the nebula. The bright following branch is remarkably devoid of large stars; it is, however, thick set with extremely small stars, just beyond the limits of distinct visibility; the places of three of these, after long attention, I have succeeded in fixing, and, with time and patience, could obtain more, but have little of either to spare; the fatigue of the eye, moreover, is extreme.

The observation made by Mr. Smith, on the 7th, of a faint ray towards the star (25) is, in a great measure confirmed; I see certainly the upper boundary of such a ray, but think it melts into, or joins with, the bright branch of the nebula below, being like a thin veil, or gauze of light, drawn up from the bright nebula, and stretched from the star to the internal

* It is scarcely to be supposed that this very common illusion is due to the sympathy of the neighbouring parts of the retina, which is only adequate to account for the usual aberration, or irradiation, of stars. If I might hazard a conjecture, I should, perhaps, attribute it to the same optical effect by which Sir J. Herschel (Mem. Ast. Soc., Vol. II., p. 490) is inclined to explain the apparent recession of the nebula Orionis from the stars of the trapezium situate within it; contrast with their strong light blotting out the nebula in their vicinity. So the diffuse starlight, which always redeems the sky from perfect blackness, may, perhaps, among many large stars, be faintly revealed by contrast with the portions effaced in the immediate vicinity of the stars. This is, at best, a very doubtful explanation, and principally thrown out for the purpose of calling attention to the phenomenon.

angle, where lies Herschel's resolvable knot. And, if I mistake not, all the space from this star to the vertex of the bend is filled up with extremely faint light. The knot is isolated from the rest of the nebula, and the vacancy in which it is situated is closed in on the right and left hand, but, I think, not above and below, or, at least, above. . . . . The nebula at the external angle stretches much farther towards the north preceding than in Herschel's figure, but with a faint shade. Mr. Smith confirms my view of his ray.

Aug. 14.—Finished the delineation of the nebula 17 of Messier by the mode of lines. The larger knot stretches faintly upwards to a second nucleus, or rather star, just above. With close attention, I am almost satisfied it is a very small star. The curve of the bright following branch is much as in Herschel's drawing; I think the curve of the faint bend differs more materially.

Aug. 19.—Attempted some observation on Messier 17, but the moon interferes. It is too late for the star seen on the 14th, in Herschel's knot, to be verified by Mr. Smith. Farther re-examination was desirable upon this nebula, and the places of the stars it contained, but such is now impracticable.

19. *Nebula* h. 2092 and 2093.

1839. *July.*—(There were several observations of little importance during the month of July, in which these two nebulæ were noted as separate, and the peculiarities of Herschel's description recorded as being "well seen.")

Aug. 1.—The faint band suspected between V. 14 and 2093 of Herschel's catalogue is fully confirmed by this evening's observation. Mr. Smith and myself were both able to trace the nebula continuously from one to the other, and the reverse, so that these are now satisfactorily ascertained to constitute one immense nebula, stretching through several fields of 30′ diameter. From the right ascensions and declinations of these two nebulæ, as given by Herschel, the whole cannot well be less than 2° or 3° long. The double star mentioned by Herschel is seen, as also the trapezium near the bifurcation, but the latter is evidently somewhat distorted in his figure. The peculiar characteristic of the upper portion of the nebula cannot be mistaken. I can think of no comparison as good as that which Herschel gives it, that of a network, or interlacing of nebula. The stars follow the disposition of this network very perfectly, and their real connexion with the nebula is as obvious as the testimony of the eye and of common sense can make it. It is almost impossible that the phenomenon can result from a mere superposition of stars; indeed, the chances against the supposition of their independence of each other must be very nearly infinite.

Aug. 3.—Attempted a triangulation among the principal stars in the great Nebula Cygni, to assist in exactly copying the nebula. Thirteen were thus taken, their angles of position with each other, and comparative distances carefully estimated and called out by one of us, while the other recorded. The power used was the ordinary observing power of 80.

Aug. 7.—Nebula Cygni. The method of fixing the places of the stars adopted on the 3d was found much too slow and tedious. I therefore fixed a lamp just beneath my feet, on the ladder of steps, and found I could, by this means, easily copy the stars from the field on a sheet of paper. I think this method is as exact as that of the 3d; I can thus correct and re-correct as long as my eye perceives any difference between the original and the copy. It is, moreover, much more rapid; I have recorded and corrected fifty-eight stars in the course of three or four hours, and affixed their magnitudes with equal care.

The nebula is, at the trapezium of stars, divided as in Herschel's figure, but just below this the larger branch forks again, or, at least, is fainter along the middle than at the edges. Mr. Smith and myself noticed this independently of each other, and without previous notice of each other's views. The brightest part of the nebula is at the bifurcation near the trapezium; the next brightest, though considerably fainter, is situated in the interlaced portion, and lies along the two stars (133) and (162.)

Aug. 9.—Figured one hundred and thirty-four stars in the same way as on August 7th; about ninety of these are new. The time occupied was about six hours. These complete all within the network portion of the nebula. All the stars down to the *minimum visibile* are put down, which are near the brighter portions of the nebula; in some excessively faint branches and convolutions, winding away to a greater distance, only those more easily seen are recorded. The scale of magnitudes is an artificial one, from 1 to 12, the star (187) being of magnitude 1, and the "*minima visibilia*" (149) and (156) being of the 12th. Care has been taken to set down every star in the dark hollows left by the interwoven nebula, and the "wonderful phenomenon" described by Herschel becomes, in this way, very apparent; for a tolerably correct representation of many of the windings of the nebula in the heavens may be obtained by simply following, on the star-chart, the courses marked out by the stars themselves. On the complete map of the stars the future nebula already strikes the eye.

In the lower part of the nebula, for convenience sake termed "the bifurcate," (while the upper may be called "the network portion,") the same faint division was seen as last night. With 220, faint stars were seen in each division of the great branch. Mr. Smith suspected another branch, turning off to the right hand, towards the bright star (8.) I am of the same opinion. There is a chain of stars, consisting of three loops, or more, which hang, festoon-like, from the preceding side of the nebula, and which seem to be mixed with nebulosity in the same way as in the network portion. If this is so, the branch noticed by Mr. Smith forms the beginning of one of those loops. But there is great liability to error where nebulosity is suspected among a congeries, or chain of stars; and especially is this the case in the present nebula, on account of the wonderful peculiarity already mentioned.

Aug. 10.—The stars along the bifurcate portion of the nebula were recorded this evening, twenty-five of which, out of between fifty and sixty, were new. On this evening, and on former evenings, the lowest power of about 80 was employed in taking all the stars down to the ninth or tenth magnitude of my scale; and a higher power of 220 was employed to obtain the fainter stars of the eleventh and twelfth magnitudes, where such were deemed desirable. The nebula itself was decidedly fainter with 220 than with 80, and on this account, as well as from its great extent, the nebula was examined and figured principally with the lowest power. (These remarks apply also to the powers commonly used on the other nebulæ.)

I think the nebula terminates near a pretty bright star (1;) I cannot certainly trace it farther. Two bright stars of my first magnitude, or rather higher than any magnitude of my scale, lie a little to the left hand of this extremity. Much of the nebula was roughly figured last night; the figuring to-night completed in the network portion—also, in the faint band down to the bifurcation. The character of this band seems to change as it approaches the network, beginning to break up into windings and hollows, as if it partially partook of the strange peculiarity of that portion in its approach thereto. The other end of the nebula seems disposed, if I may so speak, to break up into rifts and branches nearly parallel, and is certainly very different in its characteristics from the upper portion.

Aug. 19.—Nebula Cygni. Thirty or forty stars were added to the extreme lower portion, of which not one-half are new. The description of the nebula by lines begun. I am still uncertain about the three loops mentioned on the 9th. If they are as suspected, there is reason to believe the same in many places all around. Indeed, the whole back-ground of the heavens around the network, and in some places below, seems intersected with loops of suspected nebulosity; it is certainly different in appearance from other portions of the heavens. The loops and lace-work, which are certainly visible, probably fade off into such as we cannot see, or, at least, can but suspect.

I am not entirely certain of the subdivision into two of the larger bifurcate branch, first noticed August 7th. With 220, two or three minute stars are set down in each of the supposed branches, which certainly add to the effect, if they do not produce it. But, with considerable attention, the division seems to exist above and below the place where these minute stars are, the nebula between the two minor branches being not much inferior to either of them in brightness. The other division, that of Herschel, is tolerably black, and very distinct. On the whole, I think the existence of a second division is confirmed.

Aug. 20.—The description of the Nebula Cygni by lines completed. The stars in the extreme lower part of this nebula are not so accurately placed as at the bifurcation and in the network, nor do they descend to as definite and equal a limit in the scale of magnitudes. But such care is obviously of less use in this lower diffuse part.

The star (83,) at the bifurcation, was suspected to be a nucleus. With 220 it appears somewhat blotty, and different from other equal stars in the vicinity. It is in the very brightest portion of the nebula, at the principal bifurcation. With long attention, I am still uncertain whether this be a nucleus or a kind of nebulous star. To determine this point must require a telescope of greater light, or, at least, a better eye. Mr. Smith had no opportunity of examining this point.

The various particulars in the figured nebulæ were confirmed by Mr. Smith on different evenings; and such points as he did not confirm are considered as uncertain.*

Micrometrical Measures of the Stars in the Nebulæ.

20. The instrument with which these were taken was the ten feet telescope of G. Dollond, belonging to the philosophical department of Yale College. The aperture of this telescope is five inches; and its defining power is such as to resolve ξ Libræ, σ Coronæ Borealis, and other double stars of between 1″ and 2″ distance, and to exhibit the division in the ring of Saturn with ease. The micrometer is also of Dollond's most recent construction; a parallel wire micrometer, with screws of about one hundred threads to the inch, each revolution of the screw being subdivided into 100ths upon graduated heads. Farther subdivision, when desirable, is easily made by estimation. The wires are, I

* The fourteen feet telescope used in these observations was taken down in the latter part of August. On the graduation of the class in Yale College to which Mr. Smith and myself had belonged, the reflector became wholly the property of Mr. Smith, and was removed to Ohio City, Ohio. It has already been remounted there, and in a better frame, and with more perfect adjustments than before, as an extract from a recent letter of his will show:

"The stand," he writes, "is precisely similar to the engraving, in the Philosophical Transactions, of the one erected by Ramage at the Royal Observatory, Greenwich. It is full twenty feet high, and has a sliding gallery that will hold, with convenience, four persons. The telescope swings between two parallel beams, about six feet apart; up and down these the gallery can be raised or depressed by one person easily. The telescope is constructed to roll forward, so that the mouth may be at a convenient distance from the gallery. After observing, the tube can be let down into a tight box, and locked up; the whole is supported by four iron rollers, and can be turned by one person in any direction. The apparatus for slow motion in altitude is the same as in New Haven; I have been making some arrangements for a slow motion in azimuth." Mr. Smith farther writes that he has been prevented from making any observations of importance by the continuance of unfavourable weather. He has, however, lately fitted an excellent micrometer to his telescope, the work of an American artist, and will soon be prepared for fresh labours. From his zeal and activity, with so valuable an instrument, we cannot but expect the most interesting results. By the same letter I am furnished with a note of his observations on the 16th of July, 1839, which I insert as favourably exhibiting the power and capability of the telescope about the time it was employed on the foregoing nebulæ. . . . . "July 19, 8, P. M. Saw γ Virginis with 400 and 700, the latter a single lens, very beautifully; the same evening, 10, P. M., saw λ Ophinchi distinctly separated, and at 11, P. M., ζ Bootis triple." The latter I have never seen with this telescope, nor μ^2 Bootis, which Mr Smith says he has "frequently seen," but adds "that he could never separate η Coronæ Borealis." These afford good tests of the defining power of the instrument.

But few of the common tests of light have been observed. Favourable specimens of its "*minimum visibile*" are, however, (149) and (156) of the large Nebula Cygni, already instanced, besides two or three of the smallest stars in each of the other nebulæ. By an entry in the rough journal of observations, it appears that *h*. 250, or the "Polarissima" of Herschel, a nebula almost exactly at the pole, was, if certainly seen, a fair example of its limit of visual power.

believe, of platina; with the present telescope, they are each 2″.28 in thickness: their number and arrangement, as also the construction of other parts of the micrometer, is very similar to that of Troughton's spider-line micrometer, as described in Pearson's Practical Astronomy.

21. The illumination, however, is different, and resembles that employed by Frauenhofer to render visible his lines on glass. The light falls on the wires at right angles to the optical axis of the telescope, thus illuminating them upon one side, while the rest of the field is dark. This arrangement possesses considerable advantages in rendering visible small stars, which it would be otherwise extremely difficult to measure, if, indeed, they could be seen at all in an illuminated field. I found this property of great use, since nearly all the stars I wished to measure were below the tenth or eleventh magnitude. The chief faults of the present construction were two. The scale of teeth in the field of view, which marks the number of whole revolutions, is illuminated only edgewise by the light; it was in all positions difficult, and in many impossible to be read off. Great loss of time, and sometimes impaired accuracy, was the necessary consequence. The other defect was in the size of the wires; this made the line of illumination needlessly broad, and prevented small stars from being seen near or on it, unless too faintly lighted for accuracy. Neither of these faults are necessary to this construction, and both might be remedied without difficulty.

22. The telescope, being mounted with an altitude and azimuth motion, which, moreover, was quite unsteady and liable to tremors, was ill-adapted to micrometrical observation. The mode of managing the micrometer was necessarily peculiar, and its essential differences from the common and more regular employment of the instrument I shall briefly describe. The circle of the micrometer was turned until the stars in the field ran parallel to the two moveable wires. Their transits across the fixed wire, which then represented an hour circle at that point of the heavens, were noted blindly in a book at hand, no other way being practicable with a succession of stars at intervals of a few seconds each, or occasionally of less than a second. These furnished differences of right ascension. Those of declination were obtained by bringing the moveable wires over the two stars whose difference was required. No measure was considered good in which some star, brought on one of the wires for that purpose, was not completely bisected during the whole *run* across the

field; and at each new bearing of the telescope, preparatory to a fresh run, the circle of position was altered accordingly. But in this way many measures were necessarily rejected. The farther end of the telescope was steadied by contact with a double opening window-shutter, which gradually yielded to the azimuthal motion, yet with sufficient resistance to maintain the stars in the field at perfect rest.

In declination, on account of the defects before mentioned, and others of minor importance, more than one measure could seldom be obtained during a single run across the field, and that not cotemporaneously with the transits. In addition to this, the frequent necessity of entire disadjustment of the micrometer, in order to read off the scale within the field, caused a great waste of time; so that the measurement of the stars in the nebulæ, though of less importance than the observations with the reflector, occupied very much more time and labour. And it will not be surprising, after this very incomplete statement of the difficulties which it was necessary to encounter, and of the numerous sources of error thence arising, if the following measures should, in a few cases, offer somewhat greater discordances than those which occur in observations with a steady instrument, moving in the parallel of the star, and employed in measuring objects that can bear direct vision and full illumination.

23. *Reduction of the Measures.* The *value* of the *screw*, since the field would scarce include the sun's diameter, was determined entirely by passages of known stars over a given interval, a number of which were observed nearly every evening on which any measures were taken. It was subject to a very slight fluctuation, depending on changes of temperature and minute differences of focal adjustment; and hence it was checked by a comparison of the measures of the largest differences of declination on different evenings. One revolution of the screw at its mean state was equal to 17″.640.

The *zero error* was always measured by daylight, and was applied as a correction to the intervals of passage on all stars which were taken to determine the value of the scale, and to all measures in declination. During the fall months it increased gradually and uniformly from + 1″.57 to + 3″.83.

There is evidently no allowance necessary for the thickness of the wires, on account of their partial illumination, in any of the different uses to which the micrometer was applied in the present instance.

24. A correction remains to be noticed, which is due to difference of refraction in any two stars whose apparent differences of R. A. and Decl. have been measured. This becomes of considerable importance from the construction of the observatory, which was such as to limit the range of the telescope to comparatively low altitudes, for the stars of the nebulæ were observable only during the last two or three hours of their diurnal circles. The altitude of the object at the time of observation was therefore noted; at first, roughly, by means of a rude quadrant, or by estimation from the bearing of the telescope; afterwards, when the importance of this correction was fully known, and especially in the Nebula Cygni, where the distances measured were considerable, by recording the sidereal time of observation, from which the hour angle, and thence the altitude of the object is easily deduced. The altitude being known, the observed measures were corrected for refraction by the following equations:

If A′ and D′ = the observed differences of R. A. and Decl. between any two stars in the field, reckoned with their usual signs, and in minutes of space,

and A and D = the true differences, " " " " " " ,

r = difference of refraction for 1′ at the known altitude, always positive,

v = the angle of variation of the hour circle in the field of view, reckoned from the vertical around to the right hand,

and δ = the declination of the nebula,

we have these three equations:

(1.) $D = D' + r\, D' \cos^2.\, v.$

(2.) $A = A' + 2\, r\, D' \sin.\, v \cos.\, v \sec.\, \delta.$

(3.) $A = A' - r\, A' \sin^2.\, v.$

The first two are applicable to observed differences of Decl. and R. A. between two stars in the field of view; the last to observed passages of a single star between two wires, in determining the value of the scale. These equations are not such as they would be for an instrument mounted equatorially: they express the condition, that the stars in the field shall, at all altitudes, run on a parallel to one of the wires, which was, in the present instance, the only practicable mode of conducting observation.

For the three nebulæ observed the values of $r \cos^2.\, v$ (eq. 1,) and $2\, r \sin.\, v. \cos.\, v \sec.\, \delta$ (eq. 2) were calculated for every observable degree of altitude, and their logarithms to two places tabulated. Its application to each individual measure thus becomes very easy.

25. The first column of the following series of measures contains the date of observation. In the second are the numbers of the measured stars, as referred to the catalogue. The sign — between them indicates *differences* of right ascension or declination; thus, in Art. 26, 1 — 9 stands for Decl. of star (1) — Decl. of star (9.)

The third column contains the *observed* difference of right ascension (A',) or of declination of (D'.) The fourth shows the altitude or sidereal time of observation. In the fifth is the correction for refraction due to such altitude, for declination r D' $\cos^2. v$, and for right ascension $2\ r$ D' $\sin. v \cos. v \sec. \delta$, according to the formulæ above given. By the addition of this correction to the observed differences in the third column we are furnished in the sixth with the *true* differences, (A) and (D.) The seventh column contains the number of measures, of which the observed difference in the third column is the mean, and the eighth shows the probable error of each single measure, or the average difference from the mean of the set; these are respectively designated by n and e.

Nebula h. 1991.

26. Differences of Declination.

Date.		Stars.	D'	Altitude.	Correction for Refr.	D	n	e	Remarks.
Oct.	3	1 — 9	+ 905″.4	19°...18°	+ 2″.0	+ 907″.4	4	1″.2	Very liable to be affected by slight errors in pos. of wires.
"	10	"	905 .4	13	3 .4	908 .8	4	0 .4	
Nov.	2	"	897 .6	8½..7..6..5	9 .5	907 .1	13	2 .5	Low, but clear.
"	4	"	899 .9	10 ... 6	7 .4	907 .3	15	1 .3	
Oct.	5	2 — 9	216 .0	17 ...16	0 .6	216 .6	6	2 .2	
"	8	"	+ 215 .6	15 ...14	+ 0 .7	+ 216 .3	8	0 .7	
"	5	8 — 9	— 8 .1	no	corr.	— 8 .1	6	0 .8	
"	8	"	— 9 .6	no	corr.	— 9 .6	8	0 .7	
"	4	19 — 9	+ 60 .4	20 ...19	+ 0 .1	+ 60 .5	9	4 .4	Star (19) invisible near the wire.
"	8	"	65 .9	17 ...16	0 .2	66 .1	8	2 .0	Wire made as faint as possible; measures decidedly better on this account.
"	5	21 — 9	240 .0	19 ...18	0 .5	240 .5	6	0 .5	
"	8	"	237 .7	13 ...11	1 .0	238 .7	8	0 .5	
"	1	22 — 9	447 .9	18 ...16	1 .1	449 .0	3	1 .5	
"	3	"	449 .5	21	0 .8	450 .3	2	0 .7	
"	10	"	+ 450 .8	15 ...14	+ 1 .4	+ 452 .2	8	0 .4	
"	9	24 — 9	— 70 .2	20 ...18	— 0 .2	— 70 .4	6	3 .0	Excessively difficult to measure. Probably not very accurate.
"	4	25 — 9	+ 112 .4	19 ...17	+ 0 .3	+ 112 .7	8	2 .5	
"	8	"	+ 112 .5	20 ...17	+ 0 .3	+ 112 .8	9	1 .2	Wire made faintly visible; this certainly adds to accuracy.
"	9	28 — 9	— 270 .2	22 ...20	— 0 .5	— 270 .7	9	0 .6	

27. Differences of Right Ascension.

Date.	Stars.	A′	Altitude.	Correction for Refr.	A	n	e	Remarks.
Oct. 1	1 — 9	— $28^{s}.98$	21°...19°	+ $0^{s}.11$	— $28^{s}.87$	6	$0^{s}.29$	
" 3	"	28 .8	22	0 .08	28 .72	sing.	meas.	
" 4	"	29 .04	22 ...14	0 .20	28 .84	7	0 .47	
" 9	"	— 28 .84	17 ...13	+ 0 .25	— 28 .59	5	0 .51	
" 1	2 — 9	— 8 .25	20 ...19	+ 0 .03	— 8 .22	2	0 .45	–Not seen within 1^{s} of the wire.
" 3	"	8 .8	22	0 .02	8 .78	sing.	meas.	–A second in error?
" 4	"	7 .77	22 ...14	0 .05	7 .72	9	0 .22	
" 5	"	7 .8	20	0 .03	7 .77	sing.	meas.	–Wire made very faint.
" 9	"	7 .10	19 ...13	+ 0 .06	7 .04	7	0 .19	–Wires made just visible.
" 4	8 — 9	0 .52	no	corr.	0 .52	5	0 .03	
" 9	"	— 0 .5	"	"	— 0 .50	sing.	meas.	
" 3	19 — 9	+ 5 .7	"	"	+ 5 .70	"	"	–Star invisible near the wire.
" 4	"	6 .66	"	"	6 .66	5	0 .44	–Star tolerably well seen, though difficult.
" 1	21 — 9	7 .45	20 ...19	+ 0 .04	7 .49	2	0 .35	
" 3	"	7 .1	22	0 .03	7 .13	sing.	meas.	
" 4	"	8 .20	20 ...13	0 .08	8 .28	2	0 .30	
" 5	"	9 .1	20	0 .04	9 .14	sing.	meas.	–Probably the wrong second.
" 1	22 — 9	8 .40	21 ...19	0 .05	8 .45	3	0 .20	
" 4	"	8 .85	14 ...12	0 .15	9 .00	2	0 .15	
" 5	"	8 .9	21	0 .04	8 .94	sing.	meas.	
" 9	"	8 .71	19 ...13	+ 0 .11	8 .82	7	0 .21	
" 4	24 — 9	11 .60	no	corr.	11 .60	2	0 .10	
" 5	"	11 . 2	"	"	11 .20	sing.	meas.	–Too faint to be measured with much accuracy.
" 4	25 — 9	11 .80	19 ...12	+ 0 .02	11 .82	8	0 .52	
" 9	28 — 9	+ 18 .10	19 ...13	— 0 .06	+ 18 .04	9	0 .19	

Nebula h. 2008.

28. Differences of Declination.

Date.	Stars.	D′	Altitude.	Correction for Refr.	D	n	e	Remarks.
Oct. 5	11 — 21	+ 333″.9	17°...15°	+ 0″.8	+ 334″.7	7	1 .7	
" 8	"	334 .2	19 ...18	0 .6	334 .8	8	0 .9	
" 5	16 — 21	404 .0	18 ...17	0 .8	404 .8	6	0 .8	
" 8	"	404 .1	17 ...15	0 .9	405 .0	8	0 .9	
" 5	6 — 11	232 .8	14 ...13	0 .7	233 .5	6	0 .9	–Stars (4) and (6) so faint that some of these measures are very probably of (6) and (4,) or of a point between (6) and (4,) but nearer (6.)
Nov. 6	"	225 .8	16 ...13	0 .6	226 .4	11	4 .2	
" 8	"	236 .0	13	0 .7	236 .7	6	2 .3	
" 2	9 — 21	251 .5	10 ... 8	1 .5	253 .0	7	1 .5	
" 4	"	252 .5	10 ... 6	1 .9	254 .4	8	1 .5	
Oct. 5	14 — 21	443 .2	15 ...14	1 .2	444 .4	6	1 .3	
Nov. 6	14 — 11	108 .3	18 ...16	0 .2	108 .5	8	0 .8	
" 8	20 — 11	397 .7	18 ...17	0 .8	398 .5	12	1 .2	
" 8	23 — 21	55 .9	16	0 .1	56 .0	3	1 .5	–Low; stars invisible near the wires, and badly measured.
" 8	25 — 21	+ 216 .2	15	+ 0 .6	+ 216 .8	5	1 .4	

Date.	Stars.	D′	Altitude.	Correction for Refr.	D	n	e	Remarks.
Oct. 26	31 — 21	— 305″.6	17°...15°	— 0″.7	— 306″.3	8	0″.4	
Nov. 28	"	— 303 .7	7° 55′	— 2 .2	— 305 .9	sing.	meas.	
Oct. 26	31 — 30	+ 6 .0	no	corr.	+ 6 .0	5	0 .6	
" 28	"	+ 5 .8	"	"	+ 5 .8	4	1 .0	
Nov. 26	30 — 21	— 309 .2	9	— 1 .7	— 310 .9	2	0 .5 ±	
" 27	"	— 313 .3	7° 30′	— 2 .4	— 315 .7	sing.	meas.	
" 8	33 — 21	+ 12 .2	no	corr.	+ 12 .2	3	1 .7	Inaccurate on account of the great difference of R. A., and faintness of star.
Oct. 28	33 — 31	+ 311 .2	17 ...14	+ 0 .8	+ 312 .0	4	0 .8	
Nov. 6	37 — 30	176 .1	$7\frac{1}{4}$	1 .4	177 .5	sing.	meas.	
" 8	"	176 .1	14	0 .5	176 .6	2	1 .8	
Oct. 28	37 — 31	169 .2	22 ...19	0 .2	169 .4	14	0 .9	
Nov. 26	*υ* Sagittarii — 30	678 .9	6° 30′	6 .4	685 .3	sing.	meas.	
" 27	*υ* Sagittarii — 21	375 .6	7° 30′	2 .8	378 .4	"	"	
" 28	"	376 .2	7° 55′	2 .6	378 .8	"	"	
" 8	36 — 21	+ 336 .2	9 ...$6\frac{3}{4}$	+ 2 .5	+ 338 .7	3	0 .3	

29. Differences of Right Ascension.

Date.	Stars.	A′	Altitude.	Correction for Refr.	A	n	e	Remarks.
Oct. 5	6 — 11	— 4s.08	21°...11°	+ 0s.07	— 4s.01	12	0s.53	The discordance of these sets arises from the proximity of the two very faint stars (4) and (6.) (See Art. 28.)
" 9	"	3 .15	20 ...18	+ 0 .04	3 .11	5	0 .18	
" 9	9 — 11	— 0 .52	20 ...18	— 0 .01	— 0 .53	5	0 .10	
" 5	14 — 11	+ 6 .80	19°...3 meas. 11°...1 meas.	+ 0 .03	+ 6 .83	4	0 .10	
" 9	"	6 .58	20 ...18	0 .02	6 .60	4	0 .32	
" 3	16 — 11	8 .2	20	0 .01	8 .21	sing.	meas.	
" 4	"	8 .08	20 ...17	"	8 .09	4	0 .04	
" 5	"	8 .61	22...19, 11	"	8 .62	11	0 .32	
" 9	"	8 .20	20 ...19	"	8 .21	7	0 .49	
Nov. 8	"	7 .93	$6\frac{1}{2}$ ...$5\frac{1}{2}$	0 .10	8 .03	3	0 .11	
" 8	20 — 11	16 .43	7 ...$5\frac{1}{2}$	+ 0 .56	16 .99	4	0 .38	
Oct. 4	21 — 11	20 .80	20 ...17	— 0 .06	20 .74	4	0 .25	
" 5	"	20 .70	22 ...20	0 .05	20 .65	4	0 .50	
" 9	"	20 .2	20	0 .05	20 .15	2	0 .10	
" 4	30 — 11	46 .82	20 ...17	0 .13	46 .69	4	0 .62	
" 9	"	46 .73	21 ...18	0 .12	46 .61	6	0 .67	
" 4	31 — 11	51 .87	21 ...18	0 .13	51 .74	4	0 .38	
" 9	"	51 .60	20 ...17	— 0 .12	51 .48	5	0 .38	
" "	36 — 11	+ 68 .30	20 ...19	+ 0 .01	+ 68 .31	3	0 .40	
" "	6 — 16	— 12 .5	19	0 .03	— 12 .47	sing.	meas.	
" "	14 — 16	— 1 .6	19	0 .01	— 1 .59	"	"	
" "	23 — 21	+ 4 .30	15 ...14	0 .02	+ 4 .32	3	0 .20	Very faint and difficult; not seen very near the wire.
Nov. 27	25 — 23	3 .20	9	0 .11	3 .31	2	0 .10	
Oct. 9	30 — 21	27 .17	18 ...13	0 .08	27 .09	9	0 .29	
Nov. 6	"	26 .7	$7\frac{1}{4}$	0 .33	26 .37	sing.	meas.	
" 28	"	28 .20	$8\frac{1}{2}$	0 .25	27 .95	2	0 .50	
Oct. 9	31 — 21	31 .97	18 ...13	0 .08	31 .89	6	0 .33	
" "	33 — 21	36 .45	no	corr.	36 .45	6	0 .68	

Date.	Stars.	A′	Altitude.	Correction for Refr.	A	n	c	Remarks.
Oct. 9	36 — 21	48s.48	18°...13°	+ 0s.09	48s.57	8	0s.55	
" "	37 — 21	62 .10	14 ...13	— 0 .05	62 .05	2	0 .40	
Nov. 6	31 — 30	5 .8	no	corr.	5 .80	sing.	meas.	
" 8	"	5 .3	"	"	5 .30	"	"	
" 26, 27, 28	"	5 .04	"	"	5 .04	5	0 .44	
" 6, 8	37 — 30	33 .90	7 ... 6	+ 0 .30	34 .20	2	0 .40	
" 26, 27	"	34 .05	8 ...6½	0 .26	34 .31	2	0 .45	
" 28	"	+ 34 .0	8	+ 0 .21	+ 34 .21	2	0 .30	
" 6	υ Sagittarii — 30	+ 1h 0m 31s.2	7¼	+ 0 .74	+ 1h 0m 31s.94	sing.	meas.	Doubtless some mistake, or the telescope in some way jarred between the observations.
" 26	"	" " 32 .6	6 ...30	0 .87	" " 33 .47	"	"	
" 27	"	" " 32 .5	7 ...30	0 .69	" " 33 .19	"	"	
" 28	"	+ " " 33 .3	7 ...55	+ 0 .63	+ " " 33 .93	"	"	

Nebula h. 2092 and 2093.

30. Differences of Declination.

Date.	Stars.	D′	Altitude, or Sid. Time.	Correction for Refr.	D	n	c	Remarks.
Nov. 27	114 — 66	+ 588″.3	2h ...2h 16m	+ 0″.3	+ 588″.6	10	0 .8	
" "	133 — 66	983 .3	2 25 ... 40	0 .7	984 .0	9	2 .2	
" 28	47 — 66	1092 .1	3 48 ...4 2	6 .1	1098 .2	8	1 .7	
Dec. 5	"	1094 .9	1 57 ...2 10	0 .5	1095 .4	9	2 .3	
" 10	"	1093 .3	2 32 ... 37	0 .8	1094 .1	5	2 .3	
Nov. 8	187 — 66	1599 .2	30° ...14°	1 .4	1600 .6	14	4 .6	
Dec. 13	"	1593 .1	2h 20m... 35m	1 .0	1594 .1	4	2 .6	
Nov. 8	176 — 66	1565 .0	30° ...14°	1 .3	1566 .3	7	7 .2	
Dec. 10	47 — 133	109 .9	2h 50m...3h 12m	0 .2	110 .1	9	3 .1	
Nov. 27	187 — 133	614 .2	2 45 ...3 5	0 .6	614 .8	15	3 .0	
" "	176 — 133	576 .4	2 55 ...3 5	0 .7	577 .1	3	3 .0	
Dec. 10	103 — 133	1681 .0	2 15 ... 24	1 .0	1682 .0	6	1 .3	
Nov. 11	103 — 187	1073 .0	30° ...27°	0 .4	1073 .4	6	1 .7	
" 28	"	1072 .9	2h 12m... 40m	0 .7	1073 .6	18	2 .4	
" 4	190 — 187	191 .3	33° ...30°	0 .1	191 .4	8	1 .0	
" 27	"	+ 190 .4	4h 12m... 19m	+ 2 .5	+ 192 .9	4	0 .4	
Dec. 13	176 — 187	— 34 .1	4 10 ... 14	— 0 .3	— 34 .4	5	0 .5	
Nov. 27	193 — 187	— 1415 .1	3 30 ... 4 1	— 6 .2	— 1422 .0	10	3 .5	
Dec. 16	121 — 187	+ 379 .7	2 40 ... 50	+ 0 .5	+ 380 .2	4	1 .0	
Nov. 6	190 — 103	— 879 .7	32° ...30°	— 0 .3	— 880 .0	5	0 .5	
Dec. 16	121 — 103	— 695 .2	3h ...3h 25m	— 1 .0	— 696 .2	9	1 .9	
Nov. 6	24 — 103	+ 707 .4	25° ...23°	+ 0 .4	+ 707 .8	6	1 .2	
Dec. 5	130 — 103	794 .6	2h 48m... 57m	0 .7	795 .3	7	0 .6	
Nov. 6	40 — 103	1823 .0	16° ...13°	3 .3	1826 .3	7	1 .9	
" 11	"	1822 .5	25 ...23	1 .0	1823 .5	4	1 .0	
Dec. 10	"	1824 .5	2h 38m... 44m	1 .4	1825 .9	4	1 .3	
" 13	"	1828 .1	3 2 ...3 5	2 .0	1830 .1	4	1 .2	
Nov. 6	65 — 103	410 .5	23° ...20°	0 .3	410 .8	10	0 .9	
" "	62 — 103	488 .8	19 ...17	0 .6	489 .4	6	0 .6	
" 28	101 — 103	1231 .1	2h 45m... 55m	1 .1	1232 .2	13	1 .8	
Dec. 10	130 — 24	+ 90 .6	3 15 ... 32	+ 0 .2	+ 90 .8	10	2 .0	

Date.	Stars.	D′	Altitude, or Sid. Time.	Correction for Refr.	D	n	e	Remarks.
Nov. 6	24 — 40	— 1121″.9	29° ... 26°	— 0″.5	— 1122″.4	8	1 .1	
" 28	"	1119 .5	3h 5m... 20m	1 .7	1121 .2	8	1 .3	
Dec. 5	"	1125 .4	2 38 ... 45	0 .9	1126 .3	4	1 .4	
" 13	65 — 40	1411 .2	3 15 ... 33	2 .6	1413 .8	5	2 .4	
" 13	62 — 40	1331 .8	3 35 ... 40	3 .7	1335 .5	sing.	meas.	–Single measure, but excellent.
" 10	1 — 40	— 415 .9	4 0 ... 12	— 3 .1	— 419 .0	14	1 .8	
Nov. 28	31 — 40	+ 273 .4	4 19 ... 21½	3 .5	+ 276 .9	3	1 .8	
Dec. 13	133 — k Cygni	+ 1339 .7	2h 7m... 44s	+ 0 .6	+ 1340 .3	sing.	meas.	
" 13	66 — k Cygni	372 .9	4 1 ... 30	2 .3	375 .2	"	"	
" 16	"	+ 369 .5	2 33	+ 0 .5	+ 370 .0	"	"	

31. Differences in Right Ascension.

Date.	Stars.	A′	Altitude, or Sid. Time.	Correction for Refr.	A	n	e	Remarks.
Nov. 4	103 — 187	— 79s.06	28°...14°	+ 0s.20	— 78s.86	6	0s.40	
Dec. 13	"	79 .1	2h 42m	0 .17	78 .93	sing.	meas.	
Nov. 4	121 — 187	65 .36	28°...14°	0 .07	65 .29	8	0 .17	
" "	129 — 187	59 .81	28 ...18	+ 0 .06	59 .75	4	0 .35	
" "	133 — 187	58 .48	24 ...18	— 0 .11	58 .59	3	0 .67	
" 8	"	57 .64	27 ...12	0 .13	57 .77	8	0 .54	
Dec. 5	"	58 .6	2h 24m	0 .07	58 .67	sing.	meas.	
" 13	"	57 .7	2 42	— 0 .10	57 .80	"	"	
Nov. 4	144 — 187	53 .65	24°...14°	+ 0 .18	53 .47	2	0 .45	
" "	162 — 187	42 .80	24 ...16	— 0 .11	42 .91	2	0 .46	
" 8	"	42 .70	27 ...12	0 .13	42 .83	8	0 .24	
Dec. 5	"	43 .7	2h 24m	0 .07	43 .77	sing.	meas.	
" 13	"	42 .5	2 42	— 0 .10	42 .60	"	"	
Nov. 4	176 — 187	25 .08	28°...14°	——	25 .08	8	0 .23	
" 8	"	25 .20	27 ...12	——	25 .20	7	0 .43	
Dec. 13	"	— 24 .90	2h 42m	——	— 24 .90	sing.	meas.	
Nov. 4	190 — 187	+ 0 .59	28°...14°	+ 0 .04	+ 0 .63	9	0 .16	
" 8	"	+ 0 .58	27 ...12	+ 0 .05	+ 0 .63	6	0 .16	
" "	66 — 187	— 101 .49	27 ...12	— 0 .39	— 101 .88	5	0 .50	
Dec. 5	"	101 .4	2h 24m	0 .20	101 .60	sing.	meas.	
" 13	"	100 .72	2 18 ...40	0 .21	100 .93	3	0 .37	
Nov. 8	84 — 187	90 .05	25°...12°	0 .38	90 .43	6	0 .34	
Dec. 5	"	90 .3	2h 24m	0 .20	90 .50	sing.	meas.	
" 13	"	89 .7	2 18	0 .19	89 .89	"	"	
Nov. 8	98 — 187	82 .25	27°...12°	0 .32	82 .57	6	0 .31	
" "	114 — 187	72 .81	25 ...12	0 .26	73 .07	6	0 .37	
Dec. 5	"	73 .1	2h 24m	0 .14	73 .24	sing.	meas.	
" "	66 — 133	43 .70	2 0 & 30	0 .13	43 .83	2	0 .30	
" "	84 — 133	33 .81	2 0 & 30	0 .13	33 .94	2	0 .06	
" "	47 — 133	67 .43	2 0 ... 30	——	67 .43	3	0 .38	
" "	$\frac{104 \,\&\, 110}{2}$ — 133	— 19 .05	2 15 & 30	——	— 19 .05	2	——	–One rough measure of each, and the mean between them taken.
" "	162 — 133	+ 14 .90	2 15 & 30	——	+ 14 .90	2	0 .10	
" "	183 — 133	50 .73	2 0 ... 30	0 .07	50 .66	3	0 .13	
" "	193 — 133	+ 62 .90	2 0 ... 30	— 0 .10	+ 62 .80	3	0 .26	
Nov. 8	40 — 103	— 51 .41	10°...7°	+ 1 .65	— 49 .76	4	0 .52	

Date.	Stars.	A′	Altitude, or Sid. Time.	Correction for Refr.	A	n	e	Remarks.
Dec. 10	40 — 103	50s.80	3h 42m... 52m	1s.28	49s.52	2	0s.27	
" 13	"	49 .45	3 33 ... 38	0 .82	48 .63	2	0 .16	
Nov. 8	62 — 103	28 .87	10° ...8°	0 .40	28 .47	4	0 .29	
Dec. 10	"	29 .06	3h 29m... 52m	0 .27	28 .79	3	0 .48	
" 13	"	— 28 .95	3 33 ... 38	+ 0 .23	— 28 .72	2	0 .72	
Nov. 8	65 — 103	— 23 .25	10° ...8°	+ 0 .34	— 22 .91	5	0 .29	
Dec. 10	"	24 .20	3h 29m... 52m	0 .24	23 .96	4	0 .50	
" 13	"	— 23 .80	3 33 ... 38	0 .20	— 23 .60	2	0 .69	
Nov. 8	130 — 103	+ 17 .6	$8\frac{1}{2}$°	0 .94	+ 18 .54	sing.	meas.	
Dec. 10	"	+ 18 .12	3h 29m... 52m	0 .43	+ 18 .55	4	0 .07	
" "	21 — 103	— 65 .83	"	0 .24	— 65 .59	3	0 .05	
" "	24 — 103	— 61 .87	"	+ 0 .34	— 61 .53	3	0 .53	
" 13	133 — 103	+ 21 .14	2 39 ... 42	— 0 .26	+ 20 .88	2	0 .57	
" "	162 — 103	+ 36 .17	"	— 0 .26	+ 35 .91	2	0 .89	
Nov. 8	101 — 103	— 2 . ±	10° ...7°	+ 1 .1	— 0 .9	—	——	No transits noted, because their diff. of Decl. is greater than the diameter of the eye-piece, though not of the micrometer. The diff. of R. A. depends on this remark from the Journal:—"Star (101) = star (103) in R. A. nearly; has several times crossed about 2s ± before it.
" "	31 — 40	9 .44	"	0 .25	9 .19	4	0 .42	
" 28	"	9 .85	4h 19m... 22m	0 .62	9 .23	2	0 .33	
Dec. 10	"	9 .00	4 6 ... 12	+ 0 .40	8 .60	2	0 .23	
" "	1 — 40	68 .20	"	— 0 .60	68 .80	2	0 .43	
" "	10 — 40	— 36 .25	"	— 0 .53	— 36 .78	2	0 .38	
Dec. 13	66 — k Cygni	+ 10m 39 .7	2 7 & 4 1	+ 0 .23	+ 10m 39 .93	2	0 .70	
" 16	"	+ " 39 .0	2 33 & 3 55	+ 0 .20	+ " 39 .20	2	0 .85	

32. In the farther reduction of the foregoing observations, where several sets of measures have been obtained between the same two stars, they have been combined by assigning to each a weight proportioned to the value of $\frac{n}{e^2}$; with some restrictions where either n or e are so small as to render the *weight* very minute on the one hand, or immensely large on the other. And wherever, as is frequently the case, measures have been taken through a series of stars by different steps and intervals of progress, so as mutually to check each other, the most probable results have been deduced from their combination by the method of minimum squares, and are given below.

The first column contains the numbers of the stars in the catalogues, Articles 37, 38, and 39; the second and third, the differences of right ascension and declination between the several measured stars and one assumed as a zero.

Nebula h. 1991.

Stars.	Diff. of R. A.	Diff. of Decl.
1 — 9	— 0m 28s.81	+ 15′ 7″.6
2 — "	" 7 .46	+ 3 36 .3
8 — "	— " 0 .52	— 0 9 .0
18 — "	+ " 6 .39	+ 1 5 .0
21 — "	+ " 7 .90	+ 3 59 .5

Stars.	Diff. of R. A.	Diff. of Decl.
22 — 9	+ 0m 8s.77	+ 7′ 31″.8
24 — "	" 11 .47	— 1 10 .4
25 — "	" 11 .82	+ 1 52 .8
28 — "	+ " 18 .04	— 4 30 .7

Nebula h. 2008.

Stars.	Diff. of R. A.	Diff. of Decl.
6 — 21	— 0h 0m 23s.75	+ 9′ 28″.5
9 — "	" " 20 .53	4 13 .7
11 — "	" " 20 .00	5 34 .6
14 — "	" " 13 .24	7 23 .6
16 — "	" " 11 .72	6 44 .9
20 — "	— " " 3 .01	+ 12 13 .1
23 — "	+ " " 4 .32	+ 0 56 .0

Stars.	Diff. of R. A.	Diff. of Decl.
25 — 21	+ 0h 0m 7s.63	+ 3′ 36″.8
30 — "	" " 26 .94	— 5 12 .1
31 — "	" " 31 .84	— 5 6 .3
33 — "	" " 36 .45	+ 0 6 .0
36 — "	" " 48 .47	+ 5 38 .7
37 — "	" 1 1 .23	— 2 16 .9
v Sagittarii — "	+ 1 0 0 .35	+ 6 17 .5

Nebula h. 2092 and 2093.

Stars.	Diff. of R. A.	Diff. of Decl.
k Cygni — 187	— 12m 21s.12	— 32′ 35″.5
1 — "	3 16 .76	+ 41 19 .7
10 — "	2 44 .74	
21 — "	" 24 .46	
24 — "	" 20 .20	+ 29 38 .7
31 — "	" 16 .88	52 55 .6
40 — "	" 7 .96	+ 48 18 .7
47 — "	" 5 .18	— 8 20 .5
62 — "	1 47 .43	+ 26 2 .2
65 — "	" 42 .03	+ 24 43 .6
66 — "	" 41 .50	— 26 36 .4
84 — "	" 30 .70	
98 — "	" 22 .57	
101 — "	— " 19 .8±	+ 38 24 .9

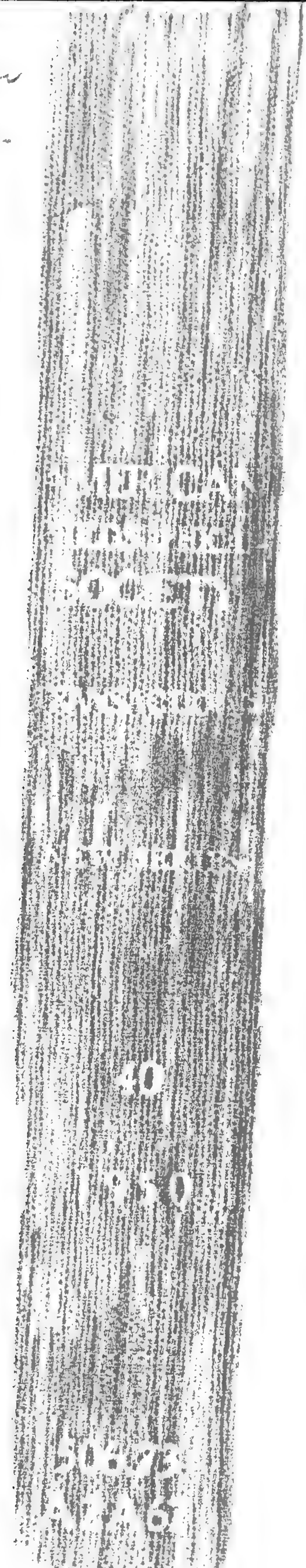
Stars.	Diff. of R. A.	Diff. of Decl.
103 — 187	— 1m 18s.87	+ 17′ 52″.7
$\frac{(104)+(110)}{2}$ — "	" 16 .80	
114 — "	" 13 .11	— 16 47 .8
121 — "	" 5 .29	+ 6 17 .5
130 — "	" 0 .32	+ 31 8 .4
129 — "	0 59 .75	
133 — "	" 57 .75	— 10 11 .2
144 — "	" 53 .47	
162 — "	" 42 .87	
176 — "	" 25 .09	— 0 34 .6
183 — "	— " 7 .09	
190 — "	+ " 0 .63	+ 3 13 .4
193 — "	+ " 5 .05	— 23 42 .0

Catalogues of Stars in and near Nebulæ h. 1991, 2008, *and* 2092–3.

33. The right ascensions and declinations in the following catalogues depend on the three stars A. S. C. 2063, *v* Sagittarii, and *k* Cygni respectively. Their places for A. D. 1830.0 have been assumed as follows:

A. S. C.	Name of Star.	Mag.	R. A. 1830.0	Decl. 1830.0
2063		6	17h 51m 36s.51	— 22° 45′ 58″.5
2251	46 v Sagittarii	5.6	19 11 59 .09	— 16 15 54 .9
——	52 k Cygni		20 38 38 .70	+ 30 6 17 .0

The two first only are to be found in the Catalogue of the Astronomical Society of London. Having no other standard source of reference within my reach, I have adopted for the place of *k* Cygni that incidentally given by Sir J. Herschel, in his description of nebula *h.* 2088, Phil. Trans. 1833. No. 1 of


40

h. 1991, in my catalogue, corresponds to A. S. C. 2063, and is in the same field with the nebula. The places of the stars of *h.* 1991 may therefore be regarded as tolerably accurate. The intervals between the other two nebulæ, and the respective stars to which they were referred, were much larger, the one occupying 1^h, the other 12^m of sidereal time; and, of course, as great exactness was not attainable by the means employed. The necessity of selecting a calm evening, and of maintaining perfect stillness in the observatory during these long intervals, on account of its height and the unsteadiness of the telescope, yet, at the same time, of correcting the uncompensated clock which was employed, by coincident observations with the transit instrument, rendered these comparisons less frequent than they otherwise would have been. The small uncertainty which this circumstance introduces into the *absolute* right ascensions of the stars is a constant error, and is of slight importance, since the places of the standard stars, as assumed above, would alone give rise to uncertainty of the same nature.

The reduced differences in Article 32 were made such as they would have been at the epoch 1830.0. The measured stars, previously arranged in the form of a catalogue, by means of the three already mentioned, were projected on paper, and compared with the original charts described in Article 7, by pricking the stars through from one upon the other.

34. To form some idea of the amount of necessary error involved in the process of estimation described in Article 7, the differences of R. A. and Decl. between the measured and estimated places in *h.* 1991 were carefully measured by a scale and vernier. They are as follows:

Star.	Error in	
	R. A.	Decl.
1	$1^s.7$	22″.7
2	0 .4	14 .5
8	0 .10	0 .9
9	0 .00	0 .0
18	0 .26	0 .0
21	0 .17	1 .4
22	0 .68	3 .8
24	0 .42	19 .5
25	0 .23	0 .0
28	0 .03	0 .9

It is to be noticed, that star (24) was excessively difficult of measurement, not being seen on or very near the wire. The large errors apparently belonging to it are probably not those of estimation, but of rough and difficult measurement. The errors of star (1) are on account of its distance from the nebula, without any intermediate stars recorded; and the remainder, except (2,) are all within very close limits.

It may be farther remarked, that the errors in *h.* 2008 were generally about four times as large as in *h.* 1991; also, in *h.* 2092–3 they were three or four times as large at similar distances, and in some instances on the remote confines, much larger. More time and pains were spent on the first of the three, partly in order to ascertain how much error was *necessarily* included in the method of estimation.

35. The places of the following stars, *h.* 1991, 24; *h.* 2008, 6, 9, 23, 25; *h.* 2092–3, 129, 144, differ in a slight degree, in the catalogues, from the results of measurement. These are cases in which the measures are rendered somewhat uncertain on account of extreme faintness, and are afterwards found to disagree with the original chart. The general closeness with which the estimations coincide with good measures authorize, in these few instances, an equal, or greater confidence in the former.

36. The artificial scale of magnitudes mentioned in the observation of Aug. 9th, Article 19, was converted into the common nomenclature by comparison with various stars, incidentally noticed by Sir J. Herschel in this respect. The magnitudes assigned, in his several catalogues of double stars, to the three individuals of the triple star in *h.* 1991, and those of six stars described by him as forming a trapezium, or oval, at the bifurcation of the Nebula Cygni, (see Article 59,) are principally relied on.

The first column in the following catalogues contains the number of the star in order of right ascension; the second, its magnitude; the third, its mean right ascension; and the fourth, its mean declination, at the epoch A. D. 1830.0.

The right ascension is given to the nearest tenth of a second of time, except that of the stars measured by the micrometer, which are distinguished from the rest by the addition of a second decimal. So the declination is in even seconds for the estimated, and descends to tenths for the measured places.

NOTE.—It appears to the committee that the coefficient 2 in Mr. Mason's formula for correcting the observed difference of right ascension should be omitted, and this correction be made only half as great as Mr. Mason's. The error from this source does not, on the average, amount to more than $0^s.1$ in time in the following catalogue.

37. *Catalogue of the Stars in the Nebula* h. 1991.

No.	Mag.	R. A. 1830.0	Decl. 1830.0	No.	Mag.	R. A. 1830.0	Decl. 1830.0
1	6.7	17h 51m 36s.51	— 22° 45′ 58″.5	16	14	17h 52m 9s.7	— 23° 1′ 41″
2	11.12	" 57 .83	" 57 30 .4	17	14.15	" 10 .6	" 0 28
3	16	" 58 .7	23 0 38	18	16	" 11 .3	22 55 20
4	16	" 59 .7	" 1 46	19	12.13	" 11 .67	23 0 1 .9
5	15	" 52 0 .6	22 59 46	20	14.15	" 12 .6	22 49 16
6	16	" 2 .5	23 2 10	21	11.12	" 13 .19	" 57 7 .2
7	14.15	" 4 .6	22 52 22	22	9	" 14 .07	" 53 34 .7
8	9.10	" 4 .76	23 1 15 .9	23	15	" 14 .8	" 55 28
9	8.9	" 5 .28	" 1 6 .9	24	12.13	" 16 .5	23 2 27
10	12	" 5 .3	" 1 2	25	12	" 17 .11	22 59 14 .0
11	15	" 7 .0	22 59 55	26	14.15	" 21 .9	" 51 48
12	15	" 7 .5	23 4 14	27	14.15	" 21 .9	" 50 18
13	15	" 8 .6	22 59 17	28	12	" 23 .31	23 5 37 .8
14	15	" 9 .5	" 55 18	29	14.15	" 28 .7	22 52 10
15	14.15	" 9 .7	" 50 56				

38. *Catalogue of the Stars in and near the Nebula* h. 2008.

No.	Mag.	R. A. 1830.0	Decl. 1830.0	No.	Mag.	R. A. 1830.0	Decl. 1830.0
1	14.15	18h 10m 28s.9	— 16° 13′ 47″	20	11	18h 10m 55s.05	— 16° 9′ 9″.6
2	14.15	" 28 .9	" 11 36	21	10.11	" 58 .56	" 21 20 .3
3	14.15	" 29 .3	" 13 11	22	16	" 11 1 .0	" 15 21
4	13	" 32 .9	" 12 24	23	12.13	" 2 .88	" 20 38
5	14	" 33 .3	" 13 51	24	14	" 6 .1	" 10 57
6	12.13	" 34 .74	" 11 45	25	12	" 6 .19	" 18 17
7	15	" 35 .3	" 12 43	26	16	" 7 .7	" 14 58
8	15	" 36 .5	" 11 50	27	14	" 8 .3	" 12 15
9	12	" 38 .51	" 17 15	28	16	" 11 .1	" 14 31
10	15	" 38 .5	" 13 23	29	12	" 20 .3	" 14 4
11	11	" 38 .56	" 15 44. 4	30	9.10	" 25 .50	" 26 31 .6
12	14.15	" 42 .2	" 13 5	31	9.10	" 30 .40	" 26 24 .2
13	14	" 43 .3	" 16 15	32	13	" 33 .3	" 19 53
14	12.13	" 45 .32	" 13 58 .9	33	11	" 35 .00	" 21 11 .6
15	16	" 46 .0	" 13 30	34	14	" 37 .7	" 17 36
16	11	" 46 .84	" 14 36 .0	35	12	" 37 .9	" 21 25
17	14.15	" 47 .3	" 12 24	36	11.12	" 47 .03	" 15 45 .8
18	16	" 50 .8	" 13 33	37	8	" 59 .79	" 23 34 .9
19	12.13	" 54 .0	" 9 37				

39. *Catalogue of the Stars in and near Nebula* h. 2092 *and* 2093.

No.	Mag.	R. A. 1830.0.	Decl. 1830.0	No.	Mag.	R. A. 1830.0	Decl. 1830.0
1	10	20h 47m 43s.14	+ 31° 20′ 16″.4	6	12.13	20h 48m 5s.6	+ 31° 15′ 0″
2	12.13	" 47 .2	" 17 52	7	12.13	" 6 .5	" 15 25
3	12.13	48 0 .3	" 14 14	8	10.11	" 10 .8	" 7 16
4	12.13	" 1 .9	" 14 36	9	10.11	" 12 .3	30 10 30
5	13	" 4 .8	" 13 17	10	11	" 15 .14	31 21 18

No.	Mag.	R. A. 1830.0	Decl. 1830.0
11	13	20h 48m 18s.8	+ 31° 8′ 18″
12	12.13	" 21 .3	" 10 49
13	12.13	" 23 .4	" 10 9
14	14	" 23 .9	30 26 17
15	13	" 24 .2	31 13 26
16	12.13	" 26 .8	" 18 14
17	12.13	" 28 .4	" 11 34
18	12.13	" 28 .5	" 20 42
19	13	" 29 .1	" 8 49
20	10.11	" 33 .7	30 7 17
21	10.11	" 35 .36	31 4 10
22	13	" 35 .6	30 15 8
23	10	" 37 .5	" 7 49
24	10.11	" 39 .43	31 8 34 .8
25	13	" 40 .3	" 11 56
26	12.13	" 40 .7	30 7 32
27	12.13	" 40 .7	31 14 14
28	13	" 41 .3	30 16 6
29	12	" 41 .5	" 20 9
30	12	" 41 .7	31 15 35
31	8	" 43 .04	" 31 51 .7
32	11	" 45 .3	" 9 31
33	16	" 48 .6	" 9 10
34	16	" 49 .1	" 10 9
35	11	" 49 .1	" 4 49
36	14	" 49 .2	30 25 11
37	15	" 49 .3	" 24 35
38	12.13	" 49 .9	31 10 55
39	12	" 50 .5	30 28 4
40	8	" 51 .94	31 27 14 .7
41	16	" 52 .6	" 8 53
42	12.13	" 52 .7	30 16 52
43	15.16	" 53 .0	31 10 7
44	11	" 53 .9	" 15 45
45	12	" 54 .2	30 25 31
46	12.13	" 54 .3	" 31 26
47	11	" 54 .50	" 30 35 .5
48	14	" 56 .6	" 22 33
49	12	" 57 .2	31 1 9
50	12.13	" 57 .8	" 1 32
51	14.15	" 58 .1	" 9 28
52	15	" 58 .4	" 9 39
53	13	" 59 .8	30 10 4
54	12.13	49 0 .3	" 30 32
55	12.13	" 0 .8	" 11 7
56	12	" 2 .7	31 11 47
57	12	" 3 .2	" 12 14
58	14.15	" 7 .2	30 30 2
59	12.13	" 7 .3	" 9 58
60	13	" 9 .0	" 10 32
61	12.13	" 10 .3	" 23 55
62	10.11	" 12 .38	31 4 57 .9
63	12.13	" 13 .4	30 9 27
64	13	" 14 .5	" 33 7
65	10.11	" 17 .77	31 3 39 .3

No.	Mag.	R. A. 1830.0	Decl. 1830.0
66	10	20h 49m 18s.09	+ 30° 12′ 19″.3
67	13	" 18 .6	" 59 48
68	14.15	" 19 .4	" 28 44
69	12.13	" 20 .2	31 6 4
70	12.13	" 21 .5	30 9 41
71	14	" 22 .0	" 8 33
72	12	" 24 .5	" 22 16
73	14.15	" 24 .9	" 32 1
74	16	" 24 .9	31 4 23
75	12.13	" 25 .1	30 8 36
76	15	" 25 .2	31 5 46
77	12	" 25 .9	30 23 21
78	16	" 26 .1	31 6 16
79	12	" 26 .6	30 25 21
80	13	" 26 .7	" 27 25
81	12.13	" 26 .7	" 59 54
82	14.15	" 27 .4	31 4 9
83	15	" 28 .4	" 7 34
84	10.11	" 28 .90	30 12 26
85	12	" 29 .0	" 15 22
86	14.15	" 29 .2	" 33 44
87	12.13	" 29 .5	" 57 35
88	13	" 29 .6	" 59 9
89	15	" 30 .4	" 27 44
90	12.13	" 31 .4	" 56 34
91	14	" 31 .9	31 8 40
92	12.13	" 32 .5	30 10 4
93	14	" 33 .4	31 4 51
94	14	" 33 .6	" 1 5
95	13.14	" 36 .7	30 58 13
96	15	" 36 .8	" 27 7
97	12.13	" 36 .9	" 8 33
98	10.11	" 37 .03	" 15 21
99	14.15	" 37 .6	" 18 36
100	12.13	" 38 .8	" 14 25
101	10.11	" 40 .1	31 17 20 .4
102	10	" 40 .9	30 3 17
103	10	" 40 .89	" 56 48 .1
104	11	" 41 .5	" 29 16
105	15	" 41 .6	" 28 25
106	13	" 43 .2	" 32 35
107	15	" 43 .3	" 26 29
108	12.13	" 43 .4	" 22 7
109	12	" 43 .5	" 21 13
110	11	" 44 .6	" 28 43
111	15	" 45 .0	" 20 29
112	12.13	" 45 .3	" 15 7
113	14	" 46 .4	" 23 16
114	11	" 46 .52	" 22 7 .6
115	12.13	" 48 .2	" 19 22
116	12	" 48 .3	" 20 16
117	12	" 49 .2	" 52 20
118	12.13	" 51 .8	" 20 30
119	13	" 53 .0	" 34 26
120	14	" 53 .5	" 23 14

No.	Mag.	R. A. 1830.0	Decl. 1830.0
121	10.11	$20^h\ 49^m\ 54^s.41$	$+30°\ 45'\ 12''.8$
122	12.13	" 54 .9	" 49 24
123	15	" 55 .5	" 25 6
124	12.13	" 57 .7	" 52 8
125	15	" 58 .1	" 23 52
126	14.15	" 58 .4	" 23 7
127	14.15	" 58 .9	" 30 33
128	14	" 59 .2	" 42 53
129	10.11	" 59 .46	" 47 13
130	10.11	" 59 .48	31 10 3 .6
131	14.15	" 50 1 .6	30 27 26
132	14.15	" 1 .7	" 31 26
133	10.11	" 1 .89	" 28 44 .0
134	12.13	" 2 .5	" 53 40
135	14	" 2 .5	" 31 45
136	12.13	" 2 .6	31 4 19
137	14.15	" 2 .6	30 23 10
138	13	" 2 .7	31 0 59
139	12.13	" 5 .9	" 1 6
140	14.15	" 6 .1	30 42 52
141	10.11	" 6 .1	" 11 46
142	14	" 6 .6	" 18 11
143	14	" 6 .9	" 40 36
144	11	" 7 .2	" 52 39
145	15	" 7 .8	" 32 30
146	12	" 8 .2	" 49 26
147	12.13	" 8 .3	" 23 3
148	14.15	" 8 .4	" 42 52
149	16	" 9 .0	" 22 40
150	15	" 9 .4	" 29 49
151	14.15	" 9 .4	" 29 8
152	13	" 10 .3	" 22 52
153	13	" 11 .3	" 23 5
154	14.15	" 11 .7	" 29 23
155	12	" 11 .9	" 54 12
156	16	" 12 .2	" 23 8
157	14	" 13 .6	" 18 13
158	14	" 14 .0	" 25 50

No.	Mag.	R. A. 1830.0	Decl. 1830.0
159	14	$20^h\ 50^m\ 15^s.3$	$+30°\ 40'\ 23''.$
160	12.13	" 16 .1	" 51 35
161	13	" 16 .6	" 40 41
162	10.11	" 16 .77	" 28 56
163	12	" 18 .1	" 43 13
164	14	" 18 .5	" 26 50
165	14	" 18 .5	" 41 56
166	12.13	" 19 .4	" 34 14
167	13	" 20 .2	" 26 6
168	14	" 21 .4	" 33 13
169	13	" 24 .0	" 29 38
170	13	" 26 .6	" 33 12
171	14.15	" 29 .2	" 17 26
172	14	" 32 .1	" 28 18
173	12.13	" 32 .2	" 16 24
174	12.13	" 33 .3	" 18 3
175	14	" 34 .6	" 34 24
176	10	" 34 .58	" 38 20 .3
177	13	" 35 .0	" 33 51
178	14	" 35 .7	" 27 17
179	12	" 38 .7	" 13 34
180	12.13	" 42 .7	" 33 4
181	14	" 44 .8	" 39 53
182	12.13	" 49 .4	" 35 0
183	10.11	" 52 .49	" 19 13
184	12	" 53 .6	" 20 1
185	12.13	" 56 .9	" 32 36
186	13	" 57 .0	" 28 11
187	8.9	" 59 .66	" 38 54 .6
188	12.13	" 59 .8	" 20 54
189	14	51 0 .1	" 21 30
190	9.10	" 0 .30	" 42 8 .0
191	11	" 2 .7	" 28 19
192	11	" 3 .2	" 29 30
193	10.11	" 4 .62	" 15 12 .5
194	11	" 10 .8	" 26 41
195	12	" 21 .3	" 18 46
196	11	" 22 .7	" 18 22

40. Of these three catalogues the first is probably the most correct. The stars in nebula *h*. 2008 are less determinate. This is chiefly due to the somewhat hurried completion of the map of that nebula in the month of August, the moon becoming troublesome sooner than was altogether convenient. And for the purposes of correction, only two or three stars exist in, or very near this nebula, of a magnitude as great as the eleventh; so that it was necessary to place reliance on the extremely difficult measures of the twelfth and thirteenth magnitudes.

But one set of measures in Decl. were taken of star (193) in the large nebula, and this was found to differ considerably from the original map. The number of even revolutions of the micrometer screw may possibly have been read off wrong; and, if this is the case, some eight or ten stars in its neighbourhood will be affected by its error. But these are out of the direct course of the nebula. In general, the *relative* places are well determined by these right ascensions and declinations.

Description of the Plates.

41. By far the greatest obstacles to the successful comparison of modern observations on nebulæ with those which own, at least, a brief antiquity, exist in the want of precision with which the labours of former observers have been conducted; and hence all attempts to trace the slow progress of their changes end in uncertain conjectures and conflicting probabilities. I shall not, therefore, incur the charge of unnecessary minuteness in endeavouring to render, by every means, our knowledge of the present form and state of at least these few nebulæ, as far as possible, standard, and, although laden with the necessary imperfections of original observations, yet free from adventitious and unnecessary vagueness in the communication of them. In order to supply, to any future observer, those slight particulars which a chart cannot easily urge upon the notice of any but the original compiler, and, farther, to indicate the degree of certainty with which different features of the nebulæ were recognised, it is thought proper to bring under this head the enumeration of various facts not expressed in the journal of observations. These are divided into "*things certain*," "*nearly certain*," *strongly suspected*," and "*slightly suspected*."

42. The plates are such as to distort, as little as possible, the relative position of the stars, since the development of the spherical surface is by projection on a plane tangent to the centre of each nebula.

The nebulæ are in the position in which they appear in a Herschellian reflector, when on the meridian; "*south*" being uppermost in the present cases, and the *preceding*, the right hand portions. The letters *s*, *p*, *n*, *f*, on the plates, serve as ready references where these terms are used in description.

In plate V., where one of the nebulæ is represented by lines of equal brightness, (Article 12,) the half lines serve to indicate suspected gradations of shade, while the even numbers mark those that are more certain. Thus, the lines 1 are the utmost limits of nebulous light perfectly and *certainly* visible, while the line $\frac{1}{2}$ is about as far as it is suspected to extend. The line $1\frac{1}{2}$ also encloses a space suspected to be a little brighter than the surrounding parts.

Nebula h. 1991.

43. *Things certain.*—1. A large nebula surrounding the star 22, not hitherto noticed. (See Art. 17, Aug. 7 and 10.)

2. A slight diminution of its light within the pentagon formed by the stars 15, 20, 27, 26 and 22. (Art. 17, Aug. 10.)

3. It is more extensive on the northern than southern side, but its gradation or concentration is evidently from all directions toward the bright star 22.

4. (In the trifid nebula.) The particulars concerning the attachment of the triple star to the skirts of the part, A, and of its eccentricity in other respects, as mentioned in Art. 17, Aug. 1 and 9.

5. The rift α suddenly shelves outwards and to the north, forming a tolerably definite boundary, as is indicated by the comparative closeness with which the lines succeed each other. (See Art. 17, Aug. 10.)

6. This boundary is convex inwards, or towards the stars 3 and 5.

7. The gradation from light to darkness on the inner boundary of the portion A., is somewhat more sudden than on that of the other two.

8. And in all three, it is more sudden, on the inner, than on the outer boundaries.

44. *Nearly certain.*—1. The portion B extends down to the stars 2 and 21.

2. It also runs up a little into the cleft β, fading off very imperceptibly, (Art. 17, Aug. 9.)

3. The boundary of A. running down from the triple star, turns faintly off at an obtuse angle at the star 19, while a portion of somewhat less intensity, encompasses the star 25. This fact is expressed in Plate V., by the bending of lines 2 and 3 at that point, and their proximity; the line 1 diverging from them to the star 25.

4. The upper extremity of A, between the stars 12 and 28, runs up to a pretty sharp angle.

5. (In the northern nebula.) A slight increase of intensity on the right hand of the vacancy; it is enclosed by the line 4. (Art. 17, Aug. 10.)

45. *Strongly suspected.*—1. A slight brightening up of the nebula where enclosed by the line $1\frac{1}{2}$, as if beginning to break up into a still farther subdivision. This, if real, subdivides the dark branch α, into two, in its outward course. (Art. 17, Aug. 10.)

2. The filling up of the clefts with faint nebulosity.

3. The same between the northern and southern nebula, faintly uniting the two.

46. *Slightly suspected.*—1. The angular irregularity on the south and fainter side of the part C, rendering it not unlike a shell with a sub-angular margin.

Nebula h. 2008.

47. *Things certain.*—1. The "resolvable knot" mentioned by Herschel (Art. 58, Phil. Trans. 1833,) near the star 18, is isolated, or nearly so, from the rest of the nebula. (Not seen resolvable by us. See Art. 18, Aug. 10.)

2. The smaller knot is apparently not affected with this peculiarity.

3. Of the faint bend or loop at the right hand, the following half is brighter than the preceding.

4. The bright branch fades gradually away to the left, terminating near the star 36; it is convex upwards.

5. The external angle of the nebula stretches down from the star 17, towards the north, preceding much farther than in Herschel's drawing. (Art. 18, Aug. 10.)

6. The bend in the drawing of Sir J. Herschel is too large, especially in a vertical direction, when compared with the bright following branch. (Art. 18, Aug. 3 and 14.)

48. *Nearly certain.*—1. The bright branch is more definitely bounded on its upper or southern side, than upon the lower.

2. From the larger knot at the internal angle of the nebula, a faint ray proceeds as far as star 25. (Art. 18, Aug. 7 and 10.)

3. The upper margin of this ray is tolerably definite, and thence it spreads downwards till it mingles with the brightness below. (Art. 18, Aug. 10.)

4. The "resolvable knot" of Herschel has either a second nucleus, or involves a faint star (18) in its upper margin. (Art. 18, Aug. 14.)

5. The partially vacant space in which it is situated is closed in by the ne-

bula on the right and left, and perhaps beneath, but is more open upward. (Art. 18, Aug. 10.)

6. The star 11 is too far down the preceding limb of the bend in Sir J. Herschel's figure; it should be nearer the vertex.

7. A slight protrusion from the upper curve of the bend involves the star 9.

49. *Strongly suspected.*—1. Very faint nebulosity stretching across from star 25 to star 9, filling all the internal angle of the nebula. (Art. 18, Aug. 10.)

2. Faint nebulosity extending from the stars 6 and 4 to or beyond star 2.

3. A considerable, but faint diffusion of the nebula at the external angle towards the north preceding.

4. The fainter knot stretches still more faintly a little way downward. (Art. 18, Aug. 1.)

5. Just above star 16 is a portion a little brighter than the rest of the bend.

50. *Slightly suspected.*—1. An extension of the appearance mentioned in No. 4 of Art. 49, downwards, past stars 19 and 20. (Art. 18, Aug. 1 and 7.)

2. A bare suspicion of nebulosity among a coarse cluster of stars between 11^m and $11^m\ 30^s$, and in about—16° 8′ or 10′ Decl. (Art. 18, Aug. 7.)

Nebula h. 2092 and 2093.

51. *Things certain.*—1. The brightest accumulation of nebulous matter is within the triangle formed by stars 69, 83 and 93.

2. Not much inferior to this in intensity is the portion included between the bright stars 133 and 162. (Art. 19, Aug. 7.)

3. The brightest loop of the network portion is a figure not altogether unlike a Greek *υ*, turned thus ⊂, and containing No. 2, just described. The first or upper bend of this figure contains two curious triplets of stars, very similar in position and magnitude; the south following angle has in it a quintuple or sextuple star, of which two individuals, 149 and 156, are about the *minima visibilia* of the 14 feet reflector. (Art. 19, Aug. 9.)

4. These two, No. 1 and 3, are the two great nuclea of the nebula.

5. From the north following angle of the *υ*, at the star 162, a branch proceeds southward, of brightness little inferior to that of the *υ*; for the sake of shortness, I call this *ψ*, though possessing no resemblance to that letter.

6. All the other loops and branches in this region except the *υ* and *ψ* are extremely faint.

7. The obtuse angled parallelogram, preceding the *v*, certainly exists.

8. All, or nearly all, the visible stars in its neighbourhood are as certainly arranged along its course in apparent intimate connexion with it. (Art. 19. Aug. 9.)

9. It is, without doubt, connected to the *v*, in the way represented in the figure.

10. The loop which parts from the *v* at the quintuple star, and passing outwards by the stars 157 and 142, rejoins it near the double triplet of stars.

11. That this loop sends out a very faint branch towards stars 171 and 174, is more than "nearly certain," though not absolutely so.

12. The same may be said of a slight nebulosity in the region of the stars 183 and 184.

13. That the stars in this neighbourhood are, to a certain extent, disposed in the same order as the nebulous matter, forming rude chains, or loops, coincident with those of the nebula, is certain. This feature is most strongly developed in the *v*, and in the parallelogram No. 7 of Art 51, and though less striking, is certainly recognisable in the circuits Nos. 3, 8, 9 and 10 of Art. 52, and in the branch No 1, of Art. 53. (Art. 19, Aug. 1 and 9.)

14. (Proceeding downwards now towards the triangle of bright stars on the parallel of 30° 40′;) the faint band connecting *h*. 2092 and *h* 2093, branches from the ψ near the star 166, and taking the conspicuous stars 176, 121, 129, and 103, in its course, brightens at last into the very considerable intensity mentioned in No. 1. This connexion undoubtedly exists. (Art. 19, Aug. 1.)

15. The faint branch starting from this band near its connexion with the ψ towards stars 177 and 180, is about as certain as that of No. 11.

16. The faint branch in the opposite direction, starting from the ψ at stars 166 and 168 towards star 119,—is certain.

17. (In the bifurcate portion.) Of the two main branches into which it forks, the upper or *s p*, is far the widest and most conspicuous. They are much too nearly equal in the drawing of Sir J. Herschel.

18. The *n f* branch extends but little beyond the double star 56, 57.

19. The *s p* branch reaches much farther, fading away in diffused nebulosity nearly or quite as far down as star 1. (Art. 19. Aug. 10.)

52. *Nearly certain.*—1. The long faint trace of light, No. 13 of Art. 51, appears, at first sight, a band of nearly uniform breadth and light, and tolerably

straight. But with long attention, the irregularities represented in the figure are pretty certainly made out. The narrow winding part differs in intensity from the rest of the band too minutely to be at all represented in an engraving, unless much exaggerated, as in Plate VI. The chief irregularities are attended with little doubt, and are as follows:

2. (Beginning at the upper end;) it bends outward so as to involve the the bright star 176, fading off very diffusely in the concavity on the opposite side.

3. It forms an ill-defined, and scarcely complete loop around the stars 163, 165, 161, 159, 143, 128; it being faintest and most imperfect on its *p* or *n p* side. It is at this point, that, in tracing the nebula from north to south, it first begins to assume the remarkable peculiarity of interweaving with stars in loops or network. (Art. 19, Aug. 10.)

4. Turning from the bright stars 121 and 129, it bends, perhaps more than in the drawing, towards the stars 146 and 160 on the following side, involving the former and the pretty bright star 144 in its course.

5. Bending back to the preceding side, it very nearly reaches, and perhaps involves, the bright star 103.

6. On the opposite side, it faintly diffuses itself to a considerable distance, fading away nearly or quite as far as the stars 138 and 139; the space between these and 155, 134 being, however, quite vacant.

7. After crossing the parallel of 30° 0′, it soon grows brighter, and passes into the bifurcate portion.

8. (In the network portion.) A very faint loop, whose extremities are the branches Nos. 11 and 15 of Art. 51, and which takes in its course No. 12 of the same, is either "nearly certain" or "strongly suspected." Its course, beginning from the south, is along the stars 174, 183, 184, 188, 189, 194, 191, 192, 180, and 177.

9. The extension of branch No. 16 of Art. 51 as far as star 119.

10. This branch also sends off a subdivision towards or along stars 145, 135, 132 and 127.

11. The part of the *v* about the double triple star brightens up a little, making a kind of feeble third nucleus with Nos. 1 and 2 of Art. 51.

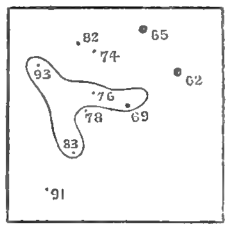
12. (In the bifurcate portion.) The broad *s p* division forks again into two, one branch of which passes, as near as can be judged, over star 32, the other be-

tween stars 32 and 24. The space between them is very little less nebulous than the branches, rendering their separate courses indefinite and somewhat uncertain. The stars of the 15th and 16th magnitudes, namely: 51, 52, 43 and 34, are in the lower, and 33, 41 are in, or just beneath, the upper of these two subdivisions. These stars prevent this from being classed in Art. 51. (See Art. 19, Aug. 7, 9, 10, 19.)

13. A diffuse and faint nebulosity fills up all the space in the principal rift.

14. The *n p* division pretty certainly involves the double star 56, 57, in its northern margin; not as Hershel describes and figures it, passing clear of it to the south.

15. At the point of bifurcation, the nebula runs up to a dense nucleus of somewhat definite outline, the figure of which, as referred to the stars in that quarter, is, by a careful comparison of the drawings of two evenings, as in the margin. The fork originates very near, or at the star 78.



53. *Strongly suspected.*—1. The faint branch of nebula, starting from the upper end of the *v*, along the bright stars 98, 84, and 66, and spreading through the cluster 97, 92, 75, 71, 70, 63, 60, 59, 55, 53. It is very faintly described in the engraving. Stars clustering thickly are so apt to deceive in this respect, that what would otherwise be considered as certain, is, in this instance, only "strong suspicion."

2. From the south preceding angle of the parallelogram No. 7 of Art. 51, a faint branch is believed to extend to star 14, or beyond. It is very slightly marked in the engraving.

3. The branch No. 9 of Art. 52 probably completes the loop by joining the *v* at the two bright stars 104 and 110.

4. The branch No. 10, of Art. 52, also probably extends to the *v*. It is pretty definitely bounded on its preceding, but fades diffusely on the following side, filling nearly all the vacancy between it and the ψ with vague nebulosity.

5. The ψ seems to be barely disjoined from the *v* at and near the star 162, as if it were in the act of breaking away by the force of contrary attractions. This may very possibly be owing to the effect of the bright star 162 in apparently effacing the nebula in its immediate vicinity.

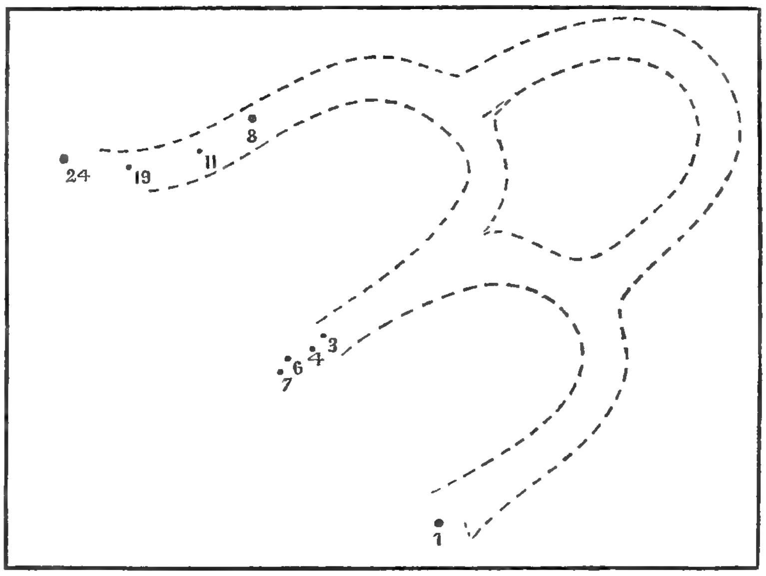
6. From the northern extremity of the parallelogram, No. 7 of Art. 51, near stars 54 and 47, the loop faintly marked in the engraving probably curves round and joins the loop No. 3 of Art. 53, near the stars 106, 119.

7. The loop No. 10, of Art. 51 is very indefinite on its inner margin, and perhaps very faint nebulosity fills all the interior.

8. The star 83, in the bright portion No. 15 of Art. 52, is believed to be peculiar,—blotty or nebulous. (Art. 19, Aug. 20.)

9. A branch curves off from the principal division of the bifurcate portion along the stars 24, 19, 11, 8. This would be certain but for the reason mentioned in No. 1 of this article. (Art. 19, Aug. 9.)

54. *Slightly suspected.*—1. Nebulosity in the three loops of stars mentioned in the observations of Aug. 9 and 19, Art. 19. They run in the direction represented in the margin, and a portion of them are also faintly traced in the plate of the nebula. The stars 24, 19, 11, 8,——7, 6, 4, 3, —— and 1, constitute but the several starting points, or origins, of these connected series of stars.



2. From the *s p* angle of No. 7, Art. 51, near the stars 45, 61, —— faint nebulosity extending among the stars 48, 29, 42, 28, 22, perhaps joining the cluster in No. 1. of Art. 53.

3. Some straggling interlacing of nebulous matter and stars to some distance *s f* the *v*, towards stars 179, 193, 196.

4. A possible extension of irregular rings and branches of nebulosity, spreading down from the parallelogram No. 7 of Art. 51, and its proximate branches, to the loops of No. 1, as above. (Art. 19, Aug. 19.)

5. The surface of the sky around is broken with almost visible wisps, and imaginings of nebulous matter,—for I can somewhat express by these terms that troubled appearance of the heavens, which continually suggests the idea of nebulosity, yet disappointing all closer scrutiny. (Art. 19, Aug. 19.) I have little doubt that, with a telescope of not much greater power, the range of this nebula might be considerably extended, and hope, at some future time, to have the means of doing so, or to see the conjecture investigated by others at an earlier date.

Former Observations of these Nebulæ.

55. All the light which we can obtain on the past history of these nebulæ becomes of great moment in the inquiry, 'Whether their present form and character are now sufficiently well determined to be a standard for the future?' I have therefore collected into one group in order of time such scattered notices of each as I have been able to find; the collection of which, as independent observations, differing greatly in point of time, is of considerable interest in detecting some important errors, and in ascertaining the probable stability of the nebulæ. And, furthermore, the distinguishing characteristics of that mode of observing and describing the nebulæ, which it is a chief object of this paper to explain, will be more distinctly illustrated by a comparison of former with the present observations.

56. At the time of pursuing these inquiries with the 14 feet Reflector, the great catalogue of Sir J. Herschel, (Phil. Trans. 1833,) was the only one with which Mr. Smith and myself were acquainted; the common abridgment of the Philosophical Transactions previous to 1800, contains of the elder Herschel's catalogues, only a very full preface and explanation of the observations, with the unfortunate omission, however, of the observations themselves,—an arrangement not very well adapted to the convenience of future observers. Recently, however, having access to the greater part of the original papers, I am enabled to extract from them:

H. V., 10, 11, 12; H. IV., 41; *h.* 1991.*

40 of the 145; Sh. 379.†

57. *Sir William Herschel; First Catalogue of* 1000. *Phil. Trans.* 1786, *Part II.*

Cl.	No.	Date.	Star.	Diff. of R. A.		Diff. of Decl.		No. of Obs.	Remarks.
V.	10, 11, 12	July 12, 1784.	5 (i) Sagittarii	Foll.	$2^m\ 42^s$	North	0° 49′	1	Three nebulæ, faintly joined, form a triangle. In the middle (a) is a double star. Very faint, and of great extent.

* Synonyms of the nebula.

† Synonyms of the triple star in its centre.

Sir William Herschel; Second Catalogue of 1000. *Phil. Trans.* 1789, *Part II.*

Cl.	No.	Date.	Star.	Diff. of R. A.		Diff. of Decl.		No. of Obs.	Remarks.
IV.	41	May 26, 1786.	14 Sagittarii	Prec.	$11^m\ 58^s$	South	1° 15′	1	A double star with extensive nebulosity of different intensity. About the double star is a black opening resembling the nebula in Orion in miniature.

Sir William Herschel; "On the places of 145 *new Double Stars." Mem. Ast. Soc., Vol. I., Part I.,* 1822.

(40.) 566 sweep. May 26, 1786. A double star within neb. IV. 41. 14 *Sagittarii* prec. $11^m\ 58^s$, south 1° 15′; R. A., $17^h\ 49^m\ 30^s$; P. D., 113° 1′

Sir William Herschel; Astronomical Observations relating to the Construction of the Heavens, arranged for the purpose of a critical examination, &c." Phil. Trans. 1811, *Part II. Under the* 11*th division "of treble, quadruple, or sextuple nebulæ," the example adduced is that of this nebula, as follows:*

Among the treble nebulæ there is one, namely, V. 10, of which the nebulosity is not yet separated. "Three nebulæ seem to join faintly together,[c] forming a kind of triangle; the middle of which is less nebulous, or perhaps free from nebulosity[c]; in the middle[a] of the triangle is a double star of the second or third class; more faint nebulosities are following[d]."

"*Mr. Herschel's and Mr. South's Observations of the apparent Distances and Positions of* 380 *double and triple Stars."—Phil. Trans.* 1824, *Part II. In the "Supplementary Catalogue of Twenty," less perfectly measured than the rest, on account of uncommon difficulty, &c., is a measure of the central star:*

No. CCCLXXIX. R. A. $17^h\ 52^m$; Decl. 22° 58′ S. 40 of the 145.

Double; 9th and 10th [e] magnitudes.

July 11, 1823. Five feet Equatorial.

Position = 61° 45′ ± s p; Distance = 10″. 952 ± single measures. "South."

May be easily measured in the 7 feet, but in its present place it cannot be directed to it.

Sir J. F. W. Herschel. "An Account of the Actual State of the Great Nebula in Orion, compared with those of former Astronomers." Mem. Ast. Soc., Vol. II., Part II., 1826. *In a note on p.* 490 *he says:*

"However, in the nebula R. A. $17^h\ 52^m$, N. P. D. 113° 1′ in Sagittarius, which belongs to the same class of objects as that in Orion, the idea of an absorption by the double star in its middle is very forcibly suggested. This nebula is broken into three parts, and the three lines of division meet in a vacancy[c], in the midst[a] of which is situated the double star. This curious object has, perhaps, a proper motion.

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[a] Art. 17., Aug. 1 and 9; Art. 43. 4. [c] Art. 45. 2. [d] Art. 61. [e] Art. 36.

Sir J. F. W. Herschel. Second Catalogue "of 295 new Double and Triple Stars, discovered in the course of a series of Observations with a twenty feet Reflecting Telescope. Mem. Ast. Soc., Vol. III., Part I., 1827.

No.	R. A. 1830.0	N. P. D. 1830.0	Angle.	Quadrant.	Dist.	Mags.	Remarks.
——	17h 52m 1s.5	113° 2′ 2″	60°	s p	10″	9, 10[e]	A most curious and interesting object; a double star placed exactly in the central (a) vacuity of a large irregular nebula, which appears to have broken up into three portions by three rifts, or cracks, extending from its centre to its circumference, and whose directions meet (b) at the double star. Twice observed in R. A., and three times in P. D. △ R. A. = 7s.1. Diff. of greatest and least P. D. = 84″. H. and S. 379. (61° 45* s p, 10″.952.)

Sir J. F. W. Herschel, in the prefatory remarks to the same paper, says:

The curious double star R. A. 17h 52m 1s.5, so remarkably situated "where three ways meet," in the midst of a very large and conspicuous nebula, affords a striking instance how easily the latter class of objects may be overlooked in the usual mode of conducting astronomical observations within doors, with lights burning and the field illuminated. Mr. South measured this star in the five feet equatorial, but the nebula which formed so very striking an appendage to it escaped his notice entirely, &c.

Sir J. F. W. Herschel. "Fifth Catalogue of Double Stars observed at Slough, in the years 1830 *and* 1831, *with the twenty feet Reflector, &c." Mem. Ast. Soc., Vol. VI.,* 1833.

No. h.	R. A. 1830.0	N. P. D. 1830.0	Pos.	Dist.	Mag.	Remarks.	Sweep.	Reference.
——	17h 51m 56s.9	113° 1′ 29″	218°.0 22 .5	10″ 3	8, 9.10[e] 8, 10	Beautifully triple In nebula IV. 41. Daylight observation; nebula not observed.	275	S h. 379.
	——	——	216 .4 20 ±	14 5±	——	Position, mean of 216°.0, 217°.1, 216°.2. Triple. Before the close star could be measured, it clouded.	276	

Position from diagram. If the rough measure of S h. 379 could be relied upon, the star B must have varied in position greatly.(f) C overlooked by my father, and by S h.

Sir J. F. W. Herschel. "Observations of Nebulæ and Clusters of Stars, made at Slough, with a twenty feet Reflector, between the years 1825 *and* 1833." *Phil. Trans.* 1833, *Part II.*

No.	Synonym.	A. R. 1830.0	N. P. D. 1830.0.	Description and Remarks.	Sweep.
1991	IV. 41.	17h 51m 56s.9	113° 1′ 29″	The double star S h. 379 in the centre[a] of the trifid nebula IV. 41. (See my 5th catalogue of double stars. Mem. Roy. Ast. Soc. and fig. 80.)	275†
		62 .4	0 41	A careful drawing taken, but the nebula is not clear from twilight and clouds. (N. B. This drawing is unfortunately lost, and that engraved in fig. 80 is constructed from much less elaborate sketches, aided by memory.)	32
		64 .3	0 6	Very large; trifid, three nebulæ with a vacuity in the midst[c], in which is centrally situated[a] the double star S h. 379, nebula = 7′ in extent. A most remarkable object.	30
		. . . .	0 43	Seen in its place, but clouds prevented observation.	31

[b] Art. 17, Aug. 9; Art. 43. 4. [f] Art. 62.

* There is an erratum here in the Mem. Ast. Soc. For "81° 45′," read "61° 45′."

† Should it not be 276? There is an erratum either here or in the catalogue referred to, since against "sweep 275" in that catalogue is the remark "Daylight observation; nebula not observed."

M. 17; *h*. 2008.

58. *Sir William Herschel. "On the Construction of the Heavens." Phil. Trans.* 1785, *Part I. M. 17 is included in the enumeration of seven "very compound nebulæ, or milky ways," which "cannot be otherwise than of a wonderful magnitude, and may well outvie our milky way in grandeur," as follows:*

The seventh is a wonderful, extensive nebulosity of the milky[g] kind. There are several stars visible in it, but they can have no connexion with that nebulosity, and are, doubtless, belonging to our own system scattered before it. It is the 17th of the Connaissance des Tems.

Sir J. F. W. Herschel. "Observations of Nebulæ and Clusters of Stars, made at Slough, with a twenty feet Reflector, &c." Phil. Trans. 1833, *Part II.*

No.	Synonym.	A. R. 1830.0	N. P. D. 1830.0	Description and Remarks.	Sweep.
2008.	M. 17	$18^h\ 10^m\ 44^s.2$	106° 17′ 55″	The principal star[h] in the preceding arc of the horse-shoe-like portion of the nebula M. 17. See fig. 35.	163
		46 .8	14 5	The small, insulated, resolvable knot[h] in the following* strait branch of the nebula.	274
		51 .8	14 19	The same knot. See description of this nebula in the Appendix. See also the figure.	358
		. . . .	15 48::	A most curious object, not unlike the nebula in Orion, (as it used to be figured, like a Greek capital omega, Ω.) There is in it a resolvable portion, or knot, distinctly separated from, and insulated in the rest, as if it had absorbed the nebula near it[i]. (A figure carefully drawn.) (The P. D. inaccurate[h], being much past meridian.)	33
		. . . .	15 27::	A large extended nebula. Its form is that of a Greek Ω with the left (or following) base-line turned upwards. The curved (or horse-shoe) part is very faint, and has many stars in it. The preceding base-line hardly visible[k]. The following, which is the principal branch, occupies nearly half the field, ($7\frac{1}{2}'$.) Its light is not equable, but blotty.[g] Strong twilight.	48

Sir J. F. W. Herschel. "Notes on the List of Figured Nebulæ," in the "Appendix" to the above paper.

Fig. 35, Mess. 17.—The figure of this nebula is nearly that of a Greek capital omega, Ω, somewhat distorted, and very unequally bright. It is remarkable that this is the form usually attributed to the great nebula in Orion, though in that nebula I confess I can discern no resemblance whatever to the Greek letter. Messier perceived only the bright following* branch of the nebula now in question, without any of the attached convolutions which were first noticed by my father.[1] The chief peculiarities which I have

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[g] Art. 18, Aug. 10.

[h] The north polar distances of these two points are, as given here, on the average, about 2′ larger than mine.

[i] Art. 47. 1; Art. 48. 4, 5. [k] Art. 49. 2.

[1] I have not been able to find Sir William Herschel's notice of these; and perhaps they are not published, since Sir J. Herschel, in another part of this paper, refers to his father's "observations of Messier's nebulæ, (which," he adds, "are not included in his catalogues,) &c."

* Two errata occur here in the Phil. Trans. In both instances, for "preceding" read "following."

observed in it are, 1st, the resolvable knot in the following portion of the bright branch, which is, in a considerable degree, insulated from the surrounding nebula; strongly suggesting the idea of an absorption of the nebulous matter[l]; and, 2dly, the much feebler and smaller knot at the north preceding end of the same branch, where the nebula makes a sudden bend at an acute angle[m]. With a view to a more exact representation of this curious nebula, I have, at different times, taken micrometrical measures of the relative places of the stars in and near it[n], by which, when laid down as in a chart, its limits may be traced and identified, as I hope soon to have better opportunity to do than its low situation in this latitude will permit.

V. 19; *h.* 2092 and 2093.

59. *Sir William Herschel. "On the Construction of the Heavens."* *Phil. Trans.* 1785, *Part I. The 2d and 3d of the seven "very compound nebulæ, or milky ways," which "cannot be otherwise than of a wonderful magnitude, and may well outvie our milky way in grandeur," both belong to this extensive nebula:*

The *second*[o] is an extremely faint milky ray, above $\frac{3}{4}$ of a degree[p] long, and 8 or 10′ broad[p]; extended from north preceding to south following. It makes an angle of about 30 or 40 degrees with the meridian, and contains three or four places that are brighter than the rest. The stars of the Galaxy are scattered over it in the same manner as over the rest of the heavens. It follows ε Cygni 11.5 minutes of time, and is 2° 19′ more south.

The *third*[q] is a branching nebulosity of about a degree and a half in right ascension, and about 48′ extent in polar distance. The following part of it is divided into several streams, which, after separating, meet each other again towards the south. It precedes ζ Cygni 16^m in time, and is 1° 16′ more north. I suppose this to be joined to the preceding one; but, having observed them in different sweeps, there was no opportunity of tracing their connexion.

Sir William Herschel; First Catalogue of 1000. *Phil. Trans.* 1786, *Part II.*

Cl.	No.	Date.	Star.	Diff. of R. A.		Diff. of Decl.		No. of Obs.	Remarks.
V.	14	Sept. 5, 1784.	52 (k) Cygni	Foll.	$11^m 24^s$	North	0° 44′	2	Branching nebulosity, extending in R. A. near $1\frac{1}{2}$°, and in P. D. 52′. The following part divides into several streams, uniting again towards the south.(r)

Sir William Herschel. "Astronomical Observations relating to the Construction of the Heavens, arranged for the purpose of a critical examination, &c." Phil. Trans. 1811, *Part II. Under the first of the many classes into which he had arranged them, we have:*

1. Of Extensive Diffused Nebulosity.

The first article of my series will begin with extensive diffused nebulosity, which is a phenomenon that

m Art. 47. 2; Art. 49. 4; Art. 50. 1.

n In Sir J. Herschel's present drawing, the places of at least four or five stars seem to have been settled by measurement.

o Corresponding to *h.* 2092; Art. 64.

p I should think over-estimated.

q & r Corresponding to *h.* 2093; Art. 64.

hitherto has not been much noticed, and can, indeed, only be perceived by instruments that collect a great quantity of light.

* * * * * * * * * *

The description of the object I shall select is of No. 14 in the 5th class, and is as follows[s] :—" Extremely faint branching nebulosity; its whitishness is entirely of the milky kind, and it is brighter in three or four places than in the rest; the stars of the milky way are scattered over it in the same manner as over the rest of the heavens. Its extent in the parallel is nearly $1\frac{1}{2}$ degree, and in the meridional direction about 52 minutes. The following part of it is divided into several streams and windings, which, after separating, meet each other again towards the south." See figure 1.

Sir J. F. W. Herschel. " Observations of Nebulæ and Clusters of Stars, made at Slough, with a twenty feet Reflector, &c." Phil. Trans. 1833, *Part II.*

No.	Synonym.	A. R. 1830.0	N. P. D. 1830.0	Description and Remarks.	Sweep.
2092	V. 14	$20^h\ 49^m\ 19^s.1$	58° 57′ 1″	Place of the southern and brightest star of a trapezium south of the bifurcation of this nebula. The nebula is extremely faint, very long, and straggling, extending at least four fields (= 1°)[t]. Its direction is (by diagram) about 20° n p to s f, and near the middle it forks into two chief branches. (See fig. 34.) In the trapezium (or oval) above spoken of are 6 stars, 1 = 11 m; 2 = 10 m; 3 = 12 m; 4 = 14 m; 5 = 15 m; 6 = 12 m[e]. The northern branch of the fork is the principal[u], and passes south of a double star[v] (7)[w].	199
		22 .7	- - - - - -	The same star in the same nebula V. 14. The nebula is of great extent, passing obliquely through and rather under (to the north* of) a small constellation, being densest where under it; but it is extremely faint, and only to be seen with an eye well prepared, and in a very clear night. The whole neighbourhood seems affected with wisps, or cirro-stratus-like masses of nebula.[x]	198
2093	Nova.	20 50 4 .4	60 26 6 [y]	(See figure 82.) A most wonderful phenomenon. A very large space, 20′ or 30′ broad in P. D., and 1^m or 2^m in R. A., full of nebula and stars mixed. The nebula is decidedly attached to the stars, and is as decidedly not stellar. It forms irregular lace-work marked out by stars, but some parts are decidedly nebulous, wherein no stars can be seen.[z] A figure (from which the drawing for the engraving was copied) represents general character, but not the minute details of this object, which would be extremely difficult to give with any degree of fidelity.	8

[s] Art. 64.
[t] Certainly over-estimated, even by the testimony of his own drawing.
[u] It is not so in his drawing. Also, see Art. 51. 17; Art. 52. 12.
[v] Art. 52. 14.
[w] I cannot conjecture to what this " (7) " refers.
[x] Art. 19, Aug. 19; Art. 54. 4.
[y] Art. 65.
[z] Art. 19, Aug. 1 and 9; Art. 51. 8, 13.
* There seems to be an erratum here in the Phil. Trans. For " to the s. of," read " to the n. of."

Sir J. F. W. Herschel. "Notes on the List of Figured Nebulæ," in the "Appendix" to the above paper.

Plate XVI. Figs. 80, 82, 83, 84, 85, represent nebulæ which offer some remarkable peculiarity of situation with regard to stars. Of these the most singular are IV. 41, (fig. 80,) and that of fig. 82. The latter, however, is very imperfectly expressed in the drawing. Indeed, it would be excessively difficult to execute a drawing of such an object with any pretensions to correctness. In this, general resemblance and character only has been aimed at, enough to express the peculiar feature of the object, which is a network or tracery of nebulæ following the lines of a similar network of stars. It is an extremely faint and difficult object, and only once observed; but I do not think it possible I could have been deceived as to the reality of the phenomenon,[z] especially since the brighter parts of the nebula are stated in the observation to have been distinctly seen.

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60. A number of interesting results are deducible from the comparison of these observations with each other, and with those embodied in this paper, some few of which I shall point out.

61. The large nebula surrounding star 22 of *h*. 1991, appears to have escaped the eyes of both the elder and younger Herschels. Unless we construe the remarks of Sir Wm. Herschel in his paper of 1811, that "more faint nebulosities are following," as a notice of this nebula. But, had Sir Wm. Herschel actually seen the nebulous companion, which, surrounding a bright star at so short a distance from the principal triple nebula, at once renders the whole system one of the most wonderful and instructive in the heavens, it is in the highest degree improbable that he would have passed over, with so light a comment, a fact more highly illustrative of his peculiar views than any of the instances he has so laboriously collected. His remark, which seems otherwise inapplicable as a description of this object, more probably refers to some smaller and very faint nebulosities, at several fields distance; one or two such were marked by us as Novæ, having no synonyms in the younger Herschel's catalogue, but for want of proper instrumental means, their places could not be settled.

62. *Measures of the triple star.* The lines drawn on the star chart to mark the directions of the components of the triple star, (see Art. 17; Obs. of Aug. 14,) were transferred to the corrected maps, and, measured by an accurate protractor, gave the following results: A B,=211°.5; A C,=15°.5, the latter not well seen. Again, from the measured right ascensions and declinations, we have

for AB, 218°.6, though, from the nature of the deduction, not much to be depended upon. An observation with the micrometer also occurs in the Journal, as follows: "Oct. 4. Two measures of AB, *s p* 52° 30′, and 55° 30′" the mean of which = 216°.0. Arranging all the measures of this star in order of time, we have

		Position.	Distance.
Herschel and South, 1823.5	61° 45′, s p	= 208° 15′	10″.9
Sir J. Herschel, 1827	60 s p	= 210 (est.)	10 (est.)
" , 1831		218 .0	10 (est.)
		216 .4	14 (est.)
Mean of the above, 1839.7		215 .4	10 .1

The conjecture of Sir J. Herschel with regard to the change of position of this star (see Art. 57, "Fifth catalogue of double stars,") seems, therefore, not to be confirmed.

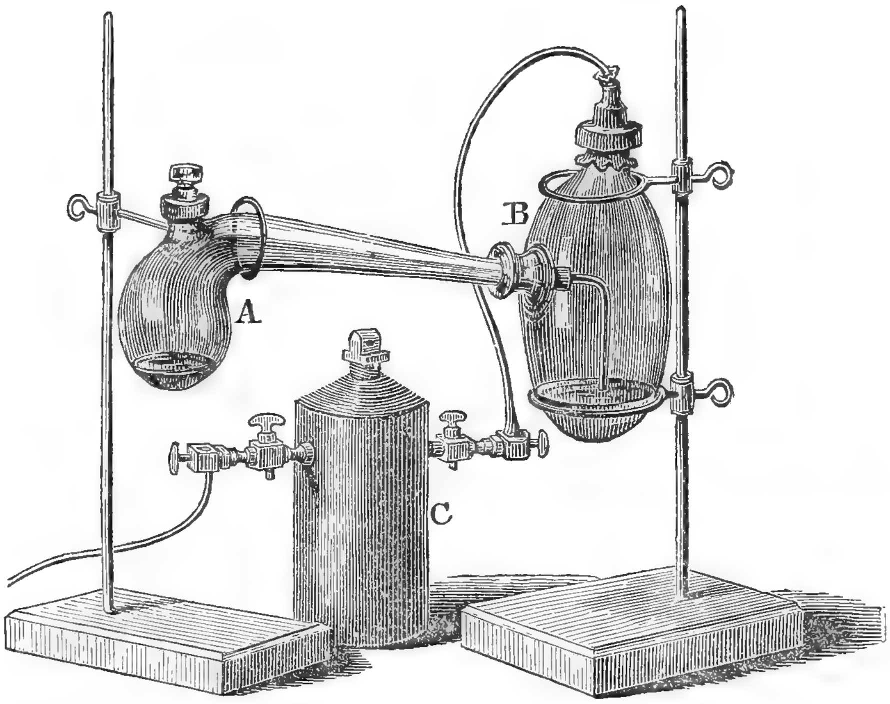
63. The nebula IV. 41, and V. 10, 11, and 12, of Sir Wm. Herschel's catalogues are identical. Sir J. Herschel seems to have recognised only the former. And it appears that Sir Wm. Herschel supposed them different nebulæ, from his assigning to them two different places in his catalogues.

64. The observations on *h.* 2092 and 2093, by former observers, are in great confusion *inter se.* Of the two "compound systems or milky ways" in Sir Wm. Herschel's first quoted paper, the "second" answers to the *bifurcate,* and the "*third*" to the network portion of this nebula. If the descriptions there given did not show conclusively that this was the case, the places assigned would remove all doubt. Again; in his first catalogue of 1000, he repeats the description of the *third* milky way, under the title of V. 14, which must therefore correspond to the *network;* and the place he assigns, when reduced, becomes R. A. $20^h\ 50^m\ 0$, Decl. + 30° 50′, which exactly coincides with the brightest point of this portion. Sir J. Herschel seems to have overlooked or mistaken some of these observations, by applying the synonym V. 14 to the bifurcate portion, and calling the network "Nova," whereas both these suppositions the above comparison shows to be unwarrantable.

There is also some reason to believe, from the description in his paper of 1811, Art. 59, that the elder Herschel saw the faint band which I have shown connects these two portions, or, in other words, traced out the whole nebula; the "figure 1," however, to which he refers so immediately, exhibits no trace of resemblance to the object, as seen by us, nor is the difference such as could be caused by any difference in telescopes. Nor is it at all in favour of this belief, that he quotes from his catalogue under the title of V. 14, which I have shown corresponds to the network only,—and assigns, as in that catalogue, an extent of 52′ in a meridional direction, a quantity entirely too small to include the whole nebula, especially when we consider that in other particulars of dimension he has rather over, than under estimated. I am therefore unable to decide this point. At the time of our own observations, and until quite recently, I did not know that there was *any* ground for attributing to the elder Herschel a full view of the whole nebula; and the remarks of the younger Herschel, show conclusively, that he was not aware of their being united, nor so understood his father's observations.

65. It will be seen, by reference to the figured nebulæ of Sir J. Herschel, that his figure 34 represents that portion of our largest nebula, included between the parallels 30° 55′ and 31° 20′ in Plate VII. Figure 82 represents the general character of the portion between 30° 10′ and 30° 40′.

66. The N. P. D. of *h*. 2093, as given by Herschel, is 60° 26′ 6″, or in declination + 29° 34′. A reference to the map or catalogue will show the brightest portion to be about + 30° 28′ 40″. The place assigned by Sir J. Herschel is therefore nearly a degree in error. I was led on this account, in early observations, to attribute to the nebula a greater extent than actually belongs to it. It does not much exceed a degree in declination, and it is between 3^m and 4^m broad in right ascension. It would be very absurd to account for the error in Herschel's place, by supposing that not this, but some nebula about a degree farther south, and unseen in our observations, is the one recorded by him. I think it probable that the confusion I have above alluded to in the synonyms of different portions of the whole nebula is chiefly owing to this mistake in P. D.



ARTICLE XIV.

Engraving and Description of an Apparatus, and Process, for the rapid Congelation of Water, by the explosive Evolution of Ethereal Vapour, consequent to the combined influence of Rarefaction and the absorbing Power of Sulphuric Acid. By Robert Hare, M. D. Read May 15, 1840.

In a verbal communication to the society, made in December last, I alluded to my having previously published a notice of a process for freezing water by the vaporization of ether; in which the congelation was expedited by the employment of sulphuric acid to absorb the ethereal vapour. I afterwards proceeded to state that, by the interposition of a vessel previously exhausted of air, with which a communication could be made by opening a cock, the process had been still farther improved, so as to cause a vaporization of the ether, and a freezing of the water, so rapid as to project the resulting ice against the upper internal surface of the containing vessel with a violence quite audible, as well as visible, to a large audience of my pupils.

I now submit to the society, for publication in their Transactions, an engraving and description of the apparatus employed agreeably to the recent modification to which I have adverted.

The retort (A) contains water covered by a stratum of hydric ether, commonly called sulphuric ether. The vessel (B) holds a stratum of sulphuric acid, of which the depth, at the deepest part, is about two inches. Into the tubulure in the side of this vessel the beak of the retort is ground to fit air-tight, and is made to receive one end of a recurved tube, of which the lower end descends about half an inch below the surface of the acid. A mercury bottle, (C,) of which the mouth is closed so as to be air-tight, is furnished with two cocks, one of which communicates, through a pipe, with an air-pump, the other, in like manner, with the vessel (B.) This bottle is previously exhausted, and kept in a state of exhaustion by closing both of the cocks. The pump being put into operation and the cocks opened, the power of the acid in absorbing the vapour, co-operating with that of the pump, and the vacuum in the bottle, in exhausting the air and vapour from the retort, causes an explosive vaporization of the ether and a rapid congelation of the water. It is upon the novelty of the last mentioned phenomena, and of the means employed in their production, that I rest the pretension of this brief communication to a place in a volume of the society's Transactions.

ARTICLE XV.

On the Insufficiency of Taylor's Theorem as commonly investigated; with Objections to the Demonstrations of Poisson and Cauchy, and the assumed Generalization of Mr. Peacock; to which are added a new Investigation and Remarks on the Development and Continuity of Functions. *By Charles Bonnycastle, Professor of Mathematics in the University of Virginia.* *Read May* 15, 1840.

Section I.

Development of Functions.

In another place I have pointed out the errors and conflicting views resulting from the vague manner in which mathematical writers have usually conceived the ultimate object of their peculiar logic.

This discussion is only incidentally connected with the present paper, but it will conduce to clearness if I state so much of the construction and object of modern analysis as we shall have occasion to refer to in what follows.

1. Numerical logic may be regarded as divided into two great branches—the body of connected arrangements and rules, to which writers have given that most awkward name "the calculus," and the operations whereby all the relations of quantity are reduced to its influence, and developed by its established principles.

2. The first of these branches, for which we have remarked a new name is so much wanted,* consists, 1st, of arithmetic—which any good calculating ma-

* See note 1.

chine might conveniently replace—and, 2dly, of algebra, elementary and transcendent, which prepares and reduces complicated relations for the application of arithmetic, or, in other words, brings them within reach of the machine.

3. The applied branch of numerical logic—nearly as ill named as that which is pure—has for its object to reduce all the relations of time and space, and such moral relations as admit the notion of definite aggregation to relations of number; or, more correctly, to reduce all *modes* of exact aggregation to the relations of that *particular* arrangement of number which constitutes the branch preceding.

4. As I cannot persuade myself to use a term so ill adapted to its purpose as "the calculus," I must employ, in its place, the circuitous definition of "the known and connected algebraic arrangements," and shall then observe that, throughout this paper, any expression composed of the known and connected algebraic arrangements is termed a *function* of numerical logic, as any expression which relates to modal aggregation, unreduced to relations of number, is termed *a modal function.*

5. The two great instruments which numerical logic employs in reducing the unknown to the known are equalities and developments. In the present mode of considering the subject, nearly all developments are derived from those which are equalities, by the simple process of omitting the remainder; so that, denoting a development by the sign $\nparallel$, either of the propositions

$$u = \overset{0}{u} + \overset{1}{u} + \overset{2}{u} + \overset{3}{u} + \&c. \, . \, \overset{m}{u} + R \tag{1}$$

or

$$u = \overset{0}{u}\overset{0}{v} + \overset{1}{u}\overset{1}{v} + \overset{2}{u}\overset{2}{v} + \overset{3}{u}\overset{3}{v} \ldots \overset{m}{u}\overset{m}{v} + R \tag{2}$$

may be said to involve the proposition

$$u \nparallel \overset{0}{u}, \overset{1}{u}, \overset{2}{u}, \overset{3}{u} \ldots \overset{m}{u} \tag{3}$$

6. A variety of instances, more general than these, might be given, but our present object is limited to the manner in which the third proposition arises from the second, and to that form of the "classifying functions" $\overset{0}{v}, \overset{1}{v}, \overset{2}{v} \ldots \overset{m}{v}$, which gives rise to the differential and the integral calculus.

To conceive the first of these neatly, we remark, that many developments are not only definite, or such as can be found by fixed rules, but also *prime*, or such as admit of only one form, and that always give the same terms when the function operated upon is varied in any way that does not affect its value.

Hence, if such a form can be found for $\overset{x}{v}$—the general term of $\overset{0}{v}, \overset{1}{v}, \overset{2}{v}$; as, within specified limits of some of the variables that enter u—shall make any one of the terms in (2) greater than all which follow—including R—the functions

$$\overset{0}{u}\overset{0}{v},\quad \overset{0}{u}\overset{0}{v}+\overset{1}{u}\overset{1}{v},\quad \overset{0}{u}\overset{0}{v}+\overset{1}{u}\overset{1}{v}+\overset{2}{u}\overset{2}{v},\ \&c.,$$

will be *osculates* of the more complicated, and less known, function u, or, in other words, will agree with it more nearly than any other functions of the same peculiar form and simplicity can agree.

The success of the method obviously depends on our obtaining known and manageable functions for the derived terms, or, rather, for those partial sums of them which we have above enumerated.

The great importance of such osculates will be felt when we consider that not only tangents, tangent planes, circles of curvature, motions in these lines and planes, and other similar geometrical and dynamical elements, are merely osculates to the function they are intended to trace, but that every physical hypothesis stands in the same relation to the function which it represents; as may be well perceived in the Newtonian law of gravity, which is merely regarded as a convenient and *finite* osculate to the law of nature.

Recent analysts, and especially LAGRANGE and FOURIER, have greatly added to this method of investigation, by the introduction of those very simple transcendental osculates which give finite osculations with any required portion of a function, and which thus enable us to separate the parts that belong to the problem in hand from those which would merely embarrass the investigation.

Having thus pointed out the manner in which the differential calculus proceeds, it may not be amiss to notice that of its converse, whereby we shall throw farther light upon the nature of the developments we are considering. These two branches of numerical logic are, indeed, so imperfectly explained in our elementary works, and have been viewed by writers of the eminence of CAUCHY and Mr. PEACOCK in a manner so much at variance with what I regard as their true principles, that I found this little preliminary sketch essential to the clear understanding of the principal subject of this paper.

Supposing, then, a numerical function P developing in a known series

$$\overset{0}{P}, \overset{1}{P}, \overset{2}{P} \ldots \overset{x}{P} \ldots \&c., \tag{4}$$

and a modal function Q developing, modally, in a similar series

$$\overset{0}{Q}, \overset{1}{Q}, \overset{2}{Q} \ldots \overset{x}{Q} \ldots \&c.; \tag{5}$$

it is evident that if we can so determine P that any corresponding terms in these developments shall agree—as, for example, that $\overset{1}{P}$ shall be the numerical representative of $\overset{1}{Q}$, the relation which exists among the terms, and whereby we pass from term to term, in either direction, along the series, will immediately determine the connexion of P and Q, of $\overset{0}{P}$ and $\overset{0}{Q}$, or of any other of these related functions. A single example, the method of determining areas, will render this abundantly clear, and as the subject is elementary, and well known, we may dismiss it in a few words:—The modal function Q is, in this case, the increased area; the related, or derived functions $\overset{0}{Q}$, $\overset{1}{Q}$, $\overset{2}{Q}$, &c., are the unincreased area—the parallelogram that composes the largest part of the increase—the right lined triangle that stands on this parallelogram, and so on. Now any one of these derived terms, the first excepted, is easily expressed algebraically, and thus, by the converse of the process that derives a term from that which precedes it, we are enabled to repass, backward, along the developments, and to determine the relation of $\overset{0}{P}$ and $\overset{0}{Q}$.

It is very remarkable that mathematicians employing extensively the theory described above, and which depends on the use made of that remainder R, concerning which so much has been said, should have entertained notions in regard to this last that were far from correct. The nature and *magnitude* of R is manifestly an inquiry essential to the proofs, both that the development is possible and that it is prime, and which is again referred to in that part of the application wherein any term of the series is said to exceed all the rest of the development. D'Alembert and Lagrange were thus led to compute the value of a term on which so much depended; but, proceeding in a vicious circle, their analysis assumed the development which it was meant to demonstrate, as we shall presently show.

Cauchy, perceiving this error, but not distinguishing between developments and equalities, and having apparently an obscure notion of that most valuable part of analysis, the theory of correlations, was led to remodel the differential calculus, and to discover R by a detailed investigation of each special case. Such a process led to rules that seemed to multiply infinitely; the unity and power of analysis became frittered away into—the limited propositions—the partial clearness—and general obscurity of synthesis; and yet so great was the influence of this clever writer, that the injury done to science may be traced even in the works of analysts the most profound,* and greatly disfigures the works of many continental writers of less reputation. The extent of this injury having been seen by Mr. PEACOCK, he was led, in opposition, to assertions that err in a contrary direction, laying down as a law, of which he regards himself as the discoverer, that not only is every development an equality, but, proceeding farther in this method of regarding the subject, that every proposition of numerical logic, once established as true within limits, is thenceforth to be looked upon as universally true—an assertion which would reduce all arrangements to one arrangement, and deny to correlation the power of restricting, or of referring propositions not conveniently grouped together, to distinct classes.

We trust that, after the preceding remarks, it will be clear that both of these views are erroneous; that developments considered *per se*, as, for example, in the theory of generating functions, involve no idea of equality between the members of the proposition, and are even, in many cases, independent of connexion between the terms, as in the proposition

$$P \not\mathrel{\#} \overset{0}{P}, \overset{1}{P}, \overset{2}{P}, \overset{3}{P}, \ldots \overset{x}{P} \ldots :$$

an independence that does not prevent the equality between the numbers of the original development

$$P = \overset{0}{P}k^0 + \overset{1}{P}k^1 + \overset{2}{P}k^2 + \ldots \overset{x}{P}k^x \ldots + R$$

whence the preceding *may* have been derived, from having its use in tracing the nature of the latter, or regulating its applications.

The development whereon the differential calculus is founded requires that we should keep these remarks in mind. The great analysts to whom that method of reasoning is due perceived that, treating $F(x+h)$ as a generating function, $F x$ becomes the first term of a series of functions $\overset{0}{P}, \overset{1}{P}, \overset{2}{P} \ldots \overset{x}{P} \ldots$ having

* The second edition of Poisson's Mechanics may be cited in proof.

important properties, and which enter as coefficients of the development

$$\overset{0}{P} + \overset{1}{P}h^1 + \overset{2}{P}h^2 + \overset{3}{P}h^3 \ldots \overset{x}{P}h^x \ldots + R,$$

that possesses the property, already mentioned, of permitting one term to be rendered greater than all the remainder.

To prove the generality of such an expansion became, therefore, a problem of moment, and as, in attempting to solve it, LAGRANGE had fallen into a material error, POISSON resumed the subject in a memoir, the substance of which may be found in the large work of LACROIX.

It was soon felt, however, that POISSON's demonstration proved too much; it was seen that his results, if demonstrated at all, should be true of every species of function, and that deviations from truths so established would not be exceptions, but anomalies. The force of these objections was increased by a discovery, partly his own, that, in a similar case, the expansion for sin n x, mathematicians, by adopting such loose reasoning, had fallen into considerable mistakes. And these doubts were again re-enforced when it was found that, in that celebrated development used by LAPLACE to investigate the theory of the planets, as well as in the case of the numerous periodic series that began now to be employed, these vague methods of development had introduced uncertainty into the most profound inquiries, and thrown doubt upon results of the highest importance.

Hence arose both CAUCHY's laborious reinvestigation of the higher analysis, and those numerous attempts which we have recently seen made, to demonstrate, in a more exact manner, the fundamental expansions of the science.

Among these it must be acknowledged that one of the most elegant and happy is POISSON's investigation, given in his Traité de Chaleur, of FOURIER's Theorem for periodic developments. And yet, even here, it must be allowed that a demonstration is still wanting that shall, at the same time, be more simple, and connect the result more readily with the elementary arrangements of numerical logic.

That such is the case with regard to the theorem that forms the subject of this paper is, I have no doubt, generally felt; and to that theorem I now return.

LAGRANGE, after an unsuccessful attempt to prove that fractional powers do not enter the development, commences his demonstration by assuming an expansion of the form

$$F(x + h) = F(x) + h.P;$$

which Poisson changes to

$$F(x + h) = F(x) + h^{\alpha}.P;$$

but with what justice we shall now consider.

The development

$$F(x + h) = F(x) + R(x, h)$$
$$\{R(x, h) = 0\}_{h=0} \ *$$

is merely an analytical expression for the hypothesis that h is independent of x, and therefore unquestionable. But, without venturing so far as the supposition of R (x, h) containing a factor which is a *power* of h, what right have we to assume that it contains a factor which is even a pure function of h? or, in other words that

$$R(x, h) = \xi(h).\ Q(x, h);$$
$$\{\xi(h) = 0\}_{h=0}?$$

It may be answered that in no other form than as a multiple could h destroy terms containing the independent variable x. But how much is here assumed will be perceived by considering that, in such simple functions as $x^{-\frac{1}{h}}$, or log. $\frac{x + h}{x}$, that vanish when $h = 0$, we do not immediately see that h^{α} enters as a factor; and although it might be demonstrated that h is so involved, yet what are we to say in regard to the extension of the assumption to that host of transcendental functions, the varying and almost capricious relations of which analysts are only beginning to understand?

Even in the simple vanishing function log x, we know that x^{α} cannot be said to enter as a factor, unless we admit that α is infinitely small; and other cases might be found still more perplexing.

A geometrical illustration will, however, suffice for this purpose. Thus, representing graphically three functions of the form

$$y = h^{\alpha}$$
$$\{y = \xi.h = 0\}_{h=0}$$
$$\{y = \phi(x, h) = 0\}_{h=0};$$

the first is seen to be continuous and parabolic; and, consequently, if the two latter partake of the same degree of continuity, we may conclude that α could

* This notation denotes the function to vanish when $h = 0$.

be so assigned as that when h was very small, the other two functions should sensibly degenerate to h^{α}. Such a conclusion would probably command the assent of the mind; but in what sense could this osculation be understood if the functions ξ and ϕ, expressed throughout their whole extent—series of unconnected points—broken portions of lines infinitely small, arranged at infinitely little intervals—denticulated—serpentining in waves such as are presented by what is termed in art a perfectly polished surface—subject to finite changes in infinitely small distances—or, in short, subjected to any of those numerous varieties of discontinuity which the modern analysis embraces. So far from the osculation being, in such cases, axiomatic, I believe that few analysts, however skilful, will venture, without much investigation, to assert its existence; and even then, their acquaintance with the infinitely small variations of functions would rather be due to a knowledge of Taylor's Theorem than drawn from the algebraic arrangements which precede it in the calculus. The changes which the second function permits might, indeed, cause it to osculate, or become identical with the third for any given value of x; but still, in this instance also, where the assumption is so far less arbitrary and restricted than Poisson's, it could scarcely be allowed; since, should x be changed, by what principle can we assume that the function ξh, which osculated with ϕ for the former abscissa, continues to agree with it for the new point of osculation?

Mr. Murphy, in one of his excellent memoirs on definite integrals* has given the name of *transient functions* to a class of expressions analogous to some of those already mentioned. The expression

$$\left\{\frac{(1-h)(1+h)}{\{1-2h(1-2t)+h^2\}^{\frac{3}{2}}}\right\}_{h=1}$$

is of this class, vanishing for every value of t excepting that in which t is zero, when the value of the function becomes infinite; and were we to rest the argument merely on functions of this kind, we might very well ask whether it can be at once asserted, as axiomatic, that all the great variety of such functions admit of being developed by powers of t?

Sir W. Hamilton and Cauchy have both taken the function

$$e^{-\frac{1}{x^2}}$$

as presenting anomalies and difficulties which cause it to violate two of the received laws of analysis. The last of these authors, indeed, considers this

* Cambridge Phil. Trans., Vol. V., p. 347.

function is alone sufficient to overthrow the customary demonstrations of Taylor's Theorem, and rests the necessity for his own method of proceeding upon the evidence it affords. It is yet manifest that every transient function must possess the same "apparent" anomaly of making the function itself, and all its differential coefficients, vanish for a given value of x; and, indeed, the whole doctrine of what CAUCHY has termed *singular integrals* rests upon the same foundation. The anomaly observed by the first of the authors we have cited consists in the fact that, whilst the function vanishes for $x = 0$, it cannot be expanded in a series proceeding by the powers of x.

Mr. PEACOCK, having adopted the maxim that all developments may be regarded as universally true, is led to hope, in noticing this function, "that more enlarged views of the analytical relations of zero and infinity, and of the interpretation of the circumstances of their recurrence, as well as of the principles and applications of Taylor's series, may enable us to explain these and other anomalies."* Without doubt, they are very easily explained in the present instance; and it may be matter of surprise that neither Sir W. HAMILTON nor Mr. PEACOCK have noticed the explanation. I have not, indeed, at present, the Irish Transactions by me, and am, therefore, obliged to restrict myself to the analysis and remarks contained in the work here quoted, but which, I presume, are drawn from the original memoir.† The method used is to put the theorem

$$e^{-\frac{1}{x^2}} = A x^{\alpha} + B x^{\beta} + C x^{\gamma} + \&c.$$

under the form

$$x^{-\alpha} . e^{-\frac{1}{x^2}} = A + B x^{\beta-\alpha} + C x^{\gamma-\alpha} + \&c. \qquad (a)$$

When, assuming $y = \frac{1}{x}$, expanding

$$\{x^{-\alpha} . e^{-\frac{1}{x^2}}\}^{-1} = y^{-\alpha} . e^{y^2}$$

under the form

$$y^{-\alpha} + y^{2-\alpha} + \frac{y^{4-\alpha}}{1 . 2} + \&c., \qquad (b)$$

and observing that when $x = 0$ or $y = \infty$, this series is infinite, it is concluded that the left hand member of (a) must be zero, and consequently $A = 0$; a re-

* Third Report, p. 346.

† I have since found this surmise correct, having received the Transactions in the interval that elapsed in going to the press.

sult which it is concluded would follow, in like manner, for all the other coefficients.

But here it will be at once seen that the expansion (b) which is unexceptionable whilst y is small, cannot, except on Mr. PEACOCK's principles, be assumed as holding good where y is infinite; and that, even assuming this expansion, it may happen that α is infinite, a result which would reduce an infinity of the first terms of (b) to zero, and thus cause the series to have both numerators and denominators infinite, and consequently render it capable of a finite sum. That such is really the case may be readily shown, for, writing

$$e^x = (e^z)^{\frac{x}{z}},$$

and putting

$$e^z = x$$

we have

$$e^x = x^{\frac{x}{\log x}};$$

and consequently

$$e^{-\frac{1}{x^2}} = \left(-\frac{1}{x^2}\right)^{\frac{-1}{x^2(-2\log x + \log - 1)}}$$
$$= \pm \frac{1}{x^{\frac{1}{x^2(\log x - \frac{1}{2}\log - 1)}}}$$

or

$$\left\{ e^{-\frac{1}{x^2}} = \pm \frac{1}{x^{\frac{1}{x^2 \log x}}} \right\}_{x=0}$$

but putting $x = \frac{1}{y}$ we have

$$\frac{1}{x^2 \log x} = -\frac{y^2}{\log y}$$

and as y^2, when y is infinite, is infinitely greater than $\log y$, we have

$$\left\{ e^{-\frac{1}{x^2}} = \pm x^{\infty} \right\}_{x=0}$$

whence we conclude that if the function in question is expanded in a series of the kind proposed, the lowest power of x must be infinite. And as log x is, in like manner, a function that expands by infinitely small powers of x, it would appear that we might take, as the classifying functions whereby developments can be arranged, the simple expressions

$$x^{a},\ e^{\pm\frac{1}{x^n}},\ (\log x)^n.$$

With these remarks I may close this preliminary outline of the subject, which, I trust, will not be considered as without interest or unnecessarily prolix by those who bear in mind the great importance of the development to which it relates, and the erroneous views of it which analysts of the first rank have taken.

The same observations will apply to another subject, which has, indeed, been only touched upon incidentally by any of the writers with whose works I am acquainted; I allude to the *continuity* of functions, and the division of this continuity into classes. D'ALEMBERT and LAGRANGE, in their discussions concerning the vibrations of a musical cord, and, more recently, FOURIER, in his admirable theory of the propagation of heat, have given us some examples of that species of arrangement which they term *discontinuous* functions; and POISSON, in resuming the inquiry treated by the two former, has shown that the theories of the musical cord require that it should every where have that species of continuity which gives a single tangent to each point. And I may add that Mr. MURPHY, in the first of his Memoirs on the Inverse Method of Definite Integrals, has divided functions according to the number of their *breaks*, giving analytical expressions for each class. But, as all these writers have regarded functions wherein the condition mentioned by POISSON is not fulfilled, as discontinuous, I have to add here some remarks on that subject.

SECTION II.

Continuity of Functions.

The observations which I intend to make on this head will, perhaps, be conveniently introduced by quoting from a small pamphlet containing some elementary views of this kind, and which I had printed, but without publication, during the course of last year.

"Continuous functions we should suppose to be such as, in increasing from one grandeur to another, passed by insensible gradations through every intermediate value; but this must be understood with considerable limitation, since the degree of continuity which serves, at present, as the type of that quality in the theory of number is the continuity possessed by the ordinary functions of the science. The elementary functions of this class are x^n, a^x, sin x; and their converses x^{-n}, $x^{\frac{1}{n}}$, log x, $\sin^{-1} x$; and the complex are such as can be formed from these by any of the operations which were used in forming these functions themselves, certain restrictions being required when those operations compose an infinite series.

Now if we assume as our unit a number ε, no otherwise assignable than as being less than any number we use in the course of the inquiry, and as being capable of indefinite diminution, the natural scale of numbers will become

$$\ldots -2\varepsilon,\ -1.\varepsilon,\ 0.\varepsilon,\ 1.\varepsilon,\ 2\varepsilon,\ 3\varepsilon,\ \ldots\ x.\varepsilon \ldots$$

where each term exceeds the preceding by the indefinitely small portion ε. Such a scale is, in fact, employed by LAPLACE, under another form, at the commencement of the Mec. Céleste, and, adding clearness to discussions concerning infinitely small variations, will be used throughout this paper, wherein we shall term it the *natural scale to the unit* ε.

But, substituting for x, either in the preceding elementary functions or their converses, the successive numbers of this scale, or making the same substitutions in any of the less complex functions that are obtained from these, our knowledge of such functions assures us that the results would be one or other of these three kinds, namely: 1. Real numbers, positive or negative, and increasing and decreasing continuously; 2. Imaginary symbols of the form $v + w\sqrt{-1}$, where v and w continuously increase or decrease; and, 3. Expressions of the form $\frac{1}{v - w}$, where w being exceedingly nearly equal to v, the continuous increase of w may cause the expression to become plus infinity; and this increase continuing, and causing w to exceed v by a quantity infinitely small, will make the value of the expression pass at once from *plus infinity to minus infinity.*

Such, at least, then, are the degrees of variation that we must admit under the notion of continuity, if we would regard the ordinary functions of algebra as continuous; and we find that our elementary writers have, accordingly, in speaking of continuous functions, limited themselves to these cases, framing a rule that, in such functions, *a number never passes from plus to minus without having previously passed through zero or infinity.*

The very simple expression $y = \tan^{-1} \frac{1}{a - z}$ will, however, show us that such a rule is not exact, since, by making z respectively equal to $a + \varepsilon$ or $a - \varepsilon$, or, which is the same, $y = \tan^{-1}\frac{1}{\epsilon}$ and $-\tan^{-1}\frac{1}{\epsilon}$, we observe that z, in passing through the value a, changes y, at once, from $+\frac{\pi}{2}$ to $-\frac{\pi}{2}$.

The great abruptness of such changes might lead us to suppose their extent of discontinuity not subject to any rule, but further inquiry will not warrant us in this conclusion; through all their changes, these functions have a connexion that admits of measurement, and which, as we have before remarked, is even made the standard of comparison for other changes; so that in the language of algebra, variations of no greater extent than these, are reckoned as within the limits of continuity, whilst changes more abrupt are regarded as transcending those limits.

But, although mathematicians may adopt this definition, it would evidently be more correct to say that continuity is divided by such writers into orders: geometrical continuity of the highest order may cease with the introduction of imaginary signs, whilst analytical continuity admits such symbols of correlation as indicative of a grouping of related problems. The expression, for example, $y = a + \sqrt{b^2 - x^2}$ ceases to be geometrically continuous with the value $x = b$; but this is far from being the case with the analytical function, wherein that value indicates a mere transition to a second problem of the same group. All functions $y = Fx$, of numerical logic, or which are expressed in terms of those unbroken arrangements of "the calculus" that lead to the rules of arithmetic—rules by which, as by a machine, the numerical values are computed—will thus constitute series of continuous terms; but it would seem that analytical writers carry this notion further, and regard every arranged series, whether reduced or not to the known arrangements of the calculus, as possessed of *some* continuity.

The functions arithmetically direct, or that merely represent additions, together with all those which, in passing from one value to another, pass through all the intermediate values, form the functions of the first degree; a continuity, it may be observed, best understood by considering the branches which functions admit.

I have, in another place, proposed to denote functions as *monoramic*, or *multiramic*, according to their division into branches. And these divisions, when applied to geometry or physics, would have again to be subdivided by their quality of being real or apparent. The circle, or the common lemniscate, for example, manifestly consists of a single branch, whilst the hyperbola, with its two opposed and separable branches, is as clearly multiramic; and still more justly, perhaps, may this quality be predicated of the figure represented by the equation $y^2 - a x^2 = 0$, which consists of two distinct right lines. These examples serve to distinguish a *real* geometrical division into branches, from that *apparent* division which belongs to the analytical function representing the curve, and which owes its multiramic character not only to the nature of the latter, but to the place of the origin, and the directions of the co-ordinates, as will be sufficiently apparent by considering the different branches under which the circle and lemniscate appear when expressed by means of linear co-ordinates.

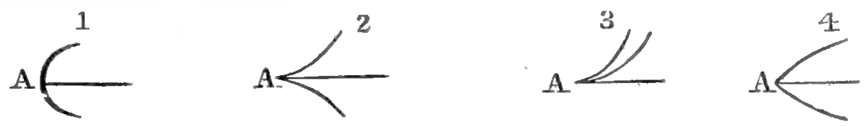
Curves really monoramic, and possessed of the first degree of continuity, would thus either return into themselves, or continue to infinity, or terminate abruptly at one or both of their extremities; the last of which conditions appears to require transcendants of a higher order than those elementary functions which are usually alluded to when we speak of the continuity of functions, or, as might be more accurately expressed by saying—when we speak of functions having a continuity of the first and second degree.

The variations admitted into this latter class have been illustrated by the examples with which we commenced this section; and we have there also remarked that its peculiar character is, that any one point of the same branch of such a curve can only have a single tangent. It is this property, therefore, which includes the ordinary definition of continuity; and as it has been found of some importance in the theory of vibrating cords, and of some other parts of applied mathematics, and as we also perceive it to form a well marked character in the arrangements of continuity, it may not be amiss to give this property an analytical, in place of a geometrical form: to effect which it will be sufficient to design the general algebraic function of the first degree

$$y = a x + b,$$

as a *linear function*, and to say that every function $F x$ has a continuity of the second degree, when each distinct branch of it has, for any given value of x, a single linear osculate.

The singular points exhibited in the annexed figures will afford an evident illustration of these remarks: the first, although determined by the usual rules for points of reflection, owes its peculiarity to the mere position of the axe of the co-ordinates, and may occur in a curve having a continuity of the first degree; the second and third, which are the only points of reflection usually



given, appear in continuities of the second order; whilst the fourth, which, viewed independently of the arbitrary arrangements of analysis, seems to present no greater breach of continuity than the second or third, is yet, from admitting two tangents at A, not regarded as a continuity by our analysts, and can only appear in those transcendants which we have described as possessing continuities of the third order.*

This last division falls, therefore, under the class which mathematicians have termed *discontinuous*, and which we propose to designate as continuities of orders lower than the second. With regard to such functions, which physical problems every where present us, and which now act so important a part in mathematics, some confusion appears to exist. Most authors, and FOURIER and POISSON in particular, have endeavoured to reduce their analytical expressions to that connected series of arrangements which I have described as constituting the arranged functions of numerical logic, and which is generally known as "the calculus."

Mr. PEACOCK, in a report to which I have frequently alluded, proposes, as, indeed, had been informally done before, to introduce a sign of discontinuity ${}^{x}D^{a}_{b}$; which amounts to an agreement that in such an expression as

$$y = \underset{x}{A} \log x + \underset{x}{B} \sin x \qquad (6)$$

the coefficients $\underset{x}{A}$ and $\underset{x}{B}$ shall not be absolutely constant, but that $\underset{x}{A}$ shall be unity and $\underset{x}{B}$ zero between the limits $x = -$ infin. and $x = n$; whilst, on the contrary, these coefficients are to interchange those values from $x = n$ to $x = +$ infinity.

This method of proceeding, which has been often used, differs from the verbal statement of the proposition in no other way than as agreeing upon some common symbol which expresses that statement in the shortest manner. It affords, therefore, no assistance towards reducing y to the arranged functions of the science, and, consequently, never leads to the remarkable expressions

* The branches are supposed to terminate at A, otherwise this would merely be a multiple point, and what is said above would not be true.

invented for this purpose. As o^x, $\Delta^m . o^n$, or $e^{(\log o)^{\log o\,(x-n)}}$, which last has the properties assigned to $\underset{x}{A}$.

Our equation (6,) in short, by whatever signs of mere agreement we express the coefficients $\underset{x}{A}$ and $\underset{x}{B}$, amounts really to the two equations

$$\{y = \log x\}_{x=-\frac{\alpha}{n}}$$

$$\{y = \sin x\}_{x=\frac{n}{\alpha}}$$

and has no other advantage than results from uniting these two equations in one.

Simple expressions connecting, with the ordinary arrangements of algebra, the different orders and kinds of *breaks* to which continuity is subject, are still wanted; expressions that should perform their work as simply as the various series and formulæ used for interpolation. Those functions to which Mr. MURPHY has given the name of *transient functions* serve well enough for most of the cases where such connexion is *not* wanted. Of these transient functions, expressions of the class

$$\frac{x - a}{a - a}$$

are the most simple; and I presume that most analysts have long used them to express such breaks of continuity as are represented in the function

$$\phi\, x = \frac{a - a}{x - a} f\, x + \frac{b - b}{x - b} f'x + F\, x.$$

But, notwithstanding the necessity which thus exists for retaining expressions that shall possess, independently of agreement, the properties in question, it seems to me that advantage would accrue from uniting these methods; and that not only some convenient notation should be agreed upon to represent these semi-constants that change per saltum at limits, but that the simplest class of periodic variables should be dealt with in the same manner, and made types of reference to which all periodic quantities could be reduced.

With this view I have elsewhere recommended that any given function $F\,x$ should be made periodic between the limits 1 and $\underset{\smile}{\pi}$ by annexing the symbol $\underset{\smile}{\mathcal{Q}}$; so that

$$\underset{\smile}{\mathcal{Q}}\, F\,(x)$$

would represent, geometrically, a series of waves formed by the continued repetition of the same portion of the given function.

The expression

$$\underset{\cdot}{\mathcal{Q}}\, x$$

would, according to this notation, express an abscissa that, regularly increasing from 0 to $\underset{\smile}{\pi}$,* recommences with the latter value, until it has again increased to the same amount; whence it follows that whatever may be the form of F, we should have

$$\underset{\cdot}{\mathcal{Q}}\, F\, x + F \,.\, \underset{\cdot}{\mathcal{Q}}\, x.$$

It would be out of place to repeat here the deductions which I have elsewhere drawn from this and similar equations; and my only object in now noticing them is to remark, that were such conventions agreed upon, every species of discontinuity might be reduced to a class, and rendered a continuity of an inferior order, the connexion with the other arranged functions of the calculus being established by seeking expressions for such simple periodic elements as we have here denoted by $\underset{\cdot}{\mathcal{Q}}\, x$.

I shall not insist further on this subject, having said enough to render clear all that I have to urge in regard to the principal topic discussed in this paper. It has appeared to me that much confusion has arisen from the vague notions entertained concerning modal functions; functions of the calculus, or of numerical logic; continuous functions, and discontinuous functions; and having, in the preceding section, illustrated the *real* distinction between the two former, I trust I have said enough in the present section to show, not only that the distinction between the latter is merely that of a superior and inferior continuity, but also that when we assume with Poisson every function of the form

$$\{F\,(x, h) = 0\}_{h=0}$$

to contain a factor h^a, we must, at best, form our conclusion on a very limited class of mathematical expressions.

Section III.

Functions arranged in the Order of their Magnitudes.—Taylor's Theorem.

Functions $\underset{1}{X}$, $\underset{2}{X}$, $\underset{3}{X}$, &c., of x, that vanish when $x = a$, are said to be arranged in the order of the evanescent magnitudes which they assume for $x = a$, when for every value of n we have

* $\underset{\smile}{\pi}$ is used to denote any period, the symbol π being left for the common period of trigonometrical functions.

$$\left\{\frac{X_n}{X_{n-1}} = 0\right\}_{x=a}$$

The order of magnitude of such a function will, therefore, evidently be that of the lowest term it contains; as it would be that of the highest term, if the function, in place of vanishing, became infinite for $x = a$. And it will equally follow from the definition, that very different functions may have the same order of magnitude; as, for example, the function x, $\sin x$, $\frac{x}{1+x}$, which, for $x = 0$, are all of the same order, and may be reduced one to another by omitting parts that are of the higher orders.

An equation,

$$P_1 X_1 + P_2 X_2 + \&c. = Q_1 Z_1 + Q_2 Z_2 + \&c. \qquad (7)$$

between two series of such terms can be shown to be impossible, unless the lowest terms are of the same magnitude. For, if not, we might suppose either term, as that on the left hand, to be the greater, and as by division we should have

$$P_1 + P_2 . \frac{X_2}{X_1} + \&c. = Q_1 . \frac{Z_1}{X_1} + Q_2 \frac{Z_2}{X_1} + \&c.$$

and as this for $x = 0$ would reduce to

$$P_1 = 0$$

the lower terms would disappear until the required equality of magnitude is obtained.

It will be readily seen that we cannot regard the *terms* X_1, X_2, Z_1, Z_2, &c., of the *series* as if they individually consisted of a single term; since, even when that is the case, we might always substitute for X_n or Z_n equivalent expressions that contained more than one term; and thus, to speak clearly, we must distinguish the total function, or term of the series, from the secondary functions or terms, which, together with their corresponding primary function, constitute X_n or Z_n; and we must bear in mind that however this primary function is changed by expanding X_n or Z_n, or by substituting equivalencies for them, it always remains of the same order; a condition which is not requisite in the secondary terms, which are, moreover, always of higher orders than their primaries, which last express the order of the whole function, or term of the series.

When this is borne in mind, it will be readily understood that if the secondary terms are not of the same magnitude with any of the terms in the series; in other words, if we have classed all the secondary terms of the different functions that may happen to agree with the primary term of X_n or Z_n, as a part of the latter, it will follow that our equation (7) cannot subsist unless we have separately

$$\left\{ P_n X_n = Q_n Z_n \right\}_{x=a}$$

for every value of n.

The restriction here supposed, however, will be unnecessary when the equation is of the form

$$P_1 X_1 + P_2 X_2 + \&c. = 0$$

since the result $P = 0$, already demonstrated, will also lead to $P_2 = 0$, and thence, generally to

$$P_n = 0$$

which is true for every value of n.

The two great forms of arranging terms which algebra employs are drawn, in common with nearly all its arrangements, from arithmetic, and are simply series connected by the operations of addition, or of multiplication; whence, denoting by $\overset{0}{\Sigma}, \overset{1}{\Sigma}, \overset{2}{\Sigma}$, prefixed respectively to the general term of a series U_x, the three arrangements

$$U_0, \quad U_1, \quad U_2, \quad U_3, \qquad\qquad U_x \ldots \&c. \qquad (1)$$

$$U_0 + U_1 + U_2 + U_3 + \&c. \ldots U_x \ldots \&c. \qquad (2)$$

$$U_0 \times U_1 \times U_2 \times U_3 \times \&c. \ldots U_x \ldots \&c. \qquad (3)$$

we shall have a concise notation for all the principal arrangements or developments of which it will be necessary to speak.

The operations of every branch of analysis consist, in a great degree, of finding equivalencies between the two last of these arrangements, and of thus, either by the species of correction employed between the terms, or by the nature of the *classifying* function U_x, suiting our analysis to the problem in hand.

Taylor's Theorem is one of the transformations of this kind, and perfectly to comprehend it, and especially to connect it with the elementary operations of the science—a task quite as important, we must consider not only such terms as enter into the series (2,) but also those which compose series of the class (3;)

or, in other words, the factors, and especially the *prime* factors, into which any given function may be divided.

That any function may be made an "apparent" factor of any other function is evident, since we have only to write

$$F(x) = fx. \frac{Fx}{fx} = fx\,\phi(x)$$

in order to make fx act the apparent part of a factor of F x. The existence of such an error, however, if made unintentionally, would become manifest on substituting for x the value a that caused fx to disappear, since such a substitution would render ϕx infinite, whilst, on the other hand, the substitution of a value b that caused fx to become infinite would cause ϕx to disappear.

When F x is an algebraic function consisting of the sums of powers of x, and which, therefore, can be actually produced by multiplying together factors of the same kind, we have the most exact idea of the nature of these last, but the same is not the case when F x and its factor are functions of different kinds; it might even be shown that

$$\{Fx\}_{x=a\ldots b}$$

$$\{Fx\}_{x=c\ldots d}$$

or F x with x varying from a to b, and F x with x varying from c to d, may be distinct functions, having distinct systems of factors; and thus, in speaking of an equivalence

$$Fx = P \times Q$$

as expressing the more correct proposition

$$\{Fx = P \times Q\}_{x=a\ldots b}$$

we omit a factor R, which acts in these expansions by products, the part of a remainder in the expansions by sums, and which has the property of being unity between the values $x = a \ldots b$, and of being variable, and, perhaps, even infinite for other values.

These remarks will be sufficient to show that F x vanishing when $x = a$, fx may be considered as a factor of $\{Fx\}_{a-\varepsilon\ldots a+\varepsilon}$ * provided that we have

$$fa = 0$$

$$\frac{Fa}{fa} \textit{ not infinite;}$$

* ε is a quantity which may be infinitely small, or, in general, as small as may be required in the proposition wherein it occurs.

and as two factors P and Q might justly be regarded as *prime* when they contained no common factor, we might define prime factors in this way; as, however, it is not always easy to find these common measures, we shall prefer a definition that is equivalent, and say that factors P and Q of any given function F x, are prime when all the values of x that make $P = 0$, make $\frac{P}{Q}$ vanish, whilst all the values that make $Q = 0$ make $\frac{P}{Q}$ infinite.

The relative magnitude of functions that vanish when $z = a$ must evidently depend upon the nature of their factors; and it will, therefore, be convenient to lay down as a definition that functions which are not prime

$$\overset{0}{U}, \overset{1}{U}, \overset{2}{U}, \overset{3}{U} \ldots \overset{x}{U}, \text{ \&c.}$$

are said to be arranged in the order of their magnitude when the fraction

$$\frac{\overset{x+1}{U}}{\overset{x}{U}},$$

formed by dividing any one of the functions by that which precedes it, is equal to zero for the value of z that makes each of the factors vanish.

Proceeding to the development of a function into a series $\Sigma \underset{x}{U}$, of functions more simple than itself, we observe that for any value a, of the independent variable z, that renders the function finite and definite, we must have

$$F z = F a + R;$$

where R vanishes for $z = a$. The nature and magnitude of R will depend altogether on that of F z; it may deviate either slowly or rapidly from the vanishing value when z departs from the value a; and it may even become infinite for an infinitely small alteration in z, or it may cease altogether to exist (as in the theory of conjugate points)* when z takes any other value than this of the single existence zero.

* The imaginary values of an ordinate, when the function is illustrated by geometry, serve very well to exhibit this distinction between y as absolutely non-existent and y as merely equal to zero, a distinction on which the whole theory of conjugate points depends; but I have elsewhere remarked that when we regard the problem as one of pure numerical arrangement, and not as illustrated by geometry, this advantage is lost, and we are left without a symbol to express a relation of so much importance.

The reader will readily perceive that $y = 0$, and $y = a\sqrt{-1}$, considered geometrically, differ in their degree of non-existence; since adding b to both, in other words, shifting the origin

But, notwithstanding all these various changes through which R may pass, we may always write

$$Fz = Fa + Q.fz$$
$$fa = 0 \;;$$

since, whilst we assert nothing more concerning fz than is contained in the second of these equations, we merely express in algebraic terms the truism that $Fa = Fa$. It will be observed, however, that if we assume fz to have the form $\xi\,(z - a,)$ and much more if we assume it as expressed by $(z - a)^m$, we depart as much from the limited condition represented, as if we assumed fz to be $\log \frac{z}{a}$, or $\sin(z - a,)$ or any other function that has the property of vanishing when $z = a$.

This function fz is the prime factor of $Fz - Fa$ that vanishes when $z = a$; but its form, far from being a matter of arbitrary assumption, must be determined by a strict analysis, which will terminate in proving that for all functions which have a certain degree of continuity, and with the exception of certain values of a, fz may be assumed as any function of $z - a$ that has the same evanescent magnitude as $z - a$ itself.

A similar analysis with regard to Q would prove

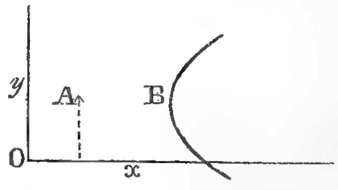
$$Q = \overset{1}{F}(a) + \overset{1}{Q}.f_{,}.z;$$

and continuing this decomposition, and writing x in place of a, we arrive at the theorem

$$Fz = Fx + \overset{1}{F}.x.fz + \overset{2}{F}x.\overset{1}{f}.z + \&c. \ldots \overset{n}{Q}.\underset{n}{f}.z$$

of the co-ordinates, we derive $y = b$, a real existence, from the first, and $y = b + a\sqrt{-1}$ from the second; which last value of y is as completely imaginary as $y = a\sqrt{-1}$.

This distinction, and its loss when the geometrical illustration is departed from, will be seen in the annexed figure, where, as there are no points of the curve existing between the conjugate point A and the vertex of the branch B, the squares, or any other functions of such non-existent co-ordinates, must be wholly imaginary. Representing these co-ordinates, however, by $y = a\sqrt{-1}$, their squares become real; and thus it is evident that in applying algebra to geometry we do, *usually*, superadd to imaginary quantities, or to such quantities when used in certain ways, the condition that no functional operation is to be regarded as removing the absurdity. It is this property for which a sign is wanted, in order to complete the theory of correlation, and thus to remove all difficulty which has arisen from regarding $\sqrt{-1}$ as a sign of perpendicularity.



where not only $\overset{1}{f}z$, $\overset{2}{f}z$, &c., vanish for $z = x$, but they are composed of factors $f_{\backslash}z.fz$, $f_{\backslash\backslash}z.f_{\backslash}z.fz$, &c., each of which vanishes when z is equal to x.

Viewed analytically, it will thus follow that

$$fz,\ \overset{1}{f}z,\ \overset{2}{f}z,\ \&c.\ \ldots\ \overset{n}{Q}$$

are functions arranged in the order of their magnitude, although we could not thence conclude that, in all cases, these functions form a converging series when z was taken infinitely near to a.

To examine this question, and to show under what circumstances $\overset{n}{f}z$ becomes of the form $\overset{n}{\varepsilon}, (z - x,)$ it will, perhaps, be most convenient to substitute h for $z - x$, or to examine when $F(x + h)$ expands under the form

$$Fx + \overset{1}{F}x.\ \overset{1}{\xi}h + \overset{2}{F}x.\ \overset{2}{\xi}h\ \ldots\ \overset{n}{Q}.\ \overset{n}{\xi}(h). \qquad (8)$$

And with this purpose we must commence with the expansion

$$F(x + h) = Fx + \overset{1}{R}$$

where $\overset{1}{R}$ is a function of x and h that is merely limited to vanish when $h = 0$.

Now, we observe that if Fx possesses a continuity of the first order, or if it possesses such a continuity between the limits $x = a - n\varepsilon$ and $x = a + n\varepsilon$, we can apply to it the idea attached to a rate of increase, and can ascertain when this increase is fastest or slowest; to illustrate which further, we remark that, if the function was expressed geometrically, the portion in question would evidently be a continuous curve, osculating with some straight line, and increasing faster or slower with the position of the latter; but, as the appeal to geometry is justly considered foreign to the subject, and does not apply to imaginary functions, where we must consider separately the increase of the real and of the imaginary part, we must use, in place of this illustration, the numerical expression of the function by means of tables.

Let its form be

$$P + Q\sqrt{-1}\ ;$$

then if, when we substitute for z the successive values $a \pm \varepsilon$, $a \pm 2\varepsilon$, &c., P and Q are found to approach to some definite rate of increase as ε is taken smaller and smaller, or, at least, if they so far approach to a definite rate of increase that we can assert the alterations to be faster or slower in one part of the portion than in another part; or, again, that such rate is the same throughout the whole portion, in either of these cases the portion has a continuity that is finite and of the first degree.

Denote by a the value of z corresponding to that part of the portion where the alteration of one of the terms P or Q is not exceeded in slowness by the values of P or Q either there or at any part of the portion, and assume

$$\xi h = F(a+h) - Fa,$$

it is then clear that

$$\frac{F(x+h) - Fh}{F(a+h) - Fa}$$

can never become infinite between the required limits, supposing, as is always done, that h does not exceed the small values employed in estimating the rates of increase above mentioned.

We thus prove that ξh is a factor of the function

$$\{F(x+h) - Fx\}_{x=a-\varepsilon\,\ldots\,a+\varepsilon}$$

and, consequently, that we may write

$$F(x+h) = Fx + Q.\,\xi.\,h$$

But it will follow from this equation that whatever function Q is of x and h, it must also, between the required limits, have a continuity of the class which we have assumed for $F(x+h)$. As will be seen by considering that a finite and definite increase of $F(x+h)$ will require a finite and definite increase in $Q.\,\xi(h)$ or $\overset{1}{R}$, and that as $\xi(h)$ has been so assumed as to increase in this manner, Q must do so likewise.

By this reasoning we therefore establish that all the functions $\overset{1}{\xi}h$, $\overset{2}{\varepsilon}h$, &c., are continuous functions of the first order, and may be taken not to contain x; whence it appears that the development (8) is just; that it constitutes a converging series when h is sufficiently small; and that $\overset{n}{Q}$ is of less magnitude than any of the terms which precede it, and may be made as small a portion of the whole as we please by taking h within proper limits.

Having thus established the equation

$$\{F(x+h) = Fx + \overset{1}{\xi}h.\,\overset{1}{F}(x) + \overset{2}{\xi}h.\,\overset{2}{F}(x) + \&c.\ldots R\}_{x=\underset{\backprime}{x}\,\ldots\,\underset{\backprime\backprime}{x}}$$

for all functions that have between $\underset{\backprime}{x}$ and $\underset{\backprime\backprime}{x}$ a continuity of the first order, and excluding from such continuity all serpentine forms that have infinitely small periods,* we proceed to investigate some of the simplest of the series

$$\overset{1}{\xi}(h),\ \overset{2}{\xi}(h),\ \overset{3}{\xi}(h),\ \&c.$$

* The rates in such forms would not become definite as ε was decreased.

Now, repeatedly substituting x + h for x, we obtain

$$F(x + n h) = F(x) + n\,\xi(h).\,\overset{1}{F}x + \overset{n}{R}$$

and, on the contrary, by putting n h for h in the expansion of F (x + h,) we also deduce

$$F(x + n h) = F(x) + \xi(n h)\,\overset{1}{F}x + \overset{n}{R}.$$

Whence the right hand members of these two equations may be equated; and as each is arranged in the order of its magnitude, we must have, by what has preceded, the first terms of the same magnitude, and consequently only differing by functions of magnitudes higher than their own. And from this, again, it follows that, by removing from the first to the higher terms in either series, magnitudes that shall leave the order undisturbed, we may render the first terms in the two series identical. Whence, writing k for n h, making h constant, and denoting $\frac{\xi h}{h}$ by c; and finally, representing, still, by ξk what ξk becomes after removing the terms in question, we have

$$c k = \xi k.$$

And as the constant c may be taken from ξk, and made a factor of $\overset{1}{F}x$, it appears, at length, that we have

$$\{F(x + h) = F x + h.\,\overset{1}{F}.\,x + \overset{1}{R}.\}_{\substack{x = x_{\prime} \ldots x_{\prime\prime} \\ h = \varepsilon_{\prime} \ldots \varepsilon_{\prime\prime}}}$$

where $\varepsilon_{\prime}$ and $\varepsilon_{\prime\prime}$ are quantities as small as may be necessary.

Denoting $\overset{1}{F}x$, according to the usual notation, by $d_x F x$, or, more simply, by $d_x F.$, the equation

$$\{F(x + h) = F. + d_x F. + \overset{1}{R}\}_{x = x_{\prime} \ldots x_{\prime\prime}} \qquad (9)$$

manifestly suffices to establish all that is commonly taught in our text books concerning first differentials, as well as so much of the theory of the higher differentials as regards them merely as the differentials of differentials, and not as the superior terms in Taylor's Theorem.

The nature of these last might now be investigated by a method very similar to that which Poisson employs for the same purpose, but the process may be shortened by having recourse to the differential calculus as establishing in the expansion (9)*

Thus it is shown in all our elementary works that

$$d^n_x F(x+h) = d^n_h . F(x+h):$$

and we may also show that when terms are arranged in the order of their magnitude, their differential coefficients have the same arrangements—propositions that will suffice for the investigation in question.

To prove the latter of these propositions we remark—that if ϕx and ψx are functions arranged by their magnitude

$$\left\{ \frac{\psi x}{\phi x} = 0 \right\}_{x=0}$$

for every value of x that makes $\psi x = 0$; but

$$\left\{ \frac{d_x \psi x}{d_x \phi x} = \frac{\psi(x+h) - \psi x}{\phi(x+h) - \phi x} = \frac{\psi(h) - 0}{\phi(h) - 0} = \frac{\psi . h}{\phi h} = 0 \right\}_{\substack{x=0 \\ h=0}}$$

where the order of the successive substitutions $x = 0$, $h = 0$, is indicated by their symbols below the right hand bracket.

To apply these propositions to the investigation of $\overset{2}{\xi} h$, $\overset{3}{\xi} h$, &c., denote the latter by $\overset{1}{H}$, $\overset{2}{H}$, &c., and write

$$W = F(x+h) = F + h d_x F + \overset{1}{H}.\overset{1}{P} + \overset{2}{H}\overset{2}{P} + \&c. \ldots R';$$

when we shall have

$$d_x W = d_x F + h d^2_x F + \overset{1}{H} d_x \overset{1}{P} + \&c. \ldots d_x R$$

$$d_h W = d_x F + d_h \overset{1}{H}.\overset{1}{P} + d_h .\overset{2}{H}\overset{2}{P} + \&c. \ldots d_h R:$$

and as these terms are arranged in the order of their magnitudes, the equation

$$h d^2_x F + \&c. = d_h \overset{1}{H} \overset{1}{P} + \&c.$$

will have the first term on the right hand, of the same magnitude with that on the left: whence it follows that by removing parts of these terms that do not

* I owe this remark to Mr. Z. P. Powers, who supplied the proof that the differential coefficients of terms arranged in the order of their magnitude, are also themselves arranged in the order of their magnitude.

change their order, and by annexing these parts to terms higher in the series, we might at length render

$$h.d_x^2 F = d_h \overset{1}{H}.\overset{1}{P};$$

and by cancelling these equal terms, and reasoning in the same manner, arrive ultimately at the equation

$$\overset{n-1}{H} d_x \overset{n-1}{P} = d_h . \overset{n}{H} \overset{n}{P}.$$

The first of these two equations is satisfied by the functions

$$\overset{1}{H} = \frac{h^2}{1.2}, \overset{1}{P} = d_x^2 F.$$

and the second by

$$\overset{n-1}{H} = d_h \overset{n-1}{H}, \overset{n}{P} = d_x . \overset{n-1}{P}.$$

whence we conclude that

$$\overset{n-1}{H} = \frac{1}{1.2\ldots n} h^n, \overset{n-1}{P} = d^n F.$$

and that *one* of the prime developments of F (x + h) is

$$F + h.d_x F + \frac{h^2}{1.2} d^2 F + \&c. \ldots$$

A very common, and, it appears to me, a universal error committed in demonstrating this theorem, consists in regarding the function $\frac{h^n}{1.2\ldots n}$ as the only classifying function by which such an expansion could be made; whereas not only is $\sum_{z=n|0} \overset{z}{A} h^z$,* a function that equally satisfies our differential equations, but, as we have already remarked, those very equations are unessential to the problem, since any function of the *order* h^n could have been made to supply its place. This error, it appears to me, lies not so much in a want of knowledge of the fact here stated, as in a total omission of that fact in the demonstrations of the theorem, whereby it necessarily follows that such demonstrations are made to prove too much.

In concluding this part of my subject, I may, perhaps, be permitted to detain the attention of the reader for a moment, by referring him to an error somewhat similar in the usual extensions of Newton's Binomial Theorem. This expansion, when confined to integral and positive indices, expresses merely that special case of the equivalence

* $\overset{n}{A}h^n + \overset{n-1}{A} h^{n-1} + \&c. \ldots \overset{1}{A}h^1 + \overset{0}{A}.$

$$\overset{2}{\underset{z=c\,|\,n}{\Sigma}}\ (x-\underset{z}{r}) = \overset{1}{\underset{z=o\,|\,n}{\Sigma}}\ .\ \overset{z}{P}\, x^z \ *$$

wherein all the factors are equal. Such an equivalence we know is just for every value of the variable, whereas when, by analogy, or any other species of proof, we extend the like proposition to negative or fractional indices, the remainder must now be taken into account—or otherwise the proposition must be limited to values of x that make the right hand member converge, when one equation becomes

$$\left\{ \overset{2}{\underset{z=1\,|\,n}{\Sigma}}\ (x-\underset{n}{r}) = \overset{1}{\underset{z=0\,|\,n}{\Sigma}}\ \overset{z}{P}\, x^z \right\}_{x=-\underset{\cdot}{x}\ldots+\underset{\cdot\cdot}{x}}$$

The same error, of course, occurs wherever remainders are neglected; neither is the error here exactly of the kind that I have been noticing in Taylor's Theorem; but I have instanced it as a very familiar case in which, also, our usual demonstrations prove too much.

That whatever functions are used in Taylor's Theorem in place of the classifying function $\frac{h^n}{1.2\ldots n}$, they must be of the same order with the latter, will be seen by considering that the form arrived at was deduced by such mere transpositions of secondary parts as did *not* alter the arrangement of the several terms.

And having thus shown that this celebrated development is truly the development of monoramic functions of the first order of continuity, and according to the prime factors of their several parts, I shall now proceed, in a few words, to consider how far the expansion is prime. This condition is essential to all the applications of the theorem, and yet no other notice of it is taken in our text books than such as relates to the terms obtained by integration, or those on the left hand of a given term, when the development proceeds from the latter, and with regard to which an omission is always made.

That the series derived from the left hand to the right is prime, immediately follows by the usual reasoning employed to show that series are identical. For, if F $(z + h)$ would expand in two series $\Sigma \overset{z}{P} h^z$, and $\Sigma \overset{z}{Q} h^z$, we should have the equation

$$\Sigma (\overset{z}{P} - \overset{z}{Q})\, h^z = 0$$

* $\overset{2}{\Sigma}$ expresses a series of factors, as Σ or $\overset{1}{\Sigma}$ does of terms.

which, by what we have already shown, would give

$$\overset{z}{P} = \overset{z}{Q}.$$

But if we suppose the development to commence with one of the terms of the expansion, as d^n_x F (x), and thence demand the most general form of the terms on the left, we shall observe that the investigation of LAGRANGE fails in generality, and that the consequence deduced from it, that only a constant can have all its differential coefficients equal to zero for the same value of x, is neither just in itself, nor so great a paradox when violated as Mr. PEACOCK seems to suppose.*

Indeed, including in modal functions of the first order of continuity such as have a portion absolutely rectilinear, and which depart thence into a curve by insensible gradations, it is clear that if we can find a numerical representative F x of such a modal function, Taylor's Theorem would hold throughout its whole extent, and that consequently Fx, a function which is not a constant, would yet fulfil the equation

$$\{d^n_x \, (F.x = 0\}_{x = x_{,} \ldots x_{,,}} \qquad (10)$$

for every value of n.

The very simple function $\frac{2}{\pi}$. F x. $\tan.^{-1} (0)^{a-x}$ is constantly zero from $x = -\alpha$ to $x = a$, and constantly equal to F x from $x = a$ to $x = \alpha$; and thus affords an elementary case of a function fulfilling the equation (10): but it should be remarked that as the transition takes place in an infinitely small interval, this function does not fall under the first order of continuity.

This example I have taken from the pamphlet before mentioned, and all that it is necessary to say further on the subject, may be taken from the same source.

"We see therefore," it is remarked, "that with proper limitations, which, too, are only necessary in regard to functions of a low order of continuity, we may assert that a constant is the only function that can give the first differential zero; and this granted it is easily seen that $a\,x + a'$ is the only function that can give the first differential a constant. For, let ϕ x be any other function that also gives $d_x \, \phi\, (x) = a$; we have

$$d_x \left\{ \phi\, x - (a\, x + a') \right\} = 0;$$

* See what has been already said on the function $e^{-\frac{1}{x^2}}$

whence

$$\phi x - (a x + a') = c$$

or

$$\phi x = a x + (a' + c) = a x + a'.$$

And, in like manner, if ϕx is a function that has its third differential coefficient equal to zero, we may write

$$d_x^2 \left\{ \phi x - (a x^2 + a' x + a'') \right\} = o$$

$$d_x \left\{ \phi x - (a x^2 + a' n + a'') \right\} = c$$

$$\phi x - (a x^2 + a' x + a'') = c x + c'$$

$$\phi x = a x^2 + a' x + a''$$

whence it appears that $a x^2 + a' x + a''$ is the only function, excepting those of the class already mentioned, which has its third differential coefficient equal to zero. And, proceeding in like manner, we find

$$\sum_{z = 0 | n-1} a^{'' \cdots z}. x^z$$

to be the only function which has its n^{th} differential equal to zero, the exception above mentioned being still kept in mind, and which is removed by substituting for each of the constants, functions that are constants between the limits assumed, and of arbitrary values beyond those limits.

Now suppose

$$d_x^n F x = d^n \phi x$$

we can divide ϕx into two parts, $F x$ and ψx, and write

$$d_x^n F x = d_x^n (F x + \psi x);$$

but this equation gives

$$d_x^n \psi x = 0$$

whence we conclude that

$$\phi x = F x + \sum_{z = 0 | n-1} a^{'' \cdot \cdot z} x^2$$

is the only function that can give the equation

$$d_x^n \phi x = d_x^n F (x)$$

or the terms to the left of $d_x^n F x$ in Taylor's Theorem become prime on adding the customary function, and substituting for the constants it contains, functions of the class we have described."

The occasion of Taylor's Theorem failing for special values of x is manifestly by such values destroying M in a term

$$\frac{h^n}{M + N \xi h}$$

that enters the remainder, and thus introducing a new term $\frac{h^n}{\xi h}$. The manner of obtaining the coefficients of such terms, and of thus extending the expansion beyond the monoramic functions of the first order of continuity, must now occupy our attention.

And on this point we may remark, that if in place of h^n we use for our classifying function any expression that fulfils the equation

$$\overset{m}{D}.\, fh = 0 \qquad (11)$$

for all values of m that exceed n, and which is unity for m = n, we shall immediately obtain the coefficient sought by performing the operation $\overset{m}{D}$ on both sides of the equation.

This operation, D, is supposed to be of that class which makes the operation performed on the sum of any number of terms equal to the sum obtained, by performing the operation on each separately; a condition conveniently expressed by the notation

$$D\,\Sigma = \Sigma\, D.$$

Now suppose F x the function expanded; $\overset{n}{F}$ the same function diminished by subtracting all the terms of the expansion up to the n^{th}; and $\overset{n}{f}x$ the classifying function: in other words, let there be

$$F\,x = \overset{1}{P}\,\overset{1}{f}x + \overset{2}{P}.\overset{2}{f}x + \overset{3}{P}.\overset{3}{f}x \ldots \overset{n}{P}\,\overset{n}{f}x \ldots$$

$$\overset{n}{F} \;= \overset{n}{P}\,\overset{n}{f}x + \&c.$$

and it will follow, if $\overset{n}{f}x$ fulfils the equation (11,) that

$$\overset{n}{P} = \overset{n}{D}\,\overset{n}{F}.$$

In the instance before us the function to be expanded is F (x + h;) and the classifying function h^n, where m may be positive or negative, whole or fractional; and all these cases will be included by supposing the values of n to constitute the series

$$-\frac{p'}{q'}, -\frac{p''}{q''} \ldots\ldots + \frac{p''^{\cdot\cdot i}}{q''^{\cdot\cdot i}}, + \&c.$$

Now, supposing μ to be the least number which is divisible by all the denominators, and denoting the quotients by μ', μ'', &c., it is clear that an operation $\overset{n}{D}$ which fulfils the equation (11) will consist in substituting k^μ in place of h, multiplying by $k^{p'\mu'}$, differentiating n times, and making k equal to zero. Whence

$$\overset{n}{P} = \frac{1}{1.2\ldots.n}. \, d^n_k. \, k^{p'\mu'} F (x + k^{\mu})_{k=0} \tag{12}$$

We have already remarked that the expansion of Fz by powers of z — x seems to be more truly the algebraic development, than the form which this expansion assumes when presented as Taylor's Theorem—the one is the development of a general monomial, the other a general trinomial function—and it seems a more natural order to deduce the latter from the former, than to follow a converse process. The substitution of z — x for h does affect the coefficients, and thus we may write

$$F.z = \Sigma \frac{(z - x)^n}{1.2\ldots.n}. \, d^n_k. \left\{k^{p'\mu'}. \, F (x + k^{\mu})\right\}_{k=0}. \tag{13}$$

where p′ is minus, the numerator of the least value of n, supposed always to be zero unless n is negative—and μ is the least number divisible by the denominators of n.

I shall not increase the size of this paper, which has already extended itself to such undue limits, by exemplifying the use of this theorem, in determining the values of vanishing fractions, or in general of functions at their critical values; but I may remark here the light which it throws on fractional differentials.

The proposition

$$F (x + h) = \Sigma \, d^n_x F (x). \frac{h^n}{1.2\ldots n}$$

is certainly that from which we obtain our only notion of a differential coefficient; and thus, were we to embrace Mr. PEACOCK's theory of the permanence of equivalent forms, it would follow that d^n_x F x was the coefficient of the n^{th} term in the expansion of F (x + h) whether n was positive or negative, whole or fractional; and, consequently, that in all but a certain class of transcendents d^n_x F x was zero whenever n was other than whole and positive. Such a result would be at variance with the received theory of fractional differentials, as would likewise happen with the values given by that theory and the formula (12) in those cases where the fractional powers appeared in the expansion.

I do not mean to deny that artifices and conventions can be made, and artifices and conventions that are perfectly allowable, whereby these seeming discrepancies would be reconciled; but I hold that such a process belongs to the doctrine of correlations—a doctrine greatly misunderstood by the writer in question. It is the office of correlations to group together by means of such conventions as are here mentioned, problems otherwise distinct; but it is equally its office to assign what groups of problems are to be separated—and to give to every form that exact limit of permanence, which will ensure a union of generality with despatch and clearness.

It would add greatly to the precision of mathematical science, if the received arrangements that compose the branch commonly designated as the calculus, and which I have called the received arrangements of numerical logic, were kept perfectly distinct from those which are yet subjects of inquiry. The latter are proper matters of investigation for the pioneers of the pure science, but their theory should form a distinct department of analysis, to which no appeal should be made in the reduction of modal relations. And in this class of doubtful and incomplete generalizations, which it may hereafter be advisable to reject or admit, it appears to me that we must place fractional differentials, encumbered as they are with an infinite series of arbitrary corrections.

A single additional remark, arising from the development we have been contemplating, may perhaps be permitted me before I close this paper. I allude to the error which several recent and distinguished writers have made, in regard to the nature of the remainder involved in such expansions. The formulæ very commonly used to express such remainders, give nearly the sum of the *developable* portion of the function, reckoned from the n^{th} term to infinity, whilst it is evident that to answer the purpose for which these formulæ are employed, they must include, not this portion alone, but more especially that which will *not* develope in the required form. An instance will render this remark sufficiently clear.

Assuming $h^{\frac{1}{2}}e^{\theta\sqrt{-1}}$ for h in Taylor's Theorem, and $h^{\frac{1}{2}}e^{-\theta\sqrt{-1}}$ for h in the expansion of $\frac{1-h^n}{1-h}$ we have evidently

$$\frac{1}{2\pi}\int_{0|2\pi} \frac{h^{\frac{n}{2}}e^{-n\theta\sqrt{-1}}}{1-h^{\frac{1}{2}}e^{-\theta\sqrt{-1}}} \cdot F\,(x+h^{\frac{1}{2}}.e^{\theta\sqrt{-1}})\,d\theta$$

for the value of the remainder from the n^{th} term to infinity, but it is equally evident, that such an expression does not comprehend the negative or fractional exponents, or in short, any of those which cause Taylor's Theorem to fail; yet numerous expressions of this kind are given without this limitation, and among others, I may mention one readily deduced from the above which that excellent analyst Mr. MURPHY has given in the Philosophical Transactions.

The theorem above given may be conveniently put under the form

$$\frac{1}{2\pi}\int_{0}^{2\pi}\frac{\left(\frac{h}{k}\right)^{n} e^{-n\theta\sqrt{-1}}}{1-\frac{h}{k}e^{-\theta\sqrt{-1}}} F\left(x+k^{\theta\sqrt{-1}}\right) d\theta,$$

where the limitation is that $\frac{h}{k}$ shall be less than unity, and h and k each sufficiently small to make F (x + h) and F (x + k) converge.

NOTE.

While this paper was going through the press, the ingenious and distinguished author fell a victim to a disease under which he had long suffered; his death occurring on the 31st of October, 1840. The first proofs only were subjected to his examination, and he was then so ill that some apology may be necessary for errors of the press in the earlier, as well as the later parts of the paper. Mathematicians will be struck by the circumstance that the formulæ are printed in Roman instead of Italic letters,—a deviation from the usage which was not observed by the author until it was too late to have it corrected.

ARTICLE XVI.

Notice of the Oolitic Formation in America, with Descriptions of some of its Organic Remains. By Isaac Lea. Read May 15, 1840.

Baron Humboldt, in his "Geognostical Essay on the Superposition of Rocks in both Hemispheres," mentions having met with the Jura Formation (Oolite of English geologists) in Venezuela and other districts of Colombia, as well as at Zacatecas, in Mexico; but I am not aware of any organic exuviæ having been described from this formation in the western hemisphere.

Some years since, my friend, Dr. Gibbon, was appointed to attend a public mission to Bogota, and, at my solicitation, kindly undertook to collect such specimens in geology and zoology as he should think might interest me. Among many other objects brought by him, I was very much surprised to find several specimens of well characterized fossils of the Oolitic series, not being then aware of any one having observed any part of that geological epoch in our hemisphere. Other more pressing occupations have caused me to defer the final examination of these interesting specimens until recently. On comparison with the fossils of the Oolite in my cabinet, from England, I find the mass possessing the same mineralogical characters, being argillo-calcareous, accompanied, occasionally, by sulphuret of iron, and the organic forms to be of the same genera. The well known genus *Trigonia* presents several species, one of which has a close resemblance to *Trigonia clavellata*, which, in Europe, is distributed through many different beds of this group. The *Ammonites*, also, seem to prevail, as in the mass of the same period in England, there being at least five species among the few specimens brought by Dr. Gibbon.

The extent of this formation in Columbia was not observed by Dr. Gibbon, nor were any observations made as regards the dip of the strata, or its direction. The labels accompanying the specimens stated that they were taken up in the road between Popoyan and Bogota, chiefly between La Messa and Tocaima. Specimens thus collected could scarcely be expected to be found perfect, and it is to be regretted that these are not better characterized. Such as they are, I have ventured to describe them, with a hope of drawing the attention of some geologist who may pass through that country and observe the deposit with attention. The mineralogical character of the specimens are very uniform, consisting of a dark slate-coloured argillaceous carbonate of lime, occasionally accompanied by crystallized sulphuret of iron.

In these few imperfect specimens we have an illustration of the importance, nay, the absolute necessity, of a knowledge of the geo-zoological characteristics to establish the age of the masses after a certain period. Zoological evidence is the unerring guide to designate the different epochs. The importance of this is established in a paper on the Age of the Limestones of South Devon, recently read by Mr. Lonsdale before the Geological Society of London. In this paper we are informed that Captain Smee and Captain Grant had recently brought to England, from Cutch, and the desert east of it, suites of fossils from "a series of beds unquestionably of the age of the Oolites of England, the fossils agreeing, in their general characters, with those of that geological epoch" in that country, and "being, in many instances, specifically undistinguishable;" thus establishing the fact of the deposits of the Oolitic period being immensely extended, and proving, with the specimens now produced, that the unity of the zoological existence of that period extended nearly, if not entirely round the globe.*

In Dr. Troost's Fifth Geological Report to the Legislature of Tennessee (p. 6) he mentions a limestone of "an *Oolitic* structure" as existing near the Cumberland Mountains. He states that the Oolite of the English geologists is of "a more recent group," and that his Oolitic limestone is invariably found

* Professor Vanuxem informed me recently that he picked up, some years since, a fossil *Trigonia* near the ruin of a building in the city of Mexico. It had evidently been part of the structure, and probably carried from some distance, as the rock over which the city is built is entirely volcanic.

beneath the coal strata. It is characterized by *Pentremites*, a fossil which has not been, I believe, observed above the carboniferous limestone.*

Orthocera Humboldtiana. Plate VIII., Fig. 1.

Testâ rectâ, elongato-conicâ, subcylindraceâ; articulis transversis, subdistantibus.

Shell straight, elongately conical, nearly cylindrical; joints transverse, rather distant.

Found in the Province of Velez, New Granada. Dr. Gibbon.
My Cabinet.

Remarks.—Unfortunately, I received only an imperfect fragment of this *Orthocera*. It is important in connexion with these fossils, as it proves them to belong to the lower series of the Oolitic group. De la Beche mentions one only, O. elongatum, as being found in the Oolitic group, and that in its lowest member, the Lias, while below that, as far down as the Transition Limestone, they are common. I propose the name of the distinguished American traveller for this species.

Ammonites Tocaimaensis. Plate VIII., Fig. 2.

Testâ orbiculari; anfractibus planulatis, transversim costulatis; costis planulatis; periphæriâ minutè sulcatâ.

Shell orbicular; whorls flattened, transversely ribbed; ribs flattened; periphery minutely furrowed.

Found on the top of a mountain between Tocaima and La Messa, in New Granada. Dr. Gibbon.
My Cabinet.

* Since the completion of this paper I have received the beautiful work of Von Buch on some of the fossils taken to Europe by Humboldt, from New Granada. I owe to the kindness of the author the opportune acquisition of this volume. His *Trigonia alæformis* may be identical with *T. Tocaimaana* (nobis.) In other cases the specific forms seem to differ.

Von Buch takes a different view from Humboldt as regards the age of these organic remains, placing them rather higher, and in the chalk formation. They certainly do not resemble the forms common to our chalk fossils, nor do they seem to me to be allied to those of England, so far as I am acquainted with them. Notwithstanding the arguments deduced by the author, I still am of opinion that the fossils brought by Dr. Gibbon from New Granada, and herein described, are properly members of the Oolitic group.

Remarks.—A small portion only of a whorl of this species was received. It differs from *A. Gibbonianus* in being more flattened, and in having a very minute furrow, being little more than a mere impressed line.

AMMONITES GIBBONIANUS. Plate VIII., Fig. 3.

Testâ orbiculari; aufractibus compressis; costis elevatis, carinatis, remotiusculis ad periphæriam.

Shell orbicular; whorls compressed; ribs elevated, carinate, somewhat distant at the periphery.

Found between Tocaima and La Messa, New Granada. Dr. Gibbon.
My Cabinet.

Remarks.—A small section only of this large species was brought by Dr. Gibbon, after whom it is named. The few characters which can be seized in such a specimen render a description very meager and doubtful.

AMMONITES OCCIDENTALIS. Plate VIII., Fig. 4.

Testâ orbiculari, utrinque umbilicatâ; aufractibus rotundatis, transversim costulatis; periphæriâ rotundâ, sulco circulari destitutâ.

Shell orbicular, umbilicate on both sides; whorls round, transversely ribbed; periphery round, being destitute of a circular furrow.

Found in the Province of Velez, New Granada. Dr. Gibbon.
My Cabinet.

Remarks.—A single imperfect specimen only was brought by Dr. Gibbon. One of the chambers has been removed without injury to the other parts. It is destitute of a carina and furrow.

AMMONITES VANUXEMENSIS. Plate VIII., Fig. 5.

Testâ orbiculari, utrinque umbilicatâ; aufractibus convexo-cylindricis, transversim crebrissimèque costulatis; periphæriâ rotundâ, sulco circulari destitutâ.

Shell orbicular, umbilicate on both sides; whorls convexly cylindrical, transversely and thickly ribbed; periphery round, being destitute of a circular furrow.

Found in the Province of Velez, New Granada. Dr. Gibbon.
My Cabinet.

Remarks.—A small species with numerous ribs, which are alternately duplicated on the outer part of the whorl. It is destitute of a carina and furrow. I name it after my friend Professor Vanuxem, the distinguished geologist.

Ammonites Americanus. Plate VIII., Fig. 6.

Testâ orbiculari; aufractibus subplanis, obliquè costulatis; periphœriâ sulcatâ.

Shell orbicular; whorls somewhat flattened, obliquely ribbed; periphery furrowed.

Found on the mountains between Tocaima and La Messa, in New Granada. Dr. Gibbon.
My Cabinet.

Remarks.—A portion only of a single whorl of this species is before me, and the description is necessarily imperfect. It is distinct from the other species which accompanied it, in being furrowed. The furrow is not very distinct, and an imperfect carina seems to be connected with it.

Trigonia Gibboniana. Plate IX., Fig. 7.

Testâ ovato-trigonâ, multicostatâ; costis transversis, sub tuberculato-asperis; areâ carinatâ.

Shell ovately triangular, many ribbed; ribs transverse, somewhat roughly tuberculate; posterior slope carinate.

Province of Velez, New Granada. Dr. Gibbon.
My Cabinet.

Diam. 1.5, Length 2, Breadth 2 inches.

Remarks.—In outline and size this species resembles Parkinson's figure of *T. spinosa,* (Vol. III., Pl. XII., Fig. 7,) which is described by Lamarck as *T. scabra.* Neither of the two specimens in my possession are very perfect. The tubercles on the ribs of the larger and broken specimen are more observable. In these tubercles it has some resemblance to *T. dœdalœa,* Sow. and Park.

Trigonia Tocaimaana. Plate IX., Fig. 8.

Testâ trigonâ, posticè productâ, inflatâ; costis transversis, lævibus.

Shell triangular, produced behind, inflated; ribs transverse and smooth.

Found between Tocaima and La Messa, New Granada. Dr. Gibbon.
My Cabinet.

Diam. 1.5, Breadth 1.3 inches.

Remarks.—Both the specimens received of this species were, unfortunately, quite imperfect. In both, the posterior angle is deficient. Judging from the curves of the margin, I presume that this species is produced like the *T. aliformis.* (Parkinson, Pl. XII., Fig. 9.) It resembles it, also, in outline, and in the position and direction of the ribs.

Trigonia Hondaana. Plate IX., Fig. 9.

Testâ ovato-trigonâ, inflatâ, multicostatâ; costis transversis, tuberculato-nodosis; areâ posticâ elevatâ, crebrissimâ nodosâ.

Shell ovately triangular, inflated, with many ribs; ribs transverse, furnished with tubercles; posterior slope elevated, with numerous tubercles.

Found between Guaderus and Honda, New Granada. Dr. Gibbon.
My Cabinet.

Diam. 2.3, Length 3.3, Breadth 3.2 inches.

Remarks.—This is larger than any species which has come under my notice. A single; rather imperfect, specimen only was brought by Dr. Gibbon. In its general outline and appearance it resembles *T. Gibboniana*, herein described, and may prove to be only an old and very large individual of that species.

Natica Gibboniana. Plate IX., Fig. 10.

Testâ ovatâ, ventricosâ; spirâ productiusculâ; aufractibus quinis, subplanulatis; aperturâ contractâ, elongatâ.

Shell ovate, inflated; spire rather produced; whorls five, rather flattened; aperture contracted, elongate.

Found on the top of a mountain between Tocaima and La Messa, in New Granada. Dr. Gibbon.

My Cabinet.

Diam. 1.3, Length 1.5 inches.

Remarks.—This is the only spiral species brought by Dr. Gibbon among the fossils from Colombia. It is the more interesting, as the Oolitic formation is the first in which this genus appears in Europe. Mr. Smith, in his "Strata Identified," figures, on his plate of the "Coral Rag and Pisolite," an *Ampullaria*, (Fig. 2,) which resembles, in form, this *Natica;* and I think that De la Beche means this when he quotes *Natica arguta.*, Smith, as existing in the Coral Rag, as Woodward does also.

Spatangus Colombianus. Plate IX., Fig. 11.

Sp. ovato-cordatus, gibbus, convexus, anticè planulato; ambulacris quinis, lanceolatis, transversim punctatis.

Sp. ovately cordate, gibbous, convex, flattened before; ambulacra five, lanceolate, transversely punctured.

Found in the mountains between Tocaima and La Messa, New Granada. Dr. Gibbon.

My Cabinet.

Height .9, Length 1.4, Breadth 1.3 inches.

Remarks.—A single specimen only was received, and it seems to be different from any which has been described.

THE OOLITE OF CUBA.

Within a few years I have received specimens of organic remains from two friends in Cuba. On examination I found part of them to belong to the Oolitic group, and, most probably, to the higher members of it. Those from near

Havanna were from Mons. Poey, under whose charge the Botanic Garden has been placed; those from Matanzas were from my friend Louis Vanuxem, Esq., and are from deposits of a more recent formation, being of a white limestone.

It is evident that Baron Humboldt had this formation in his mind in making the following observations:—"I thought I recognised in the equinoctial zone of America the Jura formation in several whitish limestones, partly lithographic, with a fracture smooth and dull, or very flat conchoidal. These are the limestones of the cavern of Caripe, (S. E. of Cumana,) the shore of Nueva Barcelona, (Venezuela,) the Isle of Cuba, (between the Havanna and Batabano; between Trinidad and the boca del Rio Guaurabo,) and the central mountains of Mexico, (plains of Salamanca and the defile of Batas.")

The specimens now described and figured are not all from the same group, and with so small a number it would be difficult, if not impossible, to arrange them correctly in their exact superposition. These are, however, sufficient to confirm the impression of the distinguished traveller that the Jura formation (Oolite) existed in Cuba. In another paper I have shown that the lower members of the Oolitic group are identified in New Granada. Future observations, with more extended means than a few specimens of a small number of species affords, will, I have little doubt, enable the geologist to make out the whole Oolitic group in America to be similar in its characters to that of Europe. In the few specimens under examination it will be perceived that the generic forms coincide with those found in the Oolite of England; and it is a matter of doubt with me if the specific characters of some be not identically the same. Thus the *Terebratula*, which I propose to call *Cubaensis*, seems to me so closely to resemble a *Terebratula* of which I have specimens from Dundry, in England, that I should not now propose a separate place for it, but that it may be the more readily distinguished and referred to. The fracture of a *Belemnite* among the specimens received presents no characters which can be observed different from those of the Oolite of England, and, therefore, will not be farther noticed.

De la Beche on the Geology of Jamaica (Geol. Soc. Trans., Vol. II., New Series) mentions a "compact white limestone formation" containing "organic remains, generally casts," which he places, with some doubt, with the "Superior, or Tertiary Rocks." Among the forms, he gives, in his list, the *Nautilus*, *Cerethium, Terebratula,* &c. From the white limestone of Matanzas I have some of the same generic forms, and have no doubt of their common origin.

In regard to this white limestone, I should agree with De la Beche, certainly, in not placing it below the Tertiary period. At the same time, we must not confound the rock containing these "casts" with the rocks containing the shells of the genera *Terebratula,* &c. These latter are, I think, of a different origin.

For the casts in my possession I propose the following names:—

Nautilus Cubaensis. Plate X., Fig, 15. Cast of the chamber.
Arca Sillimaniana. Plate X., Fig. 16.
Cucullea dubia. Plate X., Fig. 17.
Chama tortuosa. Plate X., Fig. 18.
Cardium globosum. Plate X., Fig. 20.
" *depressum.* Plate X., Fig. 21.
Conus. latus. Plate X., Fig. 19.

Terebratula Tayloriana. Plate X., Fig. 12.

Testâ triangulari, sulcis longitudinalibus impressis; valvâ inferiore in superiorem reflexâ; margine biplicato.

Shell triangular, with impressed longitudinal furrows; the inferior valve reflected into the superior one; margin doubly folded.

Found near Havanna, Cuba. Mons. Poey.
My Cabinet.

Diam. .7, Length 1, Breadth 1.2 inches.

Remarks.—This is an interesting species, and so much like one (name unknown to me) which I have from the Oolite of Dundry, England, that it can scarce be said to differ from it. It seems, however, to be a larger species, and the great flexure of the margin is more oblique. The very bad figure, Pl. VIII., Fig. 15, of Young's "Geological Survey of the Yorkshire Coast," has some resemblance to it. As, also, Dr. Fitton's fine figure of *Terebratula convexa.* "Strata Below the Chalk," Pl. XIV., Fig 12. I name this after R. C. Taylor, Esq., the Geologist.

TEREBRATULA POEYANA. Plate X., Fig. 13.

Testâ elongato-ovatâ, lævi, inflatâ; nate productâ, incurvâ; foramine submagno.

Shell ovately lengthened, smooth, inflated; beak produced, incurved; hole rather large.

Found near Havanna, Cuba. Mons. Poey,
My Cabinet.

Diam. .6, Length 1.1, Breadth .8 inches.

Remarks.—This species very much resembles some of the species of the Green Sand of New Jersey, as well as of the same deposit in England. Dr. Fitton's figure of *Terebratula prælonga*, Pl. XIV., Fig. 14, "Strata Below the Chalk," is somewhat like this shell, but it is longer, and has a furrow which does not exist in the *Poeyana.*

TELLINITES HUMBOLDTIANA. Plate X., Fig. 14.

Testâ scaleniâ, inflatâ, anticè truncatâ; striis transversis, elevatis, remotiusculus, rotundatis.

Shell scaleniform, inflated, truncate before; striæ transverse, raised, somewhat remote, rounded.

Found near Havanna, Cuba. Mons. Poey.
My Cabinet.

Diam. .7, Length .7, Breadth 1.1 inch.

Remarks.—This shell resembles very closely the *Tellinites problematicus*, *Schlottheim*, from Solenhofen; and they may both, perhaps, belong to the same period.

ARTICLE XVII.

Observations to determine the horizontal Magnetic Intensity and Dip at Louisville, Kentucky, and at Cincinnati, Ohio. By John Locke, M. D., Professor of Chemistry in the Medical College of Ohio. Read May 15, 1840.

The following observations were made to determine the relative horizontal magnetic intensities at Louisville, Kentucky, and Cincinnati, Ohio. The apparatus used was that invented by Professor Bache, in which the needles are made to oscillate in a rarefied medium. Two of the needles used (Nos. 1 and 2) were of the model of those of Professor Hansteen; the third (No. 3) was flat, with lozenge points.

Horizontal Intensity.

No. of Needle.	Time of Commencement.	Mean Temp.	Duration of 500 Vibrations.	Calculated duration at 60°.	Square of the Time.	Observations.
Cincinnati, March 7, 1840. *Latitude* 39° 06′ *N.; Longitude* 84° 27′ *W.*						
No. 1	$11^h\ 10^m\ 05^s.6$	56° 64′ F.	25.6666 Min.	25.6777 Min.	659.34428	Cloudy; sprinkles of rain.
2	11 47 04 .4	58 00	25.3733	25.3808	644.18500	do. do. do.
3	12 36 05 .6	60 00	20.6160	20.6160	425.01945	do. do. do.
Cincinnati, March 14, 1840.						
No. 1	$11^h\ 33^m\ 59^s.2$	48° 5′ F.	25.6600 Min.	25.6954 Min.	660.25358	Beginning to rain.
2	12 16 03 .2	45 0	25.3600	25.4151	645.92731	Raining.
3	12 54 59 .2	45 5	20.6066	20.6239	425.34525	do.
Louisville, Ky., March 10, 1840. *Latitude* 38° 03′ *N.; Longitude* 85° 30′ *W.*						
No. 1	$11^h\ 44^m\ 0.2^s4$	59° 50′ F.	25.3333 Min.	25.3363 Min.	641.77777	Clear; brisk N. W. wind.
2	12 20 58 .8	57 50	25.0200	25.0290	626.45084	do. do. do.
3	1 18 00 .0	57 10	20.3333	20.3368	413.58540	do. do. do.
Louisville, March 11, 1840.						
No. 1	$11^h\ 40^m\ 04^s.8$	39° 5′ F.	25.3000 Min.	25.3622 Min.	643.24119	Clear; wind moderate.
2	12 14 04	41 0	24.9733	25.0421	627.10677	do. do. do.
3	12 48 03 .2	43	20.3200	20.3400	413.71560	do. do. do.

By comparing these double suites of experiments made at each of the places, Cincinnati and Louisville, I obtain the following ratios of horizontal intensity:

Cincinnati, March 7th, and Louisville, March 10th, 1840.

	Lou.	Cin.
By needle No. 1, ...	1:	0.9733
" No. 2, ...	1:	0.9723
" No. 3, ...	1:	0.9730

Cincinnati, March 7th, and Louisville, March 11th.

By needle No. 1, ...	1:	0.9755
" No. 2, ...	1:	0.9735
" No. 3, ...	1:	0.9734

Cincinnati, March 14th, and Louisville, March 10th.

By needle No. 1, ...	1:	0.9720
" No. 2, ...	1:	0.9698
" No. 3, ...	1:	0.9723

Cincinnati, March 14th, and Louisville, March 11th.

By needle No. 1, ...	1:	0.9742
" No. 2, ...	1:	0.9709
" No. 3, ...	1:	0.9726
Mean, ...	1:	0.9727

We have, then, the horizontal intensity at Louisville to that at Cincinnati as 1 to 0.9727.

Magnetic Dip.

Cincinnati, March 6th, 1840, 2h. 30m., P. M. Longworth's Garden.

By needle No. 1, ...	70° 27′.25
" No. 2, ...	70 27 .8125
Mean, ...	70 27 .5312

Cincinnati, March, 3h. 30m., P. M., at my own house, in the garden.

By needle No. 1,	70° 24′.25
" No. 2,	70 22 .8125
Mean,	70 23 .5312

Mean dip at Cincinnati, 70° 25′.5312*

Louisville, March 10, 8h. 13m., A. M. Jacob's Woods.

By needle No. 1,	69° 55′.25
" No. 2,	69 51 .375
Mean,	69 53 .3125

Louisville, March 11, 6h. 23m., A. M. Jacob's Woods.

By needle No. 1,	69° 57′
" No. 2,	69 56 .75
Mean,	69 56 .875

Louisville, March 11th, 5h. 27m., P. M.

By needle No. 1,	69° 55′.125
" No. 2,	69 53 .75
Mean,	69 54. 4375

Mean dip at Louisville, 69° 54′.8750.

The relative total intensities at Louisville and Cincinnati, calculated from the preceding elements of dip and horizontal intensity at the same places, are as 1.0000 : 1.0031.

The following experiments were made to determine the correction for temperature of these needles.

A stove and pipe of copper were introduced into a room in my house, fifteen feet square, and having no unusual quantity of iron about it. Opening the room on the morning of the 22d of March, the apparatus was cooled down to 38° F., and the time of five hundred vibrations observed. It was then heated as rapidly as possible by means of the copper stove to 91°.4, and the time of five hundred vibrations again observed and noted. The constant coefficient

* The dip determined at Longworth's garden since this period, namely, 21st of April, 1840,

was, by Needle No. 1,	70° 29′.68
" No. 2,	70 28
Mean,	70 28 .84

was then deduced by Hansteen's formula. Similar experiments were made with the other needles, as below.

				Min. Sec.
March 22d, 1840.	Needle No. 1.	Temperature 38°.	500 vibrations in	25 34.8
		Temperature 91.4.	" "	25 44.8
			Coefficient deduced,	0.000117
March 25.	Mean temperature 37° 36′.	Needle No. 1.	500 vibrations in	25 33.8
	Mean temperature 91 5	" "	" "	25 44
			Coefficient deduced,	0.000122
			Mean for No. 1,	0.000125
March 24.	Mean temperature 50.	Needle No. 2.	500 vibrations in	25 18.8
	86.12	" "	" "	25 26.8
			Coefficient deduced,	0.000145
March 25.	Mean Temperature 48.	Needle No 3.	500 vibrations in	20 34.6
	90	" "	" "	20 37.6
			Coefficient deduced,	0.000058

This last needle, the flat one with lozenge points before referred to, seems very little affected by temperature.

It may, perhaps, excite surprise, and, possibly, some doubt as to the accuracy of my observations, that the dip given above for Cincinnati is so much less than that which I obtained in November, 1837, the latter being 70° 45′.75, and the former 70° 25′.5312; and that the dip at Louisville, August 31, 1839, should have been 70° 08′, and on March 11, 1840, only 69° 54′.4375, or, as a mean, 69° 54′.8750. It is probable, from an experiment recorded in Major Long's expedition, making the dip at St. Louis, in 1819, 70° 30′, and, by my own observations, in 1839, making it, at the same place, only 69° 31′.4, the interval being twenty years, that the dip at this part of the earth is diminishing at the rate of about 3′ per annum. This will account for part of the change observed at Cincinnati. The remainder is probably produced by the seasons, which Hansteen allows to have an influence to the extent of 15′. Allowing 7′ for the annual diminution of the dip since November, 1837, we have for the change produced by the seasons,

$$70° 25'.5312 + 7' + x = 70° 45'.75, \text{ and}$$
$$x = 70° 45'.75 - 70° 25'.5312 - 7' \text{ or}$$
$$x = 13'\ 288 = \text{the above named change.}$$

ARTICLE XVIII.

Observations upon the Meteors of August. By C. G. Forshey, City Engineer of Natchez, and late Professor of Mathematics and Civil Engineering, Jefferson College, Mississippi. Read August 24, 1840.

August is doubtless more prolific of meteors than any other month in the year; and this fact had called my attention more particularly to the character of these meteors than of others; when, in May, I think, 1838, I first met the paper of Mr. E. C. Herrick, calling the attention of observers to the night of the 9th annually. This fact appears to have been first noticed, and attention to have been specially called to it by Quetelet, of Brussels, to whom we are indebted for annual observations in reference to it since 1836. Upon reference to my register of August, 1837, I found this memorandum for the night of the 6th: "An unusual number of brilliant meteors, with long trains, chiefly from about Cassiopeia." But from this date we had near a week of cloudy, rainy weather, preventing further observation, till the night of the 14th. This evening I find a similar note, with a more minute description of a very large meteor passing from Cassiopeia to Aquila. On the night of the 16th a similar note, with particular description of two extraordinary ones. Several succeeding evenings exhibited brilliant meteors, but originating variously, and observing no common direction nor radiant.

This apparent continuation of the display, which has its maximum about the 10th, agrees with the observations of the two succeeding years, as will appear below. The above observations were made at Jefferson College, Mississippi, Latitude 31° 36′ 42″, Longitude 91° 20′.

At the suggestion of Mr. Herrick, I prepared for observation about the 10th of August, 1838; but in the gloom of a sudden and overwhelming bereavement, which had just deprived me of the companion of all my studies, I entirely forgot my appointment, until the morning of the 11th. At half past 2 o'clock, A. M., I was startled from my revery, over the fresh earth that covered my lost companion by a blaze of light, that, in the face of a full moon, near mid-heavens, lighted up the landscape with intense brilliancy. I did not see the meteor, but its light recalled the date of the expected display, and I immediately commenced observation.

The light of the moon, one of the clearest nights in the pure atmosphere of Iowa, obscured all stars below the second magnitude. Indeed, very few stars were visible in the heavens. After some fifteen minutes' observation, in which I saw ten meteors, all having trains, and radiant, with one exception, from near Cassiopeia, I awoke a friend, to aid me in observing. In so doing, about fifteen minutes were lost. But from that time till dawn, we watched closely as great a field as could be seen by two observers, one looking northwardly and the other southwardly, in an open prairie. At 4 o'clock, day-break in the east and the moon in the west concealed all the stars and terminated our observations.

In the mean while we had counted sixty-five meteors, including those first above noticed. Of the whole number seen, more than three-fourths had trains, chiefly of a pale purple colour, which remained, in several instances, a second or two after the body disappeared. Doubtless, the great number seen with trains is properly accounted for from the consideration that the larger meteors are generally attended by trains, and none but the larger ones were visible on this occasion. Their apparent velocity was by no means constant. While some passed through an arc of 40° in a second of time, others occupied 3″ in passing the same distance, and then left trains of 2″ duration. In several meteors I was confident of having observed a retardation of velocity, before the bodies disappeared. This I attributed to the resistance of the earth's atmosphere, which, I did not doubt, many of the bodies penetrated. Subsequent observation has led me to doubt the latter presumption, and consequently the correctness of the observations upon their retarding motion. I would invite the careful attention of observers to this inquiry, as its results will furnish the best evidence in regard to their entering the earth's atmosphere. No noises were heard, nor was a single explosion witnesssd—a phenomenon by no means unusual in common meteors and in the November displays.

Notes were not kept while observing, nor was the precise time or track of any one meteor preserved. But my efforts were immediately and continuously made to locate a radiant point, should such be discoverable. I had no knowledge of the probable existence of such radiant, but took the hint from the history of the November meteors.

A *radiant region*, if not *a radiant point*, was soon perceivable. The paths traced back, excepting of about five meteors which were not *conformable*, passed through a circle, described from the sword clustre of Perseus as a centre, and with a radius of 2°. Of this I sufficiently assured myself by tracing back the lines of distant ones the moment after their disappearance, though unable to find a concurrent *point* for all the tracks. In truth, these paths *would not meet in a common point*. The circle given, however, would have received nearly every one of the sixty *conformable* meteors' paths.

Considering our favourable position for observation, I think we saw every *visible* meteor over one-third of the canopy. With this estimate, there were about one hundred and eighty visible meteors per hour, or three per minute. Add to this at least four invisible ones below the second magnitude for one that reached it, (the fairness of which estimate will appear below,) and we should have seven hundred and twenty meteors obscured by the moon, making about nine hundred per hour for a clear moonless night.

These observations, for 1838, were made at Rock Island, in the upper Mississippi, three miles above the mouth of Rock River; Latitude 41° 44′ 7.5″; Longitude 13° 30′ west from Washington, D. C.

In 1839, circumstances were much more favourable for observation, there being no moon, and the weather peculiarly clear. I copy from my travelling diary.

"St. Louis, Missouri, August 9, 1839.

* * * A passenger from a coach which came in late, told me that he saw a great number of meteors during the evening; and on being questioned for their direction and locality, said, that all that he saw went from about the pole star toward the Great Bear. Doubtless his position in the coach was such as to expose only that field to his view; and all meteors observing the usual origin for this shower, and passing near Polaris, must have travelled in that direction.

" August 10th.

* * * * This was the night for the recurrence of the shower, and I was on the look-out. Before the twilight

closed, I saw one meteor with a train, and afterwards saw them repeatedly during the evening; but a previous engagement prevented my constant observation, till 20 minutes before 11, P. M.

My position for observing was at the intersection of two streets, where at least 15° of the whole horizon were obscured by the buildings. In the lapse of one hour I counted fifty meteors, and about ten were reported to me by others. The field of observation was the constellations about the divergent point, that it might be the more accurately ascertained. It was interesting to observe the identity of their origin. Yet that origin was *not a point*, but was in the vicinity of the sword cluster, in the right hand of Perseus. All the lines traced back of those observing the common law, would intersect within two degrees, at most, of that cluster. About one in every ten crossed the paths of the rest; but these were very different in their appearance, having no trains, and shining with a red, or yellow light.

There appeared, occasionally, a very splendid meteor, three times the size of a star of the first magnitude, but usually they were smaller than the first, and many were smaller than the third magnitude. Of the fifty seen by myself forty left trains, several of the largest 40° in length. The angular velocity of these was very great. The colour of the meteors was nearly uniform, being of a pale white, and as they faded, assuming a purple tinge. The trains, in a few cases, remained after the body disappeared, and faded from either extremity, growing deeper and deeper purple, till they mingled with the colour of the skies.

My field of view embraced, probably, one-seventh of the heavens; and if so, the number visible per hour, in the whole heavens, was about three hundred and fifty, or more than five per minute. The whole display resembles very much that which I saw a year since at Rock Island, with a difference of intensity in favour of the present.

"I am making my notes at half past 12, and still I see them flash past my window with about the same frequency as before."

August 11th.

On the morning of this date I left St. Louis, in a steamer, for Peoria, on Illinois river. I continue the extracts from my diary, as giving my views at the times, unmodified by subsequent observation.

* * "At $8\frac{1}{2}$, P. M., we entered the mouth of the Illinois river, and at 9 I was on deck to look out for a continuation of the meteoric display, and was soon gratified by the appearance of several very splendid ones. Their

origin was such as to leave no doubt about their connexion with the shower, and I induced two fellow passengers to aid me in observation. We stood on deck, and divided the heavens by three vertical planes, from the zenith to the horizon, and commenced observation. In the space of forty minutes we reported respectively nine, eleven, eight meteors, 7 or 8 of which did not observe the common radiant. The remainder were, in all important respects, like those described last night. On the presumption that we saw half the visible meteors, the number per hour would be about seventy-three to seventy-five, or one for every five that were visible 23 hours previously.

The convergency of their lines traced back was manifestly the same as last night, but confirmed the impression I have entertained from the first, that *they do not meet in a common point*, but in a *radiant region, or circle, which has the sword cluster for its centre, with a radius of* 2° *of a great circle.*

"I should not omit to mention the notice of two or three meteors from the common radiant, whose light, both of body and train, was of a fiery colour, (differing very much from the remainder in this respect;) and these seemed to falter in their course, and to be retarded till they expired. Are not these evidences of the correctness of my suggestion last year, that these meteors penetrate the atmosphere of the earth? And may not their light and velocity have been modified by atmospheric resistance?

They were still visible at a late hour. Weather clear, day hot, evening pleasant, and perfectly calm.

"August 12th.

Watched the heavens during the evening, and saw several, but fewer than last night. Nearly all originated as before. Perhaps the centre of the neighbourhood of radiation was a little more eastwardly. Several were very splendid, but nothing I saw seemed to require me to observe longer than to satisfy myself that the display presented no new phases.

"August 13th.

* * At night took an altitude of Polaris, for the latitude of Peoria, Illinois; and while observing, I saw two meteors with trains, having the usual radiant. I continued watching sufficiently long to be satisfied that the display still continued, but was very much diminished in intensity. One observer could see about six conformable meteors per hour."

August 9th, 1840.

On the afternoon of this date I arrived in Philadelphia; and, after some difficulty in search for observers, found Mr. S. C. Walker and others at the observatory of the High School, looking at the moon and planets through a telescope. I was courteously received by these strangers, and my proffered aid, in looking out for meteors, kindly accepted by Mr. Walker.

Some sixteen meteors were incidentally noticed before observation commenced. All these, with one exception, moved in directions which would converge between Cassiopeia, and the head of Perseus, two originating in the head of Perseus. Three of these meteors were twice as large as Jupiter, six were as bright as Jupiter, and the remainder above stars of the 3rd magnitude, or they must have been obscured by the brightness of the moon. Several had trains, say 10° visible at once. Five were visible from 1″ to 1.5″ after the bodies disappeared. There were no explosions.

At 10, P. M., mean time, our observations commenced for the night. The following is condensed from the minutes.

From 10 *h.* 7 *m.* to 12 *h.* 18 *m.* C. G. Forshey observed, S. M. Hamilton recorded.
" 12 *h.* 18 *m.* to 13 *h.* 56 *m.* S. C. Walker. " " "
" 14 *h.* 0 *m.* to 16 *h.* 6 *m.* C. G. Forshey observed and recorded.

From 10 *h.* 7 *m.* to 12 *h.* 18 *m.*, mean time, I observed the meteors, and Mr. S. W. Hamilton recorded. In this interval of 2 *h.* 11 *m.*, by bright moonlight, I saw twenty-four meteors, of which eighteen were *conformable*, and fifteen of these had trains. Of the six unconformable, four had no trains. For further particulars, see the table below, No. I.

From 12 *h.* 18 *m.* till the moon set, at 13 *h.* 56 *m.*, Mr. Walker observed meteors, and Mr. Hamilton recorded. The minutes, which have been kindly placed at my disposal, show that in 1 *h.* 38 *m.*, 28 meteors were seen, of which only 3 were *unconformable.*

Messrs. Walker and Hamilton retired at 14 *h.*, and I resumed observation just after the moon set, and continued till 16 *h.* 6 *m.*, an interval of 2 *h.* 6 *m.* Daylight terminated my observations at this time. Meanwhile I saw one hundred and three meteors, and in several places noted that half the time was lost from observation, in making my notes. Of these meteors only nine were unconformable, and they inferior ones. From moon-set to daybreak, an interval of 92 minutes, I recorded eighty-one of the one hundred and three meteors, and have no doubt that the time lost in recording was sufficient to have increased the number to one hundred and fifty. On the usual estimate, that one observer can watch one-sixth of the heavens, the whole number of meteors that fell during that time was about nine hundred, or nearly ten per minute. This result is nearly equal to the estimate for the night of the 10th, 1838. Probably we had the good fortune to witness the maximum intensity of the shower.

Permit me here to remark, that in all the published notices of August meteors I have seen, no one has hinted at the extreme difference in character from the November meteors. This should be borne in mind. The former are very uniform, and are sufficiently described above. The shower of Nov. 12, 1833, I witnessed in all its magnificence, at West Point; and after my first surprise at the grand illumination itself, the most striking feature I observed was *the great number of explosions.* I listened carefully for the noises, but heard none; nor do I believe that any could be heard, though they frequently burst into many blazing fragments, very much like sky rockets to the eye. The colours of the meteors were very various, from deep red, to bronze, yellow, and white. No meteors fell between my eye and the mountains, which rise near fifteen hundred feet within three miles. The trains of many meteors assumed a curling, nebulous form, and vanished very slowly, several remaining visible from five to ten minutes, and one, which has been so much noticed, though far below Capella at West Point, remained some fifteen minutes.

TABLE I.

Tabular Description and Classification of Meteors of August 9, 1840.

COMPARATIVE MAGNITUDES.	68 meteors seen from 8*h.* to 14*h.* by one observer.	103 meteors, seen from 14*h.* to daylight, by one observer noting for himself.	Visible paths of meteors, in arc of great circle.	Duration of visibility of meteors and trains.	Duration of visibility of trains left.	Length of trains visible at once.
Three times the size of Jupiter.	1	1	40°	$4^s.5$	$1^s.7$	20°
Twice " "	6	0	35	3 .6	1 .0	15
Equal to " "	12	2	25	2 .5	0 .8	12
" " First magnitude.	12	14	20	1 .8	0 .6	9
" " Second "	32	17	12	1 .2	0 .5	5
" " Third "	5	33	7	0 .9	0 .4	4
Below " "	none	36	6	0 .6	0 .4	4

In order to locate the radiant with precision, at different times, in the progress of the display, the following results have been obtained by projecting the paths of the meteors, from our minutes, upon a map of the heavens. In observing and noting, we recorded the points of appearance and disappearance of each conformable meteor, as well as the line in Cassiopeia or Perseus through which its path traced back would pass. This was done on the instant, while the path was fresh in the memory. Care was also taken, in commencing, to refresh the recollection by an inspection of the map, which was kept open at hand during the observations. It is probably owing to our having observed and recorded three points of their direction, that we found the probable error of a single observation, as well as of the point of convergence, so much less, (as will appear in the table below,) than the results of the European observations of 1837 and 1839. Our mode of observing has caused a greater number of the meteors seen to be rejected from the tables as *unconformable*, in proportion to the whole number seen, than is reported in the European observations. This had its effect upon the final result of the computations.

An inspection of the table will show, that at Philadelphia, the radiant had a tendency towards the S. E. This apparent motion of the radiant is in conformity with my memoranda, made last year, on the 10th and 11th of August.

For the European results in this table, as well as for the statement of the conclusions derived from the same by Mr. Erman of Berlin, (Nos. 385, 390 and 404, Schumacher's Astr. Nachr.,) I am indebted to Mr. Sears C. Walker. The Philadelphia observations show an apparent motion of the radiant in the heavens at variance with the conclusions of Mr. Erman, namely, that the motion of the radiant should be in a westerly direction, at a rate not exceeding 0.1° of a great circle in an hour.

Table II.

Table of Right Ascension and Declination, of the Points of Convergence, of the apparent Paths of the Meteors of August 9, 10, 11, *in the Years* 1837, 1839, *and* 1840, *from Observations at various Places.*

Places of Observation, and Dates.	Apparent Rt. As.	Apparent Dec.	Number of Observations.	Probable Error of single Result.	Probable Error of final Result.
1837, Berlin, August 10, ...	217°.18	— 57°.26	46	± 20.1	± 2.96
" Breslaw, " "	221 .76	— 51 .41	200	± 19.5	± 1.38
1839, Berlin, " 9, ...	224 .86	— 50 .18	50	± 11.9	± 1.68
" " " 10, ...	223 .88	— 52 .39	48	± 13.3	± 1.92
" " " 11, ...	218 .45	— 51 .05	43	± 13.5	± 2.06
" Koningsberg, August 10, . .	214 .85	— 55 .59	75	± 21.0	± 2.42
" " " 11, . .	215 .11	— 55 .29	74	± 17.4	± 2.02
1840, Philadelphia, " 9^d 10^h 57^m	216 .14	— 55 .76	12	± 2.3	± 0.67
" " " 9 13 4	214 .71	— 55 .43	15	± 4.1	± 1.05
" " " 9 15 6	219 .25	— 55 .12	29	± 1.2	± 0.22

Table III.

Table of the Difference (E) *of the single Results from the Mean adopted for the Position of the Point of Convergence of the Paths of the Meteors of August 9th,* 1840, *at Philadelphia, in Parts of a great Circle.*

First Group, by Mr. Forshey.		Second Group, by Mr. Walker.		Third Group, by Mr. Forshey.	
No. in Entire Series.	E	No. in Entire Series.	E	No. in Entire Series.	E
18	0.40	49	0.5	82	0.33
19	0.50	50	0.6	70	0.50
24	0.60	64	1.1	71	0.55
17	1.25	48	1.3	—	0.57
22	1.40	46	2.1	86	0.70
21	1.50	62	2.2	85	0.85
23	2.10	51	2.3	77	0.95
29	2.20	49	2.4	78	1.08
27	2.90	42	3.4	79	1.25
24	3.00	54	4.1	95	1.45
25	3.50	45	7.9	73	1.50
		55	8.5	72	1.53
		52	9.0	76	1.55
		60	9.3	74	1.57
		61	13.8	75	1.60
				142	1.60
				81	1.80
				83	1.90
				88	1.95
				84	1.97
				132	2.00
				137	2.12
				136	2.15
				133	2.22
				135	2.40
				133	2.50
				—	2.75
				—	2.75
				—	3.05

The annual periodicity of this phenomenon, its duration, and the manifest convergence of the paths of the meteors, would accord well with the hypothesis of *a revolving belt or zone of meteors, whose centre is the sun, and whose orbit passes very near to the orbit of the earth, piercing the plane of the ecliptic in the signs Aquarius* and *Leo.* The plane of its orbit, according to the computations of Mr. Erman, is quite beyond the limits of the zodiac, being inclined to the ecliptic by an angle of not less than 56°* The minimum velocity is fifty-five hundredths, taking that of the earth for unity. This gives them a period of one hundred and twenty-eight days. Their greatest possible velocity, by the same computations, would be one hundred and forty-three hundredths with a period indefinitely great. It is desirable that observers should keep a careful watch for the semiannual return of the August meteors. I have observed, for the past two years, about the 6th of February, but have seen nothing worth reporting. Nor do I much expect they will be visible to the naked eye, at the February node; yet an examination of the discs of the sun and moon, with a powerful telescope, may detect the transit of these meteors over them. Success in this examination, it is plain, would determine whether the February node be within or without the earth's orbit, and furnish another element for the exact determination of the orbit.

It adds no little interest to the occurrence of these meteoric showers to find that there have been several striking coincidences between their dates, and those of shocks of earthquake. A notice has recently passed the rounds of the newspapers, of a shock which was felt in various parts of New-England, on the 9th of the present month, the date of our observations at the High School, as detailed above. It occurred to me to examine how frequently such coincidences of date might be found in history, and although I could discover very little written on the subject of earthquakes, and that little deficient in precise dates, yet the search has not been wholly unavailing. I have reduced to the tabular form below, what I have been able to collect, and would respectfully invite the attention of philosophers to the consideration of this interesting matter. Should future observation and research into the past demonstrate that in the revolution of the cometary bodies which produce our meteoric showers, their proximity to the earth produces waves in her surface, by their attraction, great plausibility will thereby be conferred upon the geological hypothesis of the in-

* In the explanation of the November displays of meteors, should we not need far less of hypothesis than Prof. Olmsted has called in, to connect them with the zodiacal light, by assuming, somewhat as in the August showers, that they are a *flock of meteors*, forming a cometary body, less than an entire zone, whose period of revolution around the sun is about thirty-three years, whose perihelion is near the orbit of our earth in Pisces, and whose length is sufficient to require about one fifth of its entire period, in passing the node?

The returns of this display, I believe, have entirely ceased, and it will, perhaps, be invisible till about the year 1865; and in 1866 we may possibly have another maximum. My observations upon the phenomena of the zodiacal light, do not accord with the requirements of Prof. Olmsted's theory.

ternal fluidity of the earth. Much may be done in the solution of this inquiry by careful observations upon the tides, from the 5th to the 15th of August, from the 5th to the 15th of February, yearly; and from the 10th to the 15th November, of those years in which the November meteors appear. The waters, it is plain, should first, and most palpably, exhibit the effects of the presumed local attraction.

Table IV.

Tabular View of Earthquakes, coincident with Dates of Meteoric Showers.

August.	February.	November.	Year.	Localities.	August.	February.	November.	Year.	Localities.
		9	1408	Ætna.	4	5 to 15		1767	Zante.
10	uncer.		1510	Calabria.					Constantinople.
	4		1610	Ætna.		6		1766	New England.
	4		1669	"		17		1768	Vienna and Presburg.
12			1682	Vesuvius.	7 to 20			1770	Isle of Santorini.
		uncer.	1704	Alps.	11			1772	Batavia.
14	10		1708	Manosque and Santoni.	3			1779	Vesuvius.
	18		1712	Vesuvius.		4		1797	Riobamba, S. A.
	2		1703	Rome.		uncer.	12	1799	Ætna—Charleston.
	uncer.		1750	Philippoli, Romania.	12	6	22	1804	Vesuvius, Paris.
	5		1751	Naples.		16		1810	Malta.
	18		1756	Amsterdam.		13		1822	Vesuvius.
	3		1757	Sumatra.	9			1840	New England.

ARTICLE XIX.

On the Change effected in the Nitrates of Potash and Soda by the limited Application of Heat, with the View of obtaining pure Oxygen, by which they are only partially convertible into Hypo-nitrites: also on a Liquid and a gaseous ethereal Compound, resulting from the reaction of nascent hypo-nitrous Acid with the Elements of Alcohol. By Robert Hare, M. D., Professor of Chemistry in the University of Pennsylvania. Read July 17, 1840.

It is well known that when either nitrate of potash, or nitrate of soda, is subjected to heat, as is usual in the process for obtaining oxygen, the first portions of gas extricated are nearly pure. When the fire is carefully regulated, the residue, after cooling, is a white indurated mass. If this mass be dissolved in as much boiling water as its solution requires, a large deposition of crystals of nitrate will take place after the resulting liquid becomes cool. On boiling down the solution, a further portion of crystals of the same nature will be obtained.

The mother water being evaporated to a certain point, begins to yield crystals of hypo-nitrite. Thus the superior solubility of the hypo-nitrites of potash and soda renders it practicable to separate either of them from the nitrate having the same base. Of course repeated crystallization is requisite to obtain either of the salts in question free from the other. It is inexplicable that about a third of the salt employed should be reduced to the state of hypo-nitrite, while the remainder is not decomposed. It would seem as if there were a reaction between the nitrate and hypo-nitrite, which, having co-operated to expel a portion of the contained oxygen, afterwards restrains the evolution of a further portion, until the heat is raised to a point capable of effecting such a decomposition as to evolve the nitrogen and oxygen in a state of mixture.

Having, in obtaining large quantities of oxygen, for my experiments in fusing platinum, collected a great quantity of the indurated compound of hypo-nitrite and nitrate by the process above mentioned, I was induced to substitute these salts for nitrate of potash, or nitric acid, in the evolution of the liquid, commonly known as nitrous, or nitric ether. When, for this object, nitric acid, or, what amounts to the same thing, when a nitrate and sulphuric acid are employed, so as to bring free nitric acid into contact with alcohol, there must be an excess of two atoms of oxygen for each atom of hypo-nitrous acid which enters into combination with the elements of the alcohol.

This causes a wasteful decomposition of a proportionable quantity of the last mentioned material, and the generation of some impurities. This view of the subject led me to infer that, to obtain pure hypo-nitrous ether with the greatest economy of materials, a hypo-nitrite should be employed, with a reagent capable of liberating hypo-nitrous acid, in lieu of a nitrate or nitric acid being distilled with alcohol. The result of an experiment made under this impression justified this inference. By subjecting alcohol, mingled with a concentrated solution of a hypo-nitrite, to diluted sulphuric acid, I obtained an ether, which differs from the ether ordinarily known as nitric, or nitrous ether, in having a more bland and saccharine taste, milder odour, and greater volatility. It boils below 65° F., and, by its spontaneous evaporation from the bulb of a thermometer, produces a cold of 15° below zero F. Touched with the finger, or tongue, it hisses as does water with a red hot iron.

If, after having boiled for some time, it be allowed to stand for awhile at a temperature below its boiling point, the boiling will recommence at a lower temperature than that which was indicated by the thermometer when the boiling ceased.

This seems to arise from the partial resolution of the ether into an ethereal gas; which appears to be formed by the materials by which the liquid ether is generated, even when refrigerated below the freezing point. I have collected this aëriform ether in large quantities in bells over mercury. When subjected to great pressure, it condenses, more or less, into a yellow liquid, which produces, when allowed to escape into the mouth or nostrils, the same impression as the liquid ether. I have conjectured that this ether might be a compound of the liquid ether with nitric oxide gas, or that it may be isomeric with the liquid ether. Notwithstanding many efforts to obtain a liquid ether not resolvable partially into this gas, I have never succeeded. Hence the boiling point is extremely variable, as I have seen bubbles escaping below forty degrees, from the liquid ether, when recently condensed after distillation.

In the production of cold by mixture with solid carbonic acid, Dr. J. K. Mitchell found this ether more efficacious than that commonly known as sulphuric ether, more properly called hydric ether.

When the new ether, as it is first evolved, is distilled from powdered quicklime, this earth imbibes an essential oil, which, with the aid of water, is yielded to pure hydric ether. Of course it is easy to remove this solvent by evaporation or distillation.

The odour of this oil seems to be an ingredient in that of ordinary nitric ether. Possibly the hypo-nitrous ether may resolve itself gradually into this oil and the gaseous ether; so that its boiling point may be probably varied by this chemical change. I suspect that the essential oil in question is one of the impurities which causes the boiling point of the ether generated by nitric acid and alcohol to be higher than the boiling point of that obtained, as in my process, by nascent hypo-nitrous acid.

When the heat is raised, after the volatile ether ceases to come over from the materials above mentioned as producing it, ethereal products are distilled, of which the boiling point gradually rises as the process proceeds. Mean while, the product thus obtained becomes more and more acrid, till at last it is rendered insupportable to the tongue, as respects the after taste. On mingling these liquids with a solution of green sulphate of iron, the ether is all absorbed; but an acrid liquid, which causes the after taste, is not absorbed, and may be separated by hydric ether. The ether being vaporized by heat, the acrid liquid remains. The smallest drop of this liquid is productive of an effect upon the organs of taste and smell like that of mustard or horse-radish.

The new ether, when secured in a glass phial, by means of a well ground stopper, does not undergo any change by keeping in a cool situation for several months. A phial was suspended about fifteen feet below the surface of the ground, in a cistern of water, for about five months; another was left in a cool cellar for a longer period, without any apparent change of properties. In this case pressure prevented the escape of the ethereal gas as above mentioned.

When the ingredients for generating the new hypo-nitrous ether are refrigerated below freezing, and left to react, the ether begins to be formed as soon as the temperature rises, and if the aggregate be included in a bottle with an air-tight stopple, a stratum of ether will soon form and swim upon the surface of the mixture. The quantity which can be thus obtained is much less than that which ensues from the employment of the same quantity of materials with a retort and refrigerated receiver; because the elaboration and condensation require a greater difference of temperature than can be imparted, conveniently, to the different portions of a bottle, especially where the upper is required to be the colder portion.

In order to obtain a quantity of ether in a summary way, I resorted to this process last winter, employing about a gallon of the mixture. After I had decanted the ether which formed in the course of a night, the residue, although surrounded by snow, continued to give out the aërial ether for at least a fortnight. The gaseous ether seems to be formed in innumerable invisible bubbles throughout the mass, which, on this account, presented the singular phenomenon of an elastic liquid. On inserting the stopple, the liquid in the neck of the bottle would subside in the most striking manner, and on removing the stopple, an opposite movement was observable.

All the ethereal compounds formed by the reaction of the oxacids of nitrogen with alcohol appear to be decomposable by green sulphate of iron. Under these circumstances, according to Berzelius, a malate of iron is formed from common nitric ether.

Concentrated sulphuric acid absorbs the elements derived from the alcohol, and liberates nitric oxide gas, which is, it is well known, rapidly absorbable by the green sulphate above mentioned. Let there be three cylindrical glass jars, Nos. 1, 2, and 3, of such a ratio to each other, in size, as to allow two interstices of about half an inch between the second, or intermediate jar, No. 2, and the outer, No. 1, and innermost jar, No. 3; likewise, let two bell-glasses be provided, of such a size as that one of them, (A,) may enter the inner interstice, while the other, (B,) will cover (A,) and descend into the outer interstice. Let a wine-glass containing the ether be placed in jar No. 3, and let

No. 1 be supplied with green sulphate of iron, the other two with concentrated sulphuric acid, and let the bells be put in their respective places.

Under these circumstances the ether will be gradually vaporized, and the alcoholic elements, with some oxygen, will be absorbed by the acid, while nitric oxide, being liberated, will pass into the sulphate, and be, consequently, absorbed.

From the new ether my young friend, Mr. Boyé, who was, at the time, one of my operative pupils, succeeded in evolving alcohol by digestion with slacked lime, and subsequent distillation. The lime was found to be in the state of a hypo-nitrite, giving a precipitate with the nitrate of silver.

When, into a bell-glass containing some of the aëriform ether, a globule of potassium was introduced, and touched with a red hot knob which formed the termination of an iron rod, ignition took place, and the gas seemed to have changed its character. I had not, however, leisure to examine it eudiometrically. There was an odour produced which reminded me both of that of fish and soap.

ARTICLE XX.

Descriptions of new Species and Genera of Plants in the natural Order of the COMPOSITÆ, *collected in a Tour across the Continent to the Pacific, a Residence in Oregon, and a Visit to the Sandwich Islands and Upper California, during the Years* 1834 *and* 1835. *By Thomas Nuttall. Read Oct.* 2, 1840.

Tribe I. VERNONIACEÆ.

VERNONIA **sphæroidea*, pubescent; leaves lanceolate, serrate, beneath villous; corymb compound, many-flowered, flowers small; involucrum subglobose, scales short and equal, tomentose and reflected.—HAB. Prairies of Arkansas.

OBS.—Remarkable for the reflection of the scales of the involucrum, which are all short, equal, and densely tomentose at the base and margins.

Vernonia Arkansana, (DECAND.) nearly smooth and herbaceous; leaves linear-lanceolate, very long, serrulate; corymb simple; flowers large, nearly all pedunculate, hemispherical; leaves of the involucrum lanceolate, terminating in very long, filiform, leafy, and spreading points.—HAB. Plains of Arkansas, near Red River.

OBS.—Remarkable for the great size of the heads of flowers, more than twice as large as in any other of our species, and also singular in the great length of the squamose points of the leaflets of the involucrum, which are a little pubescent. The leaves are very long, narrow, and smooth. Achenium somewhat pubescent. Pappus double, as usual.

Tribe II. EUPATORIACEÆ. (Lessing, Decand.)

LIATRIS.

Liatris brachystachya. (Nutt.) Arkansa; also in the prairies of Missouri, common. *Liatris pychnostachya?* Mich. Vol. II., p. 91.

Liatris oppositifolia (Nutt.) is a species of Eupatorium.

Liatris virgata, (Nutt.) nearly smooth; root tuberous; stem often paniculately and virgately branched; the flowers sometimes upon short, but usually on long pedicels; involucrum subhemispherical; fifteen to twenty flowered; scales oval, nearly all equal and imbricate, somewhat acute or obtuse; pappus rather short, slightly plumose; receptacle naked, or bracteolate.—Hab. In the pine forests of Georgia, and near Newbern, N. Carolina. Very peculiar in its great tendency to branching; the branches slender. Leaves linear, sublanceolate, not remarkably unequal; erect, or reflected; smooth, or somewhat ciliated. One specimen, which I cultivated at Cambridge, Mass., had a *bracteolate receptacle,* with a foliaceous scale to each floret; in this individual the leaves were reflected,

I give the following apparently new genus of Vernoniaceæ, allied to Vernonia, collected by the late Doctor Baldwin on some part of the Pacific coast of South America, and from its curious honey-combed receptacle, I have called it

* SYMBLOMERIA.

Capitulum many-flowered, homogamous; the florets tubular and deeply five-cleft, with linear obtuse segments, the exterior series subpalmate. Receptaculum pitted with angular cavities like a honey-comb, in which the turbinate villous achenium is almost wholly immersed, (as in Baldwinia.) Involucrum hemispherical, imbricate, and somewhat squarrose, in several unequal series, the scales adnate at their base. Stigmas with the branches filiform and pubescent, acuminate. Pappus double, and, in several series, the outer whitish and much shorter, all paleaceously bristly.—A shrub eight or ten feet high, with alternate, lanceolate, acuminate, entire, smooth leaves; capituli rather large, axillary and terminal, pedicellate and corymbose (florets apparently white, judging by the dried specimen.)

Symblomeria Baldwiniana.

A branching shrub with terete somewhat cinereous puberulous branches and young shoots. Leaves about three inches long, an inch to an inch and a half wide, acuminate at each end. Capituli a little larger than those of *Vernonia noveboracensis.*

and usually ciliate at base, with the leaves of the involucrum more obtuse. Others, differing in no other external character, had a *naked* receptacle! The *Carphephorus pseudoliatris* of Cassini is, then, nothing more than a true Liatris; and I therefore retain the name I gave to the Alabama specimens, of *Liatris squamosa;* but it may, perhaps, with others, form a section CARPHEPHORUS, to which, however, our plant cannot be referred, as the chaff-bearing plant is scarcely even a permanent variety.

Liatris **lævigata*, root tuberous; in every part very smooth; radical leaves, long and linear, with smooth margins; stem somewhat attenuated, with very short, almost filiform leaves; involucrum filiformly pedicellate, smooth, of about two series of obovate, acute, coloured scales; florets about five, or more; pappus short, barbellate; achenium villous.—HAB. In Florida and Georgia.—Allied to the *L. gracilis* of Pursh, but the capituli are not at all globose, nor the pedicels spreading, but erect, and without any proper bractes. Stem three or four feet high, attenuated, and sparingly scattered with almost filiform, subulate leaves; radical ones near a foot long, pungently acute and coriaceous.

Liatris resinosa of Decandolle is apparently the *L. punctata* of Hooker, as the pappus is merely scabrous, or barbellate, in *L. resinosa*. The *L. punctata* appears intermediate with *L. squarrosa* and *L. cylindracea*.

Liatris heterophylla appears, usually, to have the stem pubescent, and not smooth.

Subgenus.—*LEPTOCLINIUM. *Suffruticose, branching; leaves opposite; capitulum attenuated at the base; receptaculum very small. Achenia acutely conic, ten to twelve striate. Pappus barbellate, elongated in several series, and, as well as the florets, purple.*

Liatris fruticosa, (NUTT.) suffruticose; leaves opposite, above alternate, smaller, cuneate-oblong, entire; branches corymbose, naked towards the summit; capituli coarctate.—HAB. Collected in East Florida by Mr. Ware. Capituli in smallish terminal clusters, upon slender pedicels; sepals lanceolate, acuminate, loosely imbricate in about three series, the innermost much the longest; florets purple, as well as the pappus, which is as long as the florets. Corolla wider at the summit, rather deeply cleft.—The habit of this singular species is much more that of *Kleinia* or *Eupatorium* than that of Liatris, with which, however, the flowers best agree.

EUPATORIUM.—Section I. CYLINDROCEPHALA. (Decand.)

*Eupatorium *calocephalum;* herbaceous, somewhat scabrous and pubescent; leaves opposite, narrow-lanceolate, oblong, denticulate, three-nerved and subpetiolate; flowers paniculate, corymbose; capituli cylindric-ovate; involucrum closely imbricate; scales three-striate, oblong-obtuse, the innermost purple; florets fifteen to twenty.—*Liatris oppositifolia,* (NUTTALL,) in Silliman's Journal, Vol. V., p. 299. A species so remarkably distinct from the other group of the United States as to have led me into the error of referring this species to the genus *Liatris:* better specimens have now proved it to be an *Eupatorium* of Decandolle's first section. The stem somewhat scabrous, slender, twiggy, and herbaceous, about two feet high, the upper branchlets terminating in trichotomous flowering corymbs. Each capitulum pedicellate; scales of the involucrum chaffy, striate, and with a coloured, slightly foliaceous tip, mostly purple; florets scarcely exserted; pappus short, slightly scabrous; achenium smooth, five-striate. Receptacle naked.

Eupatorium occidentale, β. subroseum. In the Rocky Mountains, toward the waters of the Columbia, and in the Blue Mountains of Oregon.

Eupatorium Oregonum, slightly scabrous; leaves opposite, above alternate, petiolate, ovate, acute, entire; corymb sub-coarctate, few-flowered; involucrum twelve to fifteen flowered, scales almost in a simple series, acute, pubescent; achenium five-striate.—HAB. In the Rocky Mountains, towards the sources of the Malade of the Oregon. Nearly allied to the preceding. A very dwarf species, about six inches high. Leaves about an inch long, somewhat three-nerved. Flowers pale pink.

BULBOSTYLIS. (Decand.)

*Bulbostylis *microphylla;* suffruticose low, viscidly pubescent, villous and much branched; leaves alternate, ovate, subserrate, on the branches numerous and small, nearly entire; panicle few-flowered, subfastigiate; capituli pedicellate; scales of the involucrum linear lanceolate, acuminate; pappus white.—Hab. On the shelving rocks of the Blue Mountains of Oregon.

Obs.—A very remarkable species. Perennial, forming rigid dwarf suffruticose tufts of very branching stems, scarcely a foot high, viscid, with a bitter, highly aromatic resin. The larger leaves roundish-ovate, about an inch long, those on the branches and upper part of the stem (as in some Asters) diminishing to a fourth of that size, and numerous. Involucrum ovate, squarrose at base. Flowers white?

BRICKELLIA. (Elliott.)

Eupatorium, but with the involucrum ovate, or hemispherical, of several series of loosely imbricated, usually striated scales, the inner scariose, the lower spreading, with subulate leafy points. Florets ten to fifty. Achenia subcylindric, with ten striæ. Pappus pilose, barbellate, or scarcely scabrous. Receptacle naked.—Leaves opposite, and alternate above. Corolla purple or white. Flowers corymbose, or clustered.

Section I. Eubrickellia.—*Involucrum squarrose at base; the scales with four prominent striæ on each.*

Brickellia cordifolia, (Elliott,) leaves opposite, cordate, acuminate, dentate, triply-nerved, pubescent beneath, above alternate; corolla and pappus more or less purple; achenia pilose above.—Hab. In Georgia.

Brickellia grandiflora, leaves alternate, deltoid-cordate, acuminate, incisely dentate towards the base, entire at the point, smooth on both surfaces, and covered beneath with resinous atoms; flowers in fastigiate clusters, the upper part of the stem branching; inner scales of the involucrum linear-lanceolate, acute; pappus white, achenia smooth.—*Eupatorium? grandiflorum.* Hook. Flor. Bor. Am., Vol. II., p. 26.

Hab. In the Rocky Mountain range, by streams, in gravelly places, and west, to the lower falls of the Columbia.—Perennial. Stems many from the same root, about twelve to fifteen inches high. The whole plant almost perfectly glabrous. Leaves alternate, sometimes almost opposite, approximate, on longish petioles, deltoid-cordate, acuminate, coarsely and deeply toothed towards the base, smooth and green, but shining, with a coating of yellow resinous atoms having a heavy aromatic scent; stem branching above; branches terminating in corymbulose clusters of subsessile flowers, about five capituli in each. Florets straw-yellow, inclining to white, cylindric and smooth, the border connivent. Stigmas exserted, smooth, thicker toward the extremity. Achenium cylindric, ten-striate. Pappus of a single series of twenty to twenty-four scabrous hairs. Receptacle naked, flat.

Brickellia **oblongifolia*, leaves alternate, oblong-lanceolate, acute, nearly all entire, scabrous, viscid, and shortly pubescent; stems subdecumbent, branched above; flowers corymbose, subsessile; inner scales of the involucrum long, linear, and acute; pappus barbellate, white, twenty to twenty-four rayed.—Hab. Gravel bars of the Columbia and tributary streams, and along the Wahlamet, common.

Obs.—Perennial, viscid, aromatic and heavy-scented; many stems from the same perennial root, scarcely a foot high. Involucrum at length spreading out flat, the inner sepals longer than the long, almost plumose, pappus. Lower sepals lanceolate, a little spreading. Receptacle naked. Achenium cylindric, ten-striate, somewhat pubescent. Florets thirty to forty, yellowish, narrow and inconspicuous; stigmas but little exserted, thickened at the extremity, and smooth.—Flowery in August and September. Apparently a species of *Clavigera*, but the achenium is pubescent, and deeply ten-striate.

NARDOSMIA. (Cassini.)

Nardosmia palmata, leaves reniform-cordate, unequally seven-lobed, incisely toothed; female liguli minute, stigma bifid. *Tussilago palmata*, (Ait.)—Hab. Maine.

N. **Hookeriana*, leaves cordate, not very deeply palmately lobed, the divisions angular and toothed, beneath tomentose. *N. palmata!* Hooker. Bor. Am., Vol. I., p. 308. Willd. Sp. Pl. l. c., Pursh in part. Decand, Vol. V., p. 206, not of Aiton. Closely allied, if, indeed, sufficiently distinct from *N. corymbosa.*

Nardosmia **speciosa*, dioecious, flowers and leaves coeval; leaves cordate-reniform, circular, about nine-lobed, not deeply cleft, divisions angularly toothed and mucronately denticulate, beneath more or less tomentose; scape tall, with numerous leaf sheaths; thyrsus many-flowered, smooth.—*N. palmata?* Hooker. —Hab. Shady forests of the Oregon and Wahlamet, by streams.—May. A very showy species; easily confounded with the true *N. palmata,* though wholly distinct, being a larger plant, with the leaves more numerously lobed, and not so deeply cleft. Leaves a foot high, six or more inches across, the outline circular, with denticulations as well as angular indentions. Thyrsus eighteen inches to two feet high, fastigiate. In the female, the capituli twenty to twenty-five, large and conspicuous; the liguli white, exserted, very numerous, linear-oblong, the style filiform and undivided! pappus white, moderately copious.—Quite an ornamental species, with fragrant flowers.

ADENOCAULON. (Hooker.)

*Adenocaulon *integrifolium;* primary leaves ovate, or subelliptic, the rest deltoid or subcordate, nearly entire, almost all radical.—Hab. Shady woods of the Wahlamet, near its confluence with the Oregon. A smaller species than the *A. bicolor,* which it greatly resembles, but the leaves are not lobed, the cordate ones only are a little repand at times near the base. Perhaps not sufficiently distinct from the *A. Chilense.*

Tribe III. ASTEROIDEÆ. (Less.)

Subtribe Asterineæ.

CORETHROGYNE. (Decand.)

Capitulum radiate, many-flowered, the rays sterile, in one series, destitute of achenium and pappus; discal florets tubular, shortly five-toothed, glandular. Sepals of the involucrum similar, imbricated in three to five series, more or less herbaceous and reflected at the points. Receptacle flat, alveolate, and naked. Branches of the stigma exserted, filiform, terminated by hirsute tufts of pubescence. Achenium turbinate, silky. Pappus of unequal length, in several series, scabrous.—Perennial herbaceous plants of Upper California, tomentose; stems branching; branches one or few-flowered, fastigiate; leaves linear entire, the radical and lower ones spathulate, serrate towards the apex. Liguli conspicuous, purple; disk yellow. Pappus rufous. Allied to *Heterotheca,* but with the rays neuter, the pappus simple, and the flowers heterochromous.

*Corethrogyne *incana.*, arachnoidly tomentose, leaves oblong-lanceolate, or linear, acute, amplexicaule, nearly entire; branches slender, one or few flowered, fastigiate; involucrum viscidly pubescent, of about four series of acute sepals, the lower ones squarrose; rays about twenty, as long as the disk.—HAB. Near St. Diego, Upper California. Flowering in May. Rays of a fine, light bluish purple. Stems numerous, about twelve to eighteen inches long, very leafy, branching above; branches slender, one to three-flowered; lower leaves somewhat three-nerved. Capitulum about the size of the common Daisy; the involucrum viscid, and sometimes the extreme branchlets; sepals linear-lanceolate. Rays tridentate, without any distinct germ or pappus. *C. Californica?* DECAND. *Diplopappus incanus,* LIND. *Aster? tomentellus?* (HOOK. and ARN. Bot. Beechy.) With the heavy aromatic odour of some *Gnaphaliums.*

*Corethrogyne *filaginifolia,* arachnoidly tomentose, radical leaves spathulate, serrate, those of the stem linear, or spathulate, acute, entire, sessile; branches one-flowered, fastigiate; involucrum in about three series of lanceolate, very acute, erect sepals; rays twenty to twenty-four, bidentate, scarcely as long as the disk. *Aster? filaginifolius.* HOOK. and ARN. Bot. Beech.—HAB. Around St. Barbara, Upper California.

OBS.—A smaller flowered, more slender species than the preceding, with a smaller and not viscid involucrum, the leaves more whitely tomentose.—In neither of these species have we observed any paleæ on the receptacle, as described by Decandolle, and, in consequence, they were referred to Aster by Hooker and Arnott.

ASTER. (Linn.)

*Aster *Andinus,* root-stock slender and creeping; stems several, decumbent, above pubescent, mostly one-flowered; leaves entire, smooth, radical spathulate, sublanceolate, cauline sublinear, acute, usually wider at the base and amplexicaule; scales of the involucrum linear, nearly smooth and mostly acute, ciliate; rays numerous, rather long, three-toothed; achenium nearly smooth.—HAB. On the highest summits of the Rocky Mountains, near the line of perpetual snow, in 42°. About ten thousand feet above the level of the sea. Near the summit of Thornberg's Ridge, where we made an ineffectual attempt to cross the Northern Andes, in August, still deeply buried in snow. Allied apparently to the *A. repens* of Humboldt and Bonpland.

Root perennial, creeping, wiry and slender, sending up small clusters of decumbent stems, three or four inches high, each mostly terminating in a single capitulum, about half the ordinary size of that of *A. alpinus*. Radical leaves very smooth, and somewhat coriaceous, rarely with two slight denticulations, stem leaves three or four, lanceolate-linear, amplexicaule and acute, usually somewhat ciliate. Capitulum hemispherical, involucrum of two series of narrow linear acute, herbaceous sepals, strongly pubescent on the margin, rather shorter than the disk. Rays feminine, about forty, narrow linear, mostly three-toothed, purplish-blue. Pappus scarcely scabrous, purplish; the hairs slender.—Flowering in August. In one specimen the leaves are longer, sublanceolate, slightly serrulate, and the sepals more acute.

*Aster *glacialis,* stem erect, one-flowered, pubescent above, rather naked; leaves entire, smooth, somewhat three-nerved, the primary ones spathulate-oblong, the rest lanceolate, acute, scabrous on the margin, cauline small, very acute, amplexicaule; involucrum of nearly a simple series of linear, acuminate, glandularly pubescent, brownish sepals; rays rose-purple, three-toothed; pappus barbellate; achenium pubescent.—HAB. With the preceding, which it much resembles.—Root perennial, not creeping, the stock rather thick and undivided. Leaves wholly smooth, except the scabrous margin, after the first spathulate ones, acute, attenuated below; stem often as naked as a scape. The calix quite viscid; the sepals much acuminated, of an uniform brown and herbaceous colour, about the length of the disk. Rays oblong, broader and shorter than in the preceding, about forty, somewhere about equal with the disk. Pappus paler, much shorter than in the preceding, and distinctly barbellated.

*Aster *integrifolius,* stem pubescent, simple, erect, and with the involucrum glutinous above; leaves entire, radical lanceolate, long petiolate, all acute; cauline oblong-lanceolate, scabrous, pubescent on the margin, dilated and amplexicaule at the base; capituli large, subcorymbose, about three to five, on short and nearly naked peduncles; involucrum loosely imbricated, sepals nearly equal, linear-lanceolate, acute, somewhat spreading; achenium rather villous.—An alpine species growing with the above, but at a lower elevation. Root creeping; stem robust, about a foot high; terminating in a short raceme, or small corymb, glutinous pubescent above, as well as the sepals, which are leafy. Lower leaves spathulate-lanceolate; those on the stem few and rather remote, the lowest nearly half a foot long, the uppermost scarcely an inch, and cordate-lanceolate, amplexicaule; one or two small leaves on the peduncle, which is scarcely an inch long; leaves of the involucrum about equal with the disk, about two series. Rays bluish-purple, as long as the disk, fifteen to twenty-five, the terminal capitulum much larger. Pappus brownish, scabrous, rather long and abundant.—Flowering in August. Evidently allied to Pursh's *A. peregrinus*, but the stem is pubescent below and viscid above, and the leaves amplexicaule.

*Aster *pauciflorus.* Involucrum hemispherical, sepals very viscid, acuminate, nearly equal, about two series, foliaceous, and somewhat spreading; rays few, pale purple. A genuine alpigenous Aster, no Tripolium. Allied to the preceding, but a small, slender plant. *Tripolium pauciflorum*, (NEES.)—In the Herbarium of the Academy of Natural Sciences, Philadelphia.

*Aster *denudatus*, stem erect, at length almost scapiform, pubescent above; radical leaves lanceolate or spathulate, rarely subdenticulate, smooth and coriaceous, scabrous on the margin, ciliate at base; stem leaves very small, linear-lanceolate, amplexicaule; branchlets usually one-flowered, fastigiate, forming a wide corymb; involucrum short, imbricate, outer sepals foliaceous, oblong, obtuse, the inner somewhat acute; achenium nearly smooth, acute at base.—HAB. In arid and dry grassy plains in the Rocky Mountains, near Lewis' River, about latitude 42°, not uncommon. Root creeping. Stem twelve to sixteen inches high, clothed more or less to the base with small leaves; branches of the corymb elongated, leafy, mostly one-flowered, margins of the leaves very rough, ciliate with minute hooked bristles; radical leaves mostly lanceolate, on the suckers spathulate and obtuse. Capituli about the size of those of *Erigeron alpinum*. Involucrum shorter than the disk. Rays rose-purple, thirty to forty. Pappus bright brown, scabrous. Achenium compressed, a little pubescent, almost stipitate at the base!

*β. *ciliatifolius,* leaves distinctly ciliated, stem not denuded and scapiform, leaves more proportionate, upper part of the stem pubescent; sepals of the involucrum similar, brownish, ciliate and subacute.

HAB. With the above; probably a distinct species, but my specimens are not satisfactory.

Aster ramulosus. LIND. in HOOKER, Flor. Bor. Am. II., p. 13. Common in the Rocky Mountain region, along the plains of Lewis' River. Flowers pale purple. Radical leaves lanceolate, entire, attenuated into long petioles. It bears not the most distant affinity with *A. biennis,* (*A. incanus,* PH.,) which, in fact, resembles Amellus more than Aster, and constitutes a distinct genus.

*Aster *campestris,* somewhat minutely and viscidly pubescent, leaves linear-oblong, subacute, entire and amplexicaule, obscurely three-nerved, radical, lanceolate serrulate; capituli in narrow racemose panicles, the branches mostly one-flowered; involucrum spreading, viscid, the sepals linear and very acute.

HAB. With the above, which it closely resembles, but differs in being every where somewhat pubescent and viscid, with a strong scent, and particularly in the distinctly veined, serrulate radical leaves, and the obtuse, instead of the attenuated extremities of the stem leaves. Stem about a foot high. Achenia nearly smooth; pappus brownish, scabrous.

*Aster *bracteolatus,* stem pulverulently pubescent, leaves linear or oblong-linear, acute and sessile, entire, radical. . . .; flowers racemosely paniculate, branches leafy, mostly one-flowered; involucrum smooth and leafy, spreading; sepals oblong, somewhat acute, the lower series similar with the branch leaves.

HAB. With the above, to which it is nearly allied, but remarkable by the smooth leaf-like involucrum. The radical leaves are unknown; flowers lilac-purple, rather large. Stem and branches much more leafy than in the two preceding; the leaves nearly all similar.—July.

Aster Douglasii. Common in inundated tracts, and along the low banks of the Columbia and Wahlamet. Scarcely distinct from some of the varieties of *A. Novi-Belgii,* or *A. luxurians,* though in a large collection, that of the Schweinitzian Herbarium, I find nothing exactly similar.—Flowering in August and September.

*Aster *asperrimus,* minutely hairy and very rough; stem elongated, subdecumbent, terminating in a few-flowered corymb; leaves entire, nearly similar, oblong, obtuse, amplexicaule, lower ones spathulate; branches long and leafy, the lateral one-flowered; the capituli large; involucrum loosely imbricate, squarrose; rays elongated; achenium pubescent.

Hab. In Georgia, (Dr. Baldwin and Leconte,) near Chapel-Hill, North Carolina, (Schweinitz.) —A remarkably distinct species, diffusely subdecumbent, with slender wiry stems and branchlets, terminating in one or a few (three to five) large capituli, very similar to those of *A. surculosus*, near which it ought to range. Exceedingly rough, (particularly when dry,) with minute, tuberculate, hooked bristles. Rays large, and of a purplish-blue. The inner leaves of the involucrum somewhat viscid at the tips.

*Aster *amethystinus*, pubescent; stem usually erect, villous, racemosely paniculate, many-flowered, branchlets subfastigiate; leaves entire, lanceolate-linear, acute, auricularly dilated and amplexicaule at base; involucrum loose, or squarrose, the sepals acute or acuminate; achenium villous; rays numerous, azure.

Hab. In Massachusetts, near Cambridge and Salem; rare. A well marked and ornamental species, somewhat allied to *A. graveolens*, intimately to *A. Novæ-Angliæ*, but from which it is entirely distinct, the flowers not half the size, pale blue, very numerous, and disposed in a panicle, &c.

Aster graveolens, suffruticose, divaricately branched, minutely and viscidly pubescent; leaves oblong-lanceolate, amplexicaule, entire, very acute, radical ones narrowed at the base; branches usually one-flowered, fastigiate; involucrum squarrose, loose, leafy; sepals linear-lanceolate, acuminate; achenium smooth, ten-ribbed.

Hab. On shelving rocks, near the banks of the Arkansa; also on the banks of Kentucky River, near Lexington, (Dr. Short.) On comparing the plants anew, I find the present and following from Missouri, distinct species.

Aster oblongifolius, herbaceous, stem, and linear-oblong, obtuse leaves minutely scabrous, amplexicaule; stem divaricate, flowers fastigiate; involucrum foliaceous, loose; sepals linear-oblong, acute.

Hab. Banks of the Missouri, in arid, argillaceous and denudated places. Not viscid or strong-scented, as in the preceding, to which, at the same time, it is much allied.

*Aster *Sayianus*, stem simple, terminating in a leafy corymb, above, and branchlets with the involucrum glandularly pubescent; leaves crowded, lanceolate, acuminate, distantly serrulate, amplexicaule, and scabrous on the margin, those of the branchlets ovate, entire; sepals of the involucrum spreading, nearly equal, acuminate; capitulum hemispherical, the rays blue; achenium smooth, ten-striate.

Hab. In the forests of the Rocky Mountains and the Oregon plains. Nearly allied to *A. modestus*, and proximately to *A. Novæ-Angliæ*.

OBS.—About a foot high; stem below minutely pubescent. Leaves about three inches long, less than an inch wide, scabrous towards the margin, elsewhere nearly smooth and rather shining. The corymb composed of fastigiate, mostly one-flowered, (sometimes two or three,) leafy branchlets; occasionally, from luxuriance, the branchlets are more compound, producing a rather irregular corymb; the points of the leaves long, and very acute; sepals about two series, nearly equal, herbaceous and viscid. Rays styliferous, rather numerous and narrow, pale blue. Pappus whitish, moderate, scarcely scabrous. Achenium almost perfectly smooth, compressed, ten-striate. This species has much the habit of a Galatella.

*Aster *ciliatus*, branches one-flowered, fastigiate; leaves entire, linear-oblong, acute, above lanceolate, very scabrous and ciliated on the margin, above nearly smooth, beneath minutely hairy and hirsute; involucrum foliaceous; leaflets lanceolate, very acute, margined with long ciliæ; achenium smooth.

HAB. In Louisiana, v. s., in Mr. Durand's herbarium, of Philadelphia. Closely allied to *A. montanus*, with the same achenium, but the upper leaves lanceolate, and the pubescence at variance with the section to which it belongs.

TRIPOLIUM. (Nees.)

With the flower of ASTER, but the involucrum erect, of two unequal series of oblong or ovate, obtuse, short sepals. Achenium compressed, margined, nearly smooth, without striæ, with a minute basal circle of bristles. Flowers corymbose. OBS.—To this genus, properly restricted, nothing yet belongs but the *T. vulgare*. (*Aster Tripolium*, LIN.)

Subgenus (or, perhaps, more properly a section of ASTER.) *ASTROPOLIUM.

With the flower of ASTER. Sepals of the involucrum mostly subulate, or acute, imbricated loosely in several unequal series, more or less herbaceous. Pappus slender, scarcely scabrous. Achenium nearly smooth, compressed, four or five striate.—Smooth, divaricately branching herbs, mostly with entire, narrow, or subulate, somewhat fleshy leaves. Growing commonly in saline soils or alluvial grounds.

Tripolium flexuosum, sepals lanceolate, subulate, very acute, scariose, erect; stem low and flexuous, stem leaves subulate.

HAB. Along the sea coast, New Jersey, &c.

Tripolium **Oregonum*, stem rather tall, flexuous, and divaricately branched; cauline leaves long, linear, sublanceolate, nearly equal, acute, entire, scabrous on the margin; sepals linear-lanceolate, imbricate, slightly acute, herbaceous; rays narrow.

Hab. On the inundated banks of the Wahlamet; flowers very inconspicuous, somewhat fastigiate.

Tripolium **divaricatum*, stem rather naked, slenderly and divaricately branched; radical leaves spathulate, or lanceolate, subdenticulate; stem leaves above, very short and subulate, clasping; sepals subulate, acuminate, scariose, imbricate, and somewhat equal; achenium smooth, with four striæ.

Hab. Inundated banks of the Mississippi, and in Louisiana, not uncommon. Very smooth, the radical leaves thick, flowers rather conspicuous, rays blue. Remarkable for its divaricate and naked branches. A plant very similar occurs on the coast of Cuba.

Tripolium **occidentale*, stem nearly simple, few-flowered, flowers large and corymbose; leaves all linear, subulate amplexicaule, here and there incisely serrate; involucrum loosely imbricate; sepals subulate, subherbaceous, nearly equal; rays as long as the disk, (pale blue;) achenium nearly smooth, scarcely striate, compressed.

Hab. By the margins of muddy ponds in the Rocky Mountains, seven thousand feet above the level of the sea. Root creeping, slender; stem slender, four inches to a foot high, often only one or two-flowered, seldom more than five or six. Leaves long and narrow, linear, entire, or with one or two pair of deep, incise serratures, almost approacing to a pinnatifid division; branchlets slender, one-flowered. The flower as large as a daisy, with a simple series of pale blue, or pink rays. An alpine species, approaching the true Tripolium in the fruit being almost destitute of striation.

Tripolium **frondosum*, stem much branched, leaves linear, entire, amplexicaule, rather obtuse; capituli fastigiate; sepals linear-oblong, loose and leafy, rather obtuse; rays numerous, very small and slender; achenium nearly smooth, about four-striate.

Hab. By muddy ponds in the Rocky Mountains, near Lewis' River of the Shoshonee; rare. Growing partly in the water and mud. Apparently biennial, succulent, with very inconspicuous flowers, and an entirely leafy, nearly equal involucrum of about two series of leaflets.

Tripolium subulatum. Allied to the preceding by its numerous small rays. Achenium slightly pubescent, compressed, with five striæ.

Tripolium conspicuum, also comes in this section; remarkable for the great inequality of the sepals, which are coloured at the tips. Achenium scarcely compressed, pubescent, very slenderly five-striate.

*Tripolium *imbricatum;* like the preceding, but with the long, linear, amplexicaule leaves distantly serrulate; branches somewhat corymbose; involucrum turbinate, closely imbricated in four series of acute, oblong sepals, pale below, and coloured or herbaceous at the tips; rays narrow and short. Achenium subcylindric, five-striate.

Hab. In Chili, near Valparaiso, (Dr. Styles.) Allied to the preceding, but with a very different involucrum and much larger capitulum.

*XYLORHIZA.

Capitulum radiate, rays feminine, fertile, the liguli in one series, rather large, toothed at the point; florets of the disk five-toothed, hermaphrodite, fertile. Apex of the stigma conic-lanceolate, narrowed. Involucrum widely hemispherical, sepals nearly equal, herbaceous, imbricated loosely in two series, acuminated, the inner ones with membranaceous margins. Receptacle flat, alveolate. Achenia subterete, silky, not marginated. Pappus of several series, unequal, scabrous.—Herbaceous subalpine plants, with woody roots, sending out numerous dwarf, simple stems, terminating in one, or a small corymb of large flowers. Leaves linear, entire; disk yellow. Ligulæ rose-coloured, or pale purple.—(So called from ξυλον, *wood*, and ριξον, a *root*. The root only being woody.)

Obs.—Allied to *Calimeris*, which it represents, differing somewhat in habit, and wholly in the fruit. From *Aplopappus* it differs in its heterochromous flowers, and more slender, not paleaceous pappus, as well as in habit.

*Xylorhiza *glabriuscula;* base of the stem and primary leaves only pubescent; leaves oblong-linear, or lanceolate-linear, acute, coriaceous; peduncles solitary or corymbose, three to five; sepals lanceolate, much acuminated.

Hab. In arid, argillaceous tracts in the Rocky Mountains, and on rocks toward the sources of the Platte. Flowers large, the rays pale rose-colour. Root thick and stout, woody, sending up clusters of low, simple stems, terminating in one to five flowers; leaves about two inches long, two lines wide; rays oblong, slightly three-toothed; peduncles short and naked. Stem about a span high. Pappus bright brown, barbellated.

Xylorhiza * *villosa*, softly villous; leaves oblong-linear or sublanceolate, mucronulate; stem mostly one-flowered; sepals of the involucrum lanceolate, very acute, nearly all equal; flowers large.

HAB. With the above, but less abundant. Very similar to the preceding; root equally large and woody. Flower as large as that of the garden marygold. Rays wide, and longer much than the disk, pale red. Involucrum pubescent, nearly equal. A showy plant, well deserving of cultivation. Achenia very silky, as in the preceding.

*EUCEPHALUS.

Capitulum radiate, styliferous rays, fertile; liguli of one series (seven to fifteen;) hermaphrodite florets of the disk fertile. Stigma slender, filiform, acuminate, nearly smooth. Involucrum ovate, imbricate, of three or four series of nearly similar ovate, carinated scales. Receptacle flat, alveolate, fimbrillate. Achenia angular, pubescent (or smooth in *C. alba.*) Pappus about two series, scabrous, simple and clavellate.—Herbaceous perennials with nearly simple stems, the summit, or the fastigiate branches, corymbose. Leaves entire, the radical rarely serrulate. Disk yellow. Liguli pale purple or white.—Plants with the habit of *Galatella,* and the pappus of *Sericocarpus.* (The name alludes to the elegant appearance of the calyx.)

† *Achenia pubescent, flowers purplish.*

Eucephalus * *elegans;* minutely scabrous; stem attenuated; leaves all entire, linear-lanceolate, sessile, acute, the lower three-nerved; flowers in a short, unequal, contracted corymb; sepals purplish, ovate, acute, one-nerved, pubescent on the margin; rays purplish, about six or seven.

HAB. Oregon plains and the Blue Mountains of the west. Flowering from September to October.—A very elegant species, with a stout ligneous root, sending up a cluster of simple stems, two to three feet high, thickly clad with erect leaves, becoming smaller towards the summit, one to two inches long, by a quarter to half an inch wide, scabrous towards the margin; branchlets about an inch long, one-flowered; capituli eight to twelve in number. Involucrum of four series of very elegant, purplish, ovate, acute, appressed, carinated scales, conspicuously pubescent along the margin. Rays three-toothed, about six to seven, rather narrow and distant, pale purple; tubular florets fifteen to twenty. Pappus exserted beyond the involucrum, as long as the florets, of two kinds, one bristly, the other clavellate, or wider towards the extremity. Receptacle alveolate, alveolæ with elevated, lacerated margins, much more distinctly so than in any *Sericocarpus*.

† † *Achenia smooth, flowers white.*

Eucephalus albus, leaves lanceolate linear, scabrous on the margin, remote, entire, radical ones denticulate, lanceolate; corymb few-flowered; rays fourteen to fifteen, white.—*Chrysopsis alba,* NUTT. Gen. Am., Vol. II., p. 152. *Heleastrum album,* DECAND., Vol. V., p. 264. Certainly not a congener with *H. paludosum,* which (notwithstanding the variation of pappus) is a true Aster. Involucrum of three series of greenish carinated scales.

† † † * LAGATEA.—*Inner scales of the involucrum longer; pappus scarcely clavellate.*

Eucephalus glaucus; smooth and glaucous; leaves linear-oblong, acute, subamplexicaule, entire; stem branching above; flowers racemose, corymbose; scales of the involucrum oblong-ovate, obtuse.

HAB. Towards the sources of the Platte, and in the Rocky Mountains. Rays purplish, narrow, about fourteen. Pappus slender, nearly or wholly equal; tubular florets, about fifteen to twenty. Flowers fastigiate, but sometimes racemose on the branchlets. Stem twelve to eighteen inches high. Leaves two to three inches long, smooth and somewhat coriaceous, reticulately veined, a little scabrous on the margin, less than half an inch wide. Scales of the involucrum about three series, the innermost longer, thin and acute.

*Eucephalus *ericoides;* a small alpine, cæspitose plant, canescently hirsute and glandular, with appressed short hairs; leaves subulate, minute, channelled, ciliate and acute, almost imbricately approximate, erect; branching from the base, branches one-flowered; rays white, about fifteen; achenia smooth.

HAB. Towards the summit of the Rocky Mountains. Collected by Dr. James. *Inula? ericoides,* TORREY, Lyceum Nat. Hist., N. York, l. c. *Chrysopsis ericoides,* EATON'S Manual, l. c. About four or five inches high, with leaves about the size of those of *Juniperus virginiana,* and nearly as much imbricated as the younger leaves of that tree, about a line long and half a line wide, white, with appressed hairs, nearly smooth on the upper side and pointed with a bristle, the lower ones strongly ciliate. Involucrum ovate, campanulate, imbricated in two unequal series of appressed, lanceolate, acute scales, membranous on the margin. Rays apparently white, or purplish, with exserted, filiform, smooth stigmas. Stigma in the discal florets pubescent. Pappus of rather few, scarcely scabrous, slender white rays. No double pappus.

*DIETERIA.

Flower radiate, rays styliferous, fertile? liguli one or two series, broadish, those of the disk hermaphrodite, fertile. Stigma filiform, hirsute and exserted. Sepals of the involucrum, for the most part, closely imbricated in two to four series, scariose and carinate, the tips usually reflected and herbaceous. Receptacle flat or convex, alveolate, the alveolæ deep, with toothed and lacerated margins. Achenium obovate, subcylindric, ten to fifteen striate, pubescent. Pappus of several series, scabrous and unequal, that of the ray shorter and less copious.—Annual or biennial, (in one anomalous species perennial,) divaricately branching herbs, more or less pubescent; leaves nearly entire, incisely serrate or pinnatifid, the points often pungently mucronulate. Flowers fastigiate. The disk yellow. Liguli red or purple.—Allied to *Aster*, but with the involucrum regular; the achenia convex, distinctly striate when ripe; the receptacle deeply alveolate; the pappus of the ray different from that of the disk; the leaves incise or pinnatifid, and the duration only to the first period of flowering. They are also allied to the first section of *Heterotheca* by the deficient pappus of the ray, but that of the disk is simple, and the rays are purple. The whole plant bitter to the taste.—(So called from their biennial duration.)

† *Involucrum subovate, of three or four series of scales.*

Dieteria canescens; leaves entire, linear, sessile, radical spathulate; stem low and much branched, canescently villous, as well as the involucrum; flowers fastigiate; rays about eighteen to twenty; pappus very slender.

Hab. On the denuded banks of the Missouri. *Aster canescens*, Pursh, Bor. Am., Vol. II., p. 547. Not in the least allied to *Aster multiflorus*. *A. biennis*, Nutt. Gen. Am., Vol. II., p. 155. I doubt if the leaves are always entire, a fact so contrary to all the rest of the genus to which it is, in all other respects, so intimately allied.

*Dieteria *pulverulenta;* minutely pubescent, leaves linear sessile, below here and there incisely serrulate, above entire; stem divaricate; flowers fastigiate, upon rather naked branchlets; involucrum almost hemispherical; rays eight to twelve.

Hab. Arid plains towards the sources of the Platte. Rays short, pale purple, obscurely toothed, almost entire. Nearly allied to the preceding. Scales of the involucrum about three series, acute.

*Dieteria *divaricata;* pulverulently pubescent, radical leaves spathulate or lanceolate, repandly and incisely serrate, above smaller, linear, sessile and nearly entire; stem divaricate, branchlets subracemose, or one or two flowered, fastigiate; sepals about four series, reflected; rays twelve to sixteen, about as long as the disk.

Hab. Denudated plains of the Rocky Mountains, and Oregon, common. Rays short, pale blue or purple. Pappus fulvous or white, (the white shorter and less copious, perhaps the mark of a different species;) branches rather naked, with small leaves spreading out into a compound corymb. About a foot high.

*Dieteria *viscosa;* pulverulently pubescent, and more or less glandular and viscid; leaves all linear or lanceolate-linear, pinnatifidly or incisely serrate, acuminate, uppermost entire, sessile; stems simple, racemosely and corymbosely branched; scales of the involucrum acute, reflected at the tips, imbricated closely and equally in about five series; rays eighteen to twenty, about as long as the disk.

Hab. With the above, particularly near Scott's Bluff, on the Platte. Rays longer than in the preceding, purple. Stem simple, attenuated, often very viscid, and exhaling the strong, heavy scent of *Aster graveolens* or *Gnaphalium Americanum.* Scales of the involucrum very numerous, lanceolate, acute. Leaves sometimes nearly pinnatifid or runcinate. Pappus fulvous, that of the discal florets about thirty-five to forty unequal rays, that of the radial female florets much shorter, of about twenty-four rays.

*Dieteria *sessiliflora;* viscidly pubescent; stem simple, flowers sessile, in axillary and terminal clusters; leaves linear or sublanceolate, incise or subpinnatifid, acutely acuminate, sessile; sepals in about four series; rays *ochroleucous,* twelve to fifteen, about the length of the disk.

Hab. With the above. About a foot high, stem mostly unbranched, scales of the involucrum very glutinous. Nearly allied to *Aplopappus spinulosus,* (Decand.) to which I applied the name of *Sideranthus* in Fraser's catalogue; that plant is, however, perennial. Closely allied to the preceding species, but differing much in the pale *yellow* rays; the pappus of the rays is, also, nearly equal with that of the discal florets. Flowers smaller than in any of the preceding.

† † *Root perennial. Flowers wholly yellow.* (Sideranthus.)

Dieteria spinulosa. Aplopappus spinulosus. Decand. Vol. V., p. 347. This species, though with yellow flowers, ought to find place in this genus, rather than the polymorphous one of Aplopappus, to which it is not allied.

Subgenus.—Pappochroma. Annual or biennial. Capitulum hemispherical. Receptacle nearly naked. Involucrum loosely imbricated, of about three series of nearly equal, narrow sepals, spreading towards the points. Pappus of the disk and ray equal. Achenium obovate, villous, with fifteen striæ. Rays purple, longer than the wide disk. Leaves pinnatifid and bipinnatifid.

Dieteria **coronopifolia;* pubescent and viscid, branching from the base, branches fastigiate one-flowered; lower leaves bipinnatifid, the upper pinnatifid. *Chrysopsis coronopifolia,* Nutt., in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 34.

Hab. From the Platte to the sources of the Missouri, and throughout the Rocky Mountain tract, in arid, denudated places, by streams. Flowering from July to August. A very showy and ornamental plant, with hemispherical heads nearly as large as the garden marigold. Sepals linear-lanceolate, acuminate, nearly equal, scarious and cartilaginous towards the base. Rays eighteen to twenty, wide and long, of a fine red purple. Achenia turgid, rather large; stem about a foot high, somewhat spreading.

SERICOCARPUS. (Nees.)

Obs.—Pappus unequal, scabrous, the longer rays clavellate. Liguli short and few.

Sericocarpus rigidus. β. **lævicaulis,* leaves cuneate-oblong, or spathulate; rays shorter than the pappus.

Hab. Round Fort Vancouver, common. Leaves usually obtuse.

*Sericocarpus * Oregonensis;* leaves lanceolate-oblong, entire, and, as well as the involucrum, glandular beneath, above scabrous; stem smooth, corymb compound; inner scales of the involucrum acute; rays longer than the pappus.

Hab. With the above, which it much resembles, but appears taller and stouter. Stem attenuated. Pappus distinctly scabrous, the inner row obviously clavellate, less distinctly so in *S. rigidus.* The discal florets are also exserted beyond the pappus. Stigmas filiform, acute, nearly smooth, glandular. In both these species the pappus is unusually long and silky white.

Sericocarpus Collinsii. With the whole aspect and pubescence of *S. tortifolius,* but the leaves cuneate and serrate at the summit. Scales of the involucrum fewer. *Aster Collinsii,* Nutt. East Florida. (Mr. Ware.)

Obs.—Aster *gracilis* is a true Aster, nearly allied, indeed, to *A. surculosus* and *A. spectabilis.* The receptacle is naked, the achenium nearly smooth, with five striæ, scarcely, however, compressed; the pappus, pale brown, is scabrous, but not thickened. The floral rays are long and blue; the involucrum at length somewhat squarrose.

Heleastrum, (notwithstanding the slight difference of pappus,) ought, I think, to be reunited with Aster. The achenium is quite similar to that of *Aster gracilis,* to which section, and *A. surculosus,* it evidently belongs.

Biotia. We have but two well marked species. Of *B. corymbosa* I have seen two varieties, which insensibly lose themselves in each other, on an extensive comparison, in nature as well as in the herbarium. The *B. commixta* is the *corymbosa,* when grown in dry or rocky situations; in moist grounds the heart-shaped leaves are best developed. The lowest leaves in *B. commixta* are also cordate.

The *B. glomerata* appears to be a species, though it approaches *B. commixta.* In the herbarium of the Academy of Natural Sciences of Philadelphia it is marked by Mr. Schweinitz under the name of *Aster thyrsoideus,* and was obtained near Bethlehem, in Pennsylvania. It is distinguished by the shortness of the rays and the brevity of the pappus.

GALATELLA. (Cassini.)

§ *Calianthus.—Liguli in one series, styliferous, elongated; discal florets tubular, five-toothed, hermaphrodite. Receptacle naked, flat, and punctate. Involucrum short, imbricated, sepals unequal, herbaceous, narrow and acute, in about three series. Stigmas exserted, clavate, pubescent, in the ray filiform. Achenium obovate, subcylindric, smooth and glandular, with seven to eight strong striæ, or ribs; pappus copious, slightly scabrous.—Perennial plants of wet marshes, more or less scabrous; leaves entire, lanceolate, crowded, glandular punctate; corymb of few flowers, the branchlets almost naked, like peduncles and squamose, the scales gradually passing into those which compose the very regular involucrum. Rays lilac or reddish.—Nearly allied, in habit to *Diplopappus linariæfolius,* less so to *Aster,* from which the achenium differs; also to *Calotheca*, but wholly different in the involucrum and pappus. Of the true *Galatella* we have no species. In our section the flowers are larger, fewer, and scarcely corymbose.

Galatella nemoralis, NEES. Ast. 173. DECAND. Prod., Vol. V., p. 257. *β. rubella*, smoother, with narrower leaves, a pink red flower, and a white pappus.

HAB. In sphagnose swamps, from New England to Canada. β. Quaker Bridge, New Jersey. Flowering in September.

Galatella graminifolia. HOOK. Flor. Bor. Am., Vol. II., p. 15. *Aster graminifolius*, PURSH, Flor. Bor. Am., Vol. II., p. 545. I have not had an opportunity of examining this plant, but, from its near affinity to the preceding, believe it to belong to the present section.

DIPLOPAPPUS.

Diplopappus alpinus; cæspitose and low; stems simple, one-flowered, villous, many from the same root; leaves sessile, erect, crowded, entire, oblong, apiculate, scabrous, with a cartilaginous margin; upper part of the stem terminating in a naked peduncle; involucrum villous; scales very acute; rays numerous, longer than the disk. *Chrysopsis alpina*, NUTT. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 34.

HAB. In dry prairies along the borders of Flat-Head River, in the Rocky Mountains. Flowering in June. A very elegant and distinct alpine species, still proximately allied to *D. linariæfolius*, of which it has the purple flower. Stems three to four inches high. Flowers large. Leaves oblong and linear-oblong, smooth, but very scabrous, rigid. Involucrum rather short and loose, of about three series of linear-lanceolate, appressed scales, membranaceous on the margin. Pappus scabrous, copious, the external crown white. Achenia silky villous.

TOWNSENDIA. (Hooker.)

Townsendia sericea; cæspitose; leaves narrow linear, acute, scarcely half a line wide, canescently sericeous; capituli sessile on the caudex; scales of the involucrum numerous, very narrow and acuminate.—Achenium as in the rest of the genus, obovate, margined, and flatly compressed, sericeous, with a numerous connate series of white, silky pappus, almost plumosely barbellate, and remarkably attenuated above.

Hab. On the Black Hills, (an alpine chain toward the sources of the Platte.) Flowering probably in April. By the achenium, this genus makes some approach to *Calimeris*, though totally unlike in habit.

*Townsendia *incana;* whitely canescent; many-stemmed, cæspitose; leaves linear-spathulate, somewhat acute, scales of the involucrum lanceolate, ciliate; pappus of the rays short.

Hab. With the above. Flowering in June. Stem very short, depressed and dichotomous. Flowers sessile. Rays pale lilac. Florets numerous. Pappus of about twenty-four almost plumose rays, connected together in a ring, broad below, and attenuated gradually above. Rays about twelve; three-toothed, with a short, nearly equal, barbellate pappus, similar to that of the hermaphrodite florets, except its shorter length. Stigmas of the rays slender, filiform, smooth, of the tubular slightly five-toothed discal florets included, lanceolate, a little hirsute, (as in *Aster*.) Achenium flat and margined, thinly clothed with glandular hairs.

Subgenus.—* Urophorus.

Pappus of the rays and disk equal, acuminate, and plumosely barbellate, connected into a ring above the base, deciduous.—Perhaps a genus?

*Townsendia *spathulata;* cæspitose, many-stemmed, canescently and softly tomentose; leaves spathulate obtuse; scales of the involucrum lanceolate-oblong, fimbriate.

Hab. With the above. Perennial, like all the preceding, also equally cæspitose, with the leaves in dense clusters, forming circular tufts; the flowers, also, equally solitary and sessile. The whole dwarf plant has much the aspect of the one-flowered variety of *Gnaphalium supinum;* flowers very inconspicuous; the capitulum almost imbedded in the clustered leaves. The leaves are broader than in the preceding, the liguli but little longer than the pappus, and scarcely exserted beyond the involucrum. Achenia oblanceolate, margined, slightly pubescent on the disk, and usually naked by the escape of the deciduous pappus, which is not the case in any of the preceding. Though the habit is wholly similar, the present plant probably constitutes an allied genus. By the pappus and achenium this small tribe of Asteroideæ seem to approach the Carduineæ.

Subgenus.—* Nanodia.†

With the rays infertile or neuter, flat and exserted, usually three-toothed. Pappus of the infertile ray very short, even; that of the discal florets scarcely deciduous. Receptacle flat, alveolate-punctate, fimbrillate. Achenium com-

† In allusion to its dwarf appearance.

pressed, flat, oblanceolate, marginate, the disk glandularly pubescent.—Dwarf alpine annuals, with depressed, divaricate stems, branching from the base. Strigosely and canescently pubescent; leaves linear, entire. Flowers sessile, terminal, somewhat corymbose, large for the size of the plant. Involucrum imbricate, scales lanceolate, membranous on the margin, which is lacerately ciliate. Rays longer than the disk, lilac, or rose-purple. Sometimes presenting a rudimentary style, but the achenium always imperfect.

*Townsendia *strigosa;* stem depressed, branching from the base; flowers fastigiate, subcorymbose; leaves linear-spathulate, much attenuated below; sepals lanceolate-ovate.

Hab. On the Black Hills, (or eastern chain of the Rocky Mountains,) near the banks of the Platte.—Flowering in June. Rather softly strigose, with short, appressed, whitish hairs. From two to four inches high, the branches spreading, dividing usually into a sort of leafy corymb of sessile flowers, from one to five on a forked branch. Capitulum the size of the common daisy, with much the aspect of an *Aster*, but the sepals all erect, closely imbricated, broadly membranous and lacerate on the margin. Rays twelve to fourteen, rose-red; discal florets pale yellow. Stigmas acuminate, somewhat pubescent, scarcely at all exserted.

*Townsendia *grandiflora;* stem canescent, divaricately branching from the base, branches one or few-flowered, leaves linear-sublanceolate, very acute, nearly smooth, or minutely pubescent, green; capitulum hemispherical; involucrum of three series, the sepals lanceolate, filiformly acuminate, minutely fringed; rays twenty-eight to thirty, or more, bidentate.

Hab. With the preceding, which it resembles wholly in habit, but with the flower as large nearly as that of the China Aster, (*Callistephus Chinensis.*) Branching from the base, and spreading out sometimes from six to ten inches along the ground. Leaves linear, much attenuated below, and very acute, when green rather succulent, and appearing smooth, though somewhat pubescent beneath, (seen through a glass.) Sepals elegantly imbricated, perfectly lanceolate, much acuminated, scariose, except the centre, which is green, the margin minutely lacerate-ciliate. Rays pale lilac, longer than the disk.—A plant which well deserves cultivation, from its large, showy flowers.

ERIGERON. (Linn.)

§. *Pappus mostly single, or with the external, very minute, rays numerous.*

Erigeron glabellum.—Rocky Mountain plains. Radical leaves sometimes more or less serrate. Pappus rather long and persistent, single, of about twenty-four slightly scabrous rays. Capituli sometimes as many as nine. The peduncles and upper part of the stem, from the smallness of the leaves, appearing almost naked. More or less puberulous.

Erigeron purpureum.—Oregon and Upper California, common.

*β. *attenuatum;* stem elongated and slender towards the top, very hairy at base; radical leaves spathulate-lanceolate, dentate; flowers white, the rays not much longer than the disk.

Hab. In Oregon and Arkansas Territory. Flowers white, and smaller than in *E. purpureum*, the whole plant more hairy. Perhaps a species.

Erigeron pumilum.

Hab. Rocky Mountains of the Platte. Stems one to four-flowered, heads fastigiate. Pappus single, of about twenty rays.

*Erigeron *bellidiastrum,* ⊙; stem leafy, corymbosely branched, hirsute; leaves entire, linear-oblong, sessile, scabrous on the margin, attenuated below, the radical ones slender; involucrum hemispherical, sepals lanceolate acute; rays about the length of the disk.

Hab. On the borders of the Platte, within the Rocky Mountains. About a foot high, the leaves thickish and rather smooth, one to two inches long, two to four lines wide. Rays pale red, about as numerous as in the common daisy, rather short. Pappus simple, very deciduous, of about ten rays! The natural situation of this species is in the section *Olygotrichium*, but the pappus is simple; and hence it appears that the pappus does not define the natural limits either in this or many other genera of Compositæ.

*Erigeron *cæspitosum;* cæspitose, hirsute, and almost canescent with short hairs; stems decumbent, many from the same root, mostly one-flowered; leaves linear-sublanceolate, somewhat obtuse, those on the stem sessile, all entire; sepals lanceolate acute; rays longer than the disk; achenium elongated, smooth.

Hab. On the summits of dry hills in the Rocky Mountain range, on the Colorado of the West. Flowering in August. Nearly allied to *E. Andicola.* Equally hirsute, with close white hairs. Leaves about one and a half to two inches long by two lines wide, those of the root clustered; on the slender low stems few; stems occasionally two-flowered; involucrum short and hirsute. Rays forty to fifty, rather wide, often three-toothed, white or pale rose. Pappus simple, of about twenty scabrous, slender bristles. An alpine species, with the flower as large as a daisy.

§. † *Rays of the capitulum not very numerous, pappus mostly simple.*
(ASTEROIDEA.)

Erigeron **filifolium;* canescently villous and somewhat hirsute; root woody, sending up many low, erect stems; leaves long and filiform, flowers corymbose, white; sepals acute, short; floral rays about twenty-five; achenia smooth. *Diplopappus filifolius?* (HOOK. Flor. Bor., Vol. II., p. 21,) but the rays are not yellowish.

HAB. In the Rocky Mountain range, in Oregon. Stems about eight to twelve inches. Leaves two to three inches long, narrow as those of the pine, on the young or infertile branches crowded. Rays about the length of the disk, few. Pappus simple, the bristly rays about twenty-five. Allied to *E. Montevidense*, but not shrubby.

Erigeron radicatus. HOOKER, l. c.

HAB. Blue Mountains, Oregon. A very dwarf, almost cæspitose species, with a short hirsute involucrum, and very short, white rays. Pappus simple, of about ten to twelve, very slender, scarcely scabrous bristles.

Erigeron **nanum;* dwarf and hirsute, leaves linear subspathulate, stem one-flowered, nearly naked; sepals lanceolate, hirsute; rays white, shorter than the disk; achenium pubescent; rays of the pappus barbellate, about fifteen.

HAB. In the Rocky Mountains. Resembles the preceding, but has hirsute leaves, and a different achenium and pappus.

Erigeron **pedatum;* smooth, cæspitose; primary leaves simple or trifid, afterwards pedate, unequally five-cleft; petioles elongated, strongly ciliate; scapes numerous, one-flowered; capitulum small, sepals acuminate, linear, a little hirsute; rays about the length of the disk; achenium pubescent.

HAB. On the gravel bars of small streams to the east of Walla-Walla, in Oregon. Nearly allied to *E. trifidus*, but very glabrous, and somewhat succulent; the flowers, also, numerous, and less than half the size, with the involucrum nearly smooth. Rays pale rose. Achenium somewhat sericeous; pappus of about twenty very slender, almost entire rays.

† † *Rays rather few, pappus double in ray and disk.*

Erigeron corymbosum; minutely pubescent, somewhat canescent; many stems from the same root, erect and low, terminating in a few-flowered corymb; leaves lanceolate-linear, sessile, entire and acute; sepals hispid, acute; rays blue, a little longer than the disk, (about thirty;) achenium nearly smooth, and striate.

HAB. Rocky Mountains, towards the Oregon. A very elegant and peculiar species, bearing some affinity with *E. speciosum.* Covered with a short, dense, pubescence, and with the margins of the leaves scabrous. Stem six to eight inches high. Corymb of three or four capituli. Pappus brownish, the exterior of white and slender paleæ.

*Erigeron * decumbens;* somewhat glabrous below; root creeping; stem leafy, somewhat decumbent, many from the same root; leaves long and linear, acute, scabrous on the edge, attenuated below, the upper ones somewhat pubescent; flowers in a corymb; branchlets one-flowered, slender, and often leafy; sepals acuminate, hirsute; rays white, about fifty, twice as long as the disk; external pappus minute.

HAB. With the above, of which, at first glance, it appears a variety, but differs in the numerous rays and minute external pappus, as well as general habit.

*Erigeron * ochroleucum;* subcæspitose; stem pubescent above; radical leaves linear-sublanceolate, entire, crowded, smooth, those of the stem narrower, short, and sessile; stems one-flowered, scapoid or corymbose, and few flowered, the branchlets long; sepals tomentose, canescent, lanceolate, acute; rays numerous, about the length of the disk, (ochroleucous,) achenium pubescent.

HAB. Plains of the Oregon. August. Allied to the preceding, but with much larger flowers and rays; remarkable for the clustered root leaves, which, in the scapoid variety, resemble a tuft of pine leaves, ordinarily three to four inches long, by about a line wide, smooth and thick, much like those of an *Armeria.* Stem about a span, branchlets three to five, one-flowered, forming, in stout plants, an irregular corymb. Rays of the pappus, in both ray and disk, very obviously double, the external ring white and shining, internal, of about fifteen bristles.

*Erigeron * foliosum;* rather hirsute and somewhat scabrous; stem simple, erect, terete, attenuated, the summit corymbose; leaves oblong-linear, sessile, entire, acute, crowded; sepals lanceolate, pubescent, acute, in about two series, and nearly equal; rays short, red, about thirty, achenia subhirsute.

HAB. Near St. Barbara, in Upper California. Flowering in May. A very remarkable species; the stem terete, full of leaves, one and a half to two inches long, and about two lines wide, diminishing in size with the attenuation of the stem. Sepals lanceolate. Pappus double, the outer small, the inner of many brownish rays. Stigma exserted, smooth, and nearly equally filiform in the ray; obliquely *truncate* and slightly pubescent in the discal florets. The rays narrow, about the length of the involucrum, of a full purple red. This species appears to be considerably allied to *Corethrogyne,* but it has the achenium of Erigeron, somewhat prismatic, with three or four longitudinal brown lines or nerves; but the obtuse stigma appears to be an anomaly in the genus. The aspect of the plant is much that of an *Aster.* (My specimens are too young to be satisfactory.)

† † *Leaves dissected. Achenium not striated, rays rather numerous. Pappus double, the setæ barbellated.* (TRIDACTYLIA.)

Erigeron compositum. (PURSH, Vol. II., p. 535.) Pappus double in ray and disk, the outer short, entire, the inner of eighteen to twenty barbellate, deciduous rays.

HAB. Kamas prairie, in the Rocky Mountains. Flowering in June.

§. PHÆNACTIS, (*Stenactis* in part.)—Pappus persistent and scabrous, of fifteen to twenty-four setæ, external minute pappus simple; achenium compressed, with three to five striæ, radial florets very numerous.—Perennial, with entire leaves.

Erigeron speciosum, (DECAND., Vol. V., p. 284.) OBS.—Pappus double both in ray and disk; the exterior short and subulate. *Stenactis speciosa,* (LIND. Bot. Reg. t. 1577.) Common on the plains of the Oregon.

Erigeron macranthum; smooth, lower leaves spathulate-oblong, obtuse, attenuated at base; stem leaves elliptic-ovate, or ovate, abruptly apiculate, scabrous on the margin; peduncles few, one-flowered, corymbose; rays a little longer than the disk; sepals narrow and acuminate, glandular.—*Erigeron grandiflorum,* NUTT. in Journ. Acad. Nat. Sci., Vol. VII., p. 31, not of HOOKER.

HAB. Sources of the Missouri and the plains of the Platte. Flowering in August. Allied to the preceding. Rays numerous, blue. About eighteen inches high. Flowers four or five on a stem.

*Erigeron *hispidum;* stem erect, corymbose, above scabrous and hispid; leaves entire, ciliate and scabrous on the margin, radical spathulate, cauline sessile, acuminate; peduncles elongated, one-flowered; sepals of the involucrum hoary, hispid, very hirsute, much acuminated; rays very numerous.

HAB. St. Barbara, Upper California. Nearly allied to *E. speciosum,* from which, however, it is very distinguishable by its exceedingly hirsute involucrum, and hispid, naked, elongated peduncles; the leaves appear, also, broader, and scabrous towards the points. Rays blue, more numerous than in *speciosum,* and not so long. Pappus double in ray and disk; rays twenty to twenty-four, persistent.

*Erigeron *maritimum;* stem pilose, decumbent, branching from near the base; leaves thick and entire, spathulate-oblong, sessile, obtuse, the lower narrowed at base; branches several, one-flowered, flower large, rays very numerous; involucrum lanuginous as well as the margins of the leaves, sepals acuminate.

HAB. On the sea-coast of the Oregon and Upper California. A large, rather succulent leaved plant, sending up several stems about a foot high, with leaves and flowers very similar with those of *Erigeron bellidifolius.* Stem and uppermost leaves softly hairy, somewhat three-nerved. Flower very large, rays pale red. Achenium angular, with four or five brown striæ. Pappus double, rays of the pappus twenty to twenty-four, about the length of the discal florets, and not deciduous.

Annual or perennial. Leaves entire or lobed. Pappus double in ray and disk, the inner of eight to fifteen, short, deciduous, somewhat scabrous rays. OLYGOTRICHIUM; (STENACTIS in part.)

*Erigeron *divaricatum;* ⊙ hirsute, stem branching from the base; branchlets one-flowered, rather naked, fastigiate; radical leaves spathulate, the rest linear, sessile, acute, attenuated below, all entire; inner pappus of about eight setæ; rays very numerous, narrow, white.

HAB. In the Rocky Mountains and the plains of Oregon. About one foot high, at length very much branched, the leaves an inch or more long, about a line wide. Pappus double in ray and disk, the inner of remarkably few rays, very deciduous.

Erigeron tenue, (GRAY.) *E. quercifolium,* NUTT. and DECAND., not of LAM., pappus double in ray and disk, the inner of about twelve short deciduous bristles.

Erigeron strigosum β. gracile; stem leaves and involucrum pubescent, branches fastigiate.

HAB. Oregon plains.

*Erigeron *occidentale,* ♃; hispid with a short pubescence, corymb compound, irregular; lower leaves oblong-lanceolate, obtuse, subserrulate, upper linear entire; sepals lanceolate, acute, scarcely hirsute; rays very numerous, red; inner pappus of about twelve rays; the outer very distinct.

HAB. In Oregon. A low perennial species, with broadish leaves on the lower part of the stem. Allied to *E. strigosum,* but scarcely the same, with red flowers and broad leaves.

§. TRIMORPHÆA. (Decand. Vol. V., p. 290.)

*Erigeron *nivale;* stem subcæspitose and hairy at the base, mostly with one capitulum; radical leaves spathulate, cauline lanceolate, acuminate, subamplexicaule; summit of the stem and involucrum glandularly pubescent; sepals linear and acuminate, (not hirsute;) pappus longer than the linear, elongated, somewhat pubescent achenium.

HAB. In the central chain of the Rocky Mountains, towards the sources of the Colorado of the West, on the limits of perpetual snow, (lat. 42°.) Allied to *E. alpinus*, but with semiamplexicaule leaves, widest at the base. Pappus longer than the involucrum. Rays? . . . . A few filiform female florets outside the discal ones. Achenium long and linear, compressed, slightly silky.

Erigeron ***racemosum;* lower leaves spathulate, smooth; petioles ciliate; several stems from one root, simple, racemose, peduncles or one-flowered branchlets usually elongated; cauline leaves somewhat hirsute, sessile, long and linear, subacute; sepals few, hirsute acute; rays very numerous, scarcely exserted beyond the pappus, (tubular styliferous florets none;) pappus more than twice the length of the linear pubescent achenium. *β. *angustifolium;* radical leaves linear-spathulate, peduncles contracted. *E. glabratus*, HOOK. Flor. Bor. Am., Vol. II., p. 18, not of Decandolle, (as a variety of *E. alpinus.*) Allied to the *E. elongatum* of Ledebour.

§. CÆNOTUS. (Nutt.)

Erigeron canadense, LINN.

HAB. In Oregon common; also in the Sandwich Islands at Ouau, or a variety of it.

*ASTRANTHIUM.

Capitulum many-flowered, heterogamous; rays about one series, ligulate, neuter, or sterile. Discal florets tubular, hermaphrodite, five-toothed. Receptacle conic, alveolate. Involucrum hemispherical, the sepals lanceolate and very acute, membranaceous on the margins, imbricated in two to three series, and nearly equal. Achenia obovate, compressed, narrowed at the apex, somewhat scabrous, without any prominent margin, and destitute of pappus.—Divaricately branching annual plants; leaves alternate spathulate, or linear, entire. Rays numerous, pale red. Flowers terminal, fastigiate.

Astranthium integrifolium. ⊙ *Bellis integrifolia*, (MICH. Flor. Am., Vol. II., p. 131. In Tennessee and Arkansa. This genus appears to be much more allied, by the fruit, to *Eclipta* than to *Bellis.*

Division III.—CHRYSOCOMEÆ.

Receptacle naked. Capitulum wholly yellow, with or without rays, rays neuter or feminine. Pappus paleaceous or pilose, rarely wanting; similar or dissimilar in the ray and disk. In the section *Chrysopsideæ* double, the exterior short and chaffy.

BRACHYRIS.

BRACHYRIS *Euthamiæ*.

HAB. In the Rocky Mountains, towards the upper branches of the Platte. Suffruticose.

Brachyris **divaricata;* suffruticose, glutinous, corymbosely and divaricately branched; leaves narrow linear, acute; flowers nearly all pedunculate; involucrum turbinate, the scales ovate, rays about six, discal florets about seven or eight, pappus of the ray somewhat shorter, the rest elongated.

HAB. With the above, in the Rocky Mountains, to which it is nearly allied, but with larger and seldom sessile flowers. Very resinous and heavy-scented.

*AMPHIACHYRIS.

(DECAND. Vol. V., p. 313, as a section of BRACHYRIS.)

Character nearly that of BRACHYRIS, but with the involucrum obovate and bracteolate, scales few and obtuse, not herbaceous at the points. Receptacle deeply alveolate. Rays feminine, eight to ten, oval. Discal hermaphrodite florets twenty-five to thirty, small. Pappus of the discal florets united at base, dividing into about six entire setæ. Radial florets, with a very minute crown of scarcely visible setæ.—A very distinct genus, allied to *Hemiachyris*, but wholly different in the pappus, which scarcely differs from that of Grindelia, but it is united at base, and quite persistent.

Amphiachyris dracunculoides. (DECAND., under *Brachyris*, Vol. V., p. 313.) I collected this plant in 1818, on the margins of ponds, near Salt River of Arkansas. Flowering in September.

GRINDELIA. (Willd.)

GRINDELIA **robusta;* herbaceous, smooth; leaves cordate-oblong, obtuse, amplexicaule, coarsely serrate, scabrous on the margin, the upper ones acute, nearly entire; capituli corymbose, involucrum squarrose and leafy at base; receptaculum paleaceous near the margin, pappus of two setæ.

HAB. St. Pedro, Upper California. Flowering in April. A very stout and robust species, about eighteen inches high, apparently biennial, very smooth; leaves about an inch broad, an inch and a half long. Rays forty to fifty, flowers very large, more than twice the size of those of *G. squarrosa*, which this species much resembles, but the leaves are broadest at the base. Stigma hirsute, pointed, but little exserted.

*Grindelia *virgata;* smooth or pubescent, herbaceous, (biennial;) stem virgate, cylindric, tall and slender, branching towards the summit, branches mostly one-flowered, fastigiate; leaves linear-oblong, or oblong-lanceolate, very acute, entire, or serrulate, semiamplexicaule; involucrum glutinous, the lower sepals filiformly attenuated and spreading; rays neuter, pappus of two to three setæ.

HAB. Forests of Oregon, near Fort Vancouver, &c. Nearly related to the *G. integrifolia*, but the leaves are narrow, not ovate, and resemble those of a willow. Stem slender, twiggy and tough, three to four feet high, terminating in about five or six flowers, about the size of those of *G. squarrosa*. Leaves about three inches long, half an inch wide, above, all entire, diminishing much in size on the branchlets, pungently acute. Radical leaves spathulate-linear. Allied to *G. stricta*, DECAND., but with a squarrose involucrum.

*Grindelia *nana;* perennial, smooth and glandularly punctate; many low, decumbent stems from the same root, terminating in a single flower, or in a few-flowered corymb; leaves narrow lanceolate or oblong, sessile, narrowed below, serrate, those of the branches near the flower often minute, entire; sepals with short, reflected tips, which descend to the branch; rays few, (sixteen,) scarcely styliferous; pappus of about two setæ.

HAB. With the above. Nearly allied to *G. humilis* of HOOK. and ARN. β. **integrifolia;* leaves nearly entire, involucrum globular, squarrose to the base.

OBS.—Scarcely a foot high, usually decumbent, or assurgent. Lower leaves often incisely serrate, linear-lanceolate, narrowed below. Rays a little longer than the disk; involucrum glutinous. In the entire leaved variety the leaves are smooth on the margin; perhaps a distinct species; allied to *G. integrifolia* of Decandolle.

Grindelia **discoidea;* herbaceous, perennial, smooth and resinously punctate; branches one or two-flowered, fastigiate; leaves oblong-linear, acute, sessile, minutely serrulate; involucrum glutinous; reflected points of the sepals short; flowers discoid; pappus of two setæ.

Hab. On the banks of the Oregon. A genuine species of the present genus, though devoid of rays. Stigmas pointed, pubescent. Capitulum rather small. Leaves about one and a half inches long by two to three lines wide, the serratures very delicate and minute. Stem about a foot high, several from the same root.

Grindelia **cuneifolia;* smooth, leaves entire? cuneate-oblong, obtuse, or linear-oblong, acute, amplexicaule; capitulum sessile, somewhat glutinous, squarrose; stigmas very long, acute, pubescent.

Hab. St. Barbara, Upper California. Of this I have seen only two small branches, the lower leaves may be different. The capitulum like that of *G. glutinosa,* of which it is, perhaps, a variety. The stigmas very long and exserted. Leaves pellucidly punctate. Pappus of five or more setæ.

HETEROTHECA. (Cassini.)

Heterotheca **grandiflora;* villous and pilose; lower leaves oval, sparingly serrate, petiolate, upper leaves sessile, entire, lanceolate, acute; stem densely pilose below, the summit paniculately corymbose, glandular, as well as the narrow, acute sepals; rays linear; pappus double, the outer dimidiate; achenia obovate-compressed, sericeous. *Diplopappus scaber?* Hook. Flor. Bor. Am., Vol. II., p. 22.

Hab. On rocks near the sea, round St. Barbara, Upper California. A very showy, large flowered species. Stem about eighteen inches high, covered with long, softish hairs, diminishing toward the summit, which becomes glandular. Peduncles rather long, and, as well as the narrow linear sepals, clothed with a short, glandular, darkish pubescence. Pappus very copious, bright brown, the outer nearly the same colour, not very distinct; radial achenia naked, triangular, nearly smooth. In the *H. scabra* the pappus is about half the length of the present, (as is the capitulum,) scarcely half as copious, and the outer, very conspicuous pappus, is silvery white. This plant I have never seen in Oregon or in California.

CHRYSOPSIS. (Nutt.)

Chrysopsis Lamarckii. (*Heterotheca Lamarckii,* Cassini. *C. divaricata,* Elliott.) Certainly no *Heterotheca,* there existing an uniform double pappus;

the outer chaffy crown, is, however, very short, and best seen in an early stage of growth.

Chrysopsis hispida. (*Diplopappus hispidus*, Hook. Flor. Bor. Am., Vol. II., p. 22.) In this species, so much allied to *C. villosa*, there are numerous aromatic, resinous glands spread over most part of the plant; the quantity of this resinous matter, however, varies, but is never wholly wanting. The involucrum is rarely at all smooth, more or less slenderly pilose, and sometimes glandular. Perennial, often somewhat decumbent, six to eight inches high, fastigiately branched; the rays deep yellow, pappus brownish, scabrous. Radical leaves spathulate, long petiolate. Achenium silky. Outer short pappus chaffy, white, very distinct.—In *C. villosa* the outer pappus is far less distinct, and much more slender than in the present plant.

*Chrysopsis *foliosa;* ♃, sericeously villous, and more or less canescent, the margin and lower surface of the leaves scabrous; flowers fastigiate, corymbose; leaves entire, oblong or oblong-ovate, subamplexicaule, crowded, acute, ciliate below; scales of the involucrum linear, acute, villous; achenium silky; pappus scarcely scabrous, outer pappus slender, dimidiate.

Hab. In the Rocky Mountain plains, near the banks of the Platte. Flowering in August. About a foot high, sending up many hairy stems from the same root. Nearly allied to *C. villosa*, but far more pubescent and hoary, with the leaves widest at the base. In some specimens quite hoary, the hairs feel as soft as silk, but on removing this clothing, the under surface is covered with numerous scabrous elevations. A very showy species.

*Chrysopsis *mollis,* ♃; sericeously villous, leaves entire, spathulate-oblong, the lower narrowed below, the rest oblong and sessile, mostly obtuse; corymb few-flowered; involucrum villous; the scales lanceolate, acute; achenium silky, the outer pappus minute.

Hab. With the above, which it much resembles, but the leaves are more oblong, not in the least scabrous nor any where ciliate; the stem, also, softly villous.

§ I. Subgenus. *Phyllopappus.† *Receptacle alveolate. Involucrum, sepals in about two series, subequal, flat. Outer pappus of about twenty paleaceous, linear-lanceolate, eroded scales, the inner of about twenty-five scabrous setæ. Annual, with the lower leaves incisely serrate.*

† From the exterior pappus being leaf-like.

Chrysopsis pilosa, ⊙; very softly pubescent and hairy; leaves elongated, linear-lanceolate, acute, the lower ones incisely serrate, scales of the involucrum linear-lanceolate, acuminate, nearly equal; achenium with ten ribs; (a character common to the fruit of other species of Chrysopsis when perfectly mature.) *C. pilosa,* NUTT., Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 66. (Small specimens, in which the leaves often occur entire.)

Subgenus.—*PHYLLOTHECA. *Rays feminine, with rudiments of stamina or filaments. Stigmas of the ray very long, filiform, and smooth, those of the disk pubescent at the apex, and somewhat lanceolate. External paleaceous pappus minute, the inner pilose and scabrous; involucrum imbricate, and bracteolate or foliaceous.*

*Chrysopsis *sessiliflora;* ♃; viscid and pubescent, leaves oblong acute, entire, sessile; branches fastigiate, with one to three sessile capituli.

HAB. St. Barbara, Upper California. Flowering in April. Possessing a heavy aromatic odour and bitter taste, almost like that of some *Gnaphaliums.* The whole plant more or less hirsute and viscidly glandular; leaves about an inch long, three or four lines wide, linear-oblong, rather crowded, narrowed below, sessile. The capitulum surrounded by leaves at its base, like those of the stem, only narrower and longer. The outer pappus scarcely visible. Rays narrow and elongated, deeply toothed, about thirty.

*PITYOPSIS.†

Flowers heterogamous, rays feminine; florets of the disk five-toothed, tubular. Stigmas slenderly filiform, equal and obtuse, in the ray smooth, in the disk hirsute. Receptacle alveolate, dentate, naked. Involucrum imbricated in several unequal series; scales carinate, rigid, membranaceous on the margin. Achenium slender, cylindric-fusiform, internally angular, even, and ten-striate, contracted and rostrate at the summit, acuminate below; pappus double, each in a single series, the external short, slender and paleaceous, the inner pilose and scarcely scabrous, (of forty to forty-five rays.)—Perennials, with alternate, entire, filiform or grass-like leaves, naked, or more usually clothed

† *P. pinifolia* having leaves resembling those of the pine tree, and hence the allusion.

with a very long, flaky, silk-like, more or less deciduous pubescence! flowers in corymbs, simple or paniculate; rays rather broad and few, yellow, as well as the disk. Pappus very slender, fulvous, the external chaffy kind, also, nearly of the same colour. Achenium very remarkable for its tenuity and acumination at either extremity, black or brown when ripe, and somewhat sericeous; the striatures not elevated above the surface into ribs, and very slender.

Pityopsis pinifolia; smooth, leaves crowded, very long and filiform; branches one-flowered, corymbose; scales of the involucrum in three or four series, carinate, pubescent at the tips; achenium pilose, with a very distinct rostrum.

HAB. In Georgia, on sand hills, between Flint and Chatahoochee rivers.

§ I. SERICOPHYLLUM.—*Leaves gramineous, clad with flakes of a long, somewhat deciduous, appressed silky pubescence. Achenium with a shorter rostrum.*

Pityopsis falcata; deciduously sericeous, subdecumbent; corymb simple, peduncles or naked branchlets one-flowered, axillary and terminal; leaves short, linear, sessile, falcately recurved, acute; achenium sericeous, distinctly rostrate.

HAB. In barren pine woods, near Quaker-Bridge, in New Jersey, where alone I have ever seen it. Achenium rostrate and acuminate at base; pappus brownish, at first white, the external very slender.

Pityopsis graminifolia. OBS.—Involucrum and upper branchlets glandularly pubescent. Achenium slender, attenuated at either extremity. *Chrysopsis graminifolia,* ELLIOTT. Decand., Vol. V., p. 326.

Pityopsis argentea.—Involucrum pubescent, not glandular. Achenium nearly black when mature, acuminated at each extremity. *Chrysopsis argentea,* ELLIOTT. Decand., Vol. V., p. 326.

*ERICAMERIA.

Capitulum few-flowered, heterogamous; rays feminine, three to six, short and oblong, three-toothed, sometimes bilabiate; discal florets about seven to nine, campanulate, five-cleft. Stigmas very long and slender, acuminate, pubescent, in the ray smooth. Receptacle naked, alveolate, dentate. Involucrum imbricate, the inner scales membranaceous on the margin, below passing insensibly into the minute leaves of the branchlet. Achenium smooth, or somewhat hirsute, linear, angular and striate. Pappus pilose, scabrous, simple, unequal. Flowers wholly yellow?—Dwarf, often resinous shrubs, resembling heaths, exceedingly branched, branches very leafy; leaves minute and subcylindric, acerose and semipervirent, crowded; flowers small, in a contracted, leafy corymb, or solitary and terminal.—(So named from a resemblance to the genus *Erica* in the minute sempervirent leaves.)

*Ericameria *microphylla;* not viscid, leaves terete, distichally imbricated in the axils; rays three or four; achenium smooth; scales of the involucrum obtuse. *Aplopappus ericoides*, DECAND., Vol. V., p. 346.

HAB. On rocks in a mountainous situation, near St. Barbara, Upper California. Six to eight inches high, much branched from the base. Leaves three to six lines long, half a line wide, nearly cylindric, obtuse and rigid, at first, as well as the young branches, tomentose, at length smooth. Flowers crowded into an unequal corymb, the branchlets one-flowered, full of leaves to the summit; scales of the involucrum in about three series, the outer leafy and acute, the inner obtuse. This cannot be, in any respect, a congener with *Aplopappus ciliatus*, or the genuine Chilian species.

*Ericameria *nana;* smooth and somewhat glutinous, densely branched; leaves linear acerose, acute, channelled; branchlets one to three-flowered; flowers terminal, fastigiate; scales of the involucrum similar; rays about four; achenium subhirsute.

HAB. On shelving rocks on the Blue Mountains of Oregon. A shrub scarcely a span high, exceedingly branched and very brittle, somewhat resinous from exudation. Leaves no thicker than those of the pine, half an inch to an inch in length, somewhat narrower at base, sessile. Discal florets about eight, not deeply toothed, and, as well as the rays, yellow. Achenium nearly the length of the brownish pappus, linear, somewhat oblong, slightly hirsute when mature, somewhat angular and compressed.

*Ericameria *resinosa;* every where glutinous, smooth; branches numerous, slender, corymbose; flowers pedicellate; scales of the involucrum acute, the base microphyllous and squarrose; leaves subulate, acute; rays about six, often bilabiate! discal florets about twelve, all ochroleucous, five-cleft.

HAB. With the above, for which I had at first confounded it, but the flowers are larger and not perfectly yellow, the branches more slender and open, the leaves somewhat longer, and a little broader. Involucrum turbinate, receptaculum narrow. The rays often, but not always, with two lower, strap-shaped, narrow segments, opposed to the bifid tipped liguli. The same thing, though less distinct, occurs in the preceding species. Discal florets deeply cleft, campanulate; anthers and stigmas much exserted, filiform, acuminate, hirsute. Achenium, when young, hirsute, and apparently almost cylindric. This species is so glutinous as to stick to the paper, and leave its impression behind.

OBS.—A very remarkable genus, altogether peculiar in habit, resembling some microphyllous shrub of the Cape of Good Hope.

*ISOCOMA.

Capitulum homogamous, many-flowered, (twenty;) florets subcampanulate, deeply five-toothed. Branches of the stigma with an ovate apex, pubescent externally. Receptacle alveolate, dentate. Involucrum imbricate, inversely conic, scales membranaceous on the margin. Achenium subterete, sericeous; pappus pilose, copious, scarcely scabrous.—A stout perennial or suffruticose plant of California, with the aspect of a *Vernonia*, but the flowers yellow, in terminal corymbose clusters. Leaves alternate, cuneate-oblong, sharply serrate, rather small and crowded.—(So called from its equal flowers.)

*Isocoma * Vernonioides.*

HAB. In marshes near the sea, at St. Barbara, Upper California. Common. Flowering in April and May. One to two feet high, smooth, except the upper part of the stem, which is somewhat tomentose. Leaves about an inch long, by two to three lines wide, crowded in the axills, rather succulent, linear-oblong or cuneate, acute, sharply serrate, the serratures ending in bristly points; flowers terminal, conglomerate, in sessile or pedunculated clusters, bright yellow. Allied to *Lessingia*, but with the florets wholly similar. Also to the section *Aplodiscus* of *Aplopappus*, in DECAND., Vol. V., p. 350, yet the stigma appears to be wholly different.

*ERIOCARPUM.

Capitulum homogamous. Florets tubular, four to five-toothed, closed. Stigmas lanceolate, hirsute. Involucrum hemispherical, imbricate, the scales unequal, rigid, membranaceous on the margin. Receptaculum flat, alveolate, producing small, membranaceous, not exserted scales. Achenium obovate, compressed, densely lanuginous; pappus short and unequal, pilose, barbellate.—A low subalpine perennial, with a ligneous root, sending up many stems; leaves alternate, cuneate, serrate, the serratures ending in bristles; capituli corymbose.—Allied to *Aplopappus*, but very distinct from the true Chilian species, both in the absence of rays and the nature of the pappus. Allied to the preceding genus, but with a different involucrum, receptaculum and stigma, &c.—(So called from its lanuginous fruit.)

Eriocarpum * *Grindelioides.*

HAB. On shelving rocks in the Rocky Mountain range, Oregon. Stems about six inches high, pubescent, as well as the under side of the leaves. Leaves about one to one and a half inches long, by three to four lines wide, ciliate, serrate, cuneate-oblong. Florets scarcely exserted beyond the fulvous pappus, pale yellow, the teeth never expanding, and the summits or cusps of the anthers exserted and conspicuous. Pappus scarcely longer than the achenium.

*AMMODIA.

Capitulum homogamous, many-flowered, florets tubular, five-toothed; stigmas elongated, slenderly filiform, equal and pubescent. Anthers not bisetose. Receptacle naked, alveolate. Involucrum loosely imbricate, scales acute, flat, one-nerved, membranous on the margin, gradually shorter. Achenium oblong-linear, compressed, pubescent, slenderly striate, acuminate at base; pappus pilose, copious, slender, scarcely scabrous.—An inconspicuous flowered perennial, with entire, alternate, oblong, narrowish leaves. Capituli in an irregular compound corymb; involucrum obconic, florets very numerous, pale yellow, upper part of the stem and involucrum glandular.—Allied apparently to *Inula*, but the anthers not bisetose, and the ray wholly wanting. Yet, at first glance, the plant might readily be mistaken for *Inula viscosa*, in which the anthers are furnished with basal setæ, or the *I. ammophila, β. salsoloides* of China!—(The name given is in allusion to its predilection for sandy places.)

Ammodia * *Oregona.*

Hab. On the sand and gravel bars of the Oregon and its tributary streams; common. Flowering in August. Many stems from the same root, about a foot high, more or less hirsute; the leaves nearly smooth, scabrous on the margin, oblong, acute, sessile, rather numerous; flowers in an irregular, paniculate corymb, very inconspicuous, of a pale yellow, the florets nearly hid in the pappus, which is white and very slender, as in Inula. Achenia almost fusiform. Scales of the involucrum lanceolate, acute, in about four series. Florets fifty, or more. The whole plant possesses a heavy aromatic odour.

*MACRONEMA.†

Capitulum heterogamous, or homogamous, many-flowered, rays few or none, feminine, often with the rudiments of stamina; florets of the disk tubular-campanulate, five-cleft at the apex. Branches of the style very long, equally filiform, exserted, acute, and hirsute. Involucrum subimbricate in two nearly equal series, the inner rigid and membranaceous on the margin, the outer bracteolate or foliaceous. Receptaculum alveolate. Achenium linear-oblong, compressed, very long, obscurely striate, smooth or pubescent. Pappus pilose, copious, scabrous, unequal.—Low, viscidly pubescent shrubs, with many stems and much branched; branches one-flowered, fastigiate; rays and disk yellow; leaves alternate, entire.—Allied to *Aplopappus*, though remotely, having a different pappus and involucrum, &c.

*Macronema *suffruticosa;* minutely and viscidly pubescent, leaves oblong-linear, acute, numerous, rays six to eight.

Hab. On the sandy and gravelly banks of the Malade, a stream of the Oregon, near the Blue Mountains. A rather elegant low shrub, woody towards the base, about six to eight inches high, sending up numerous slender, simple, mostly one-flowered branches, from the summit of the low, woody stem; leaves about one to one and a half inches long, by about two lines wide, rather crowded. Capitulum large and hemispherical, containing thirty or more florets, with about eight linear-oblong, three-toothed rays, having often the same pubescent stigmas with the discal florets, and not unfrequently the rudiments of stamens. Pappus fulvous, exserted beyond the short involucrum, nearly as long as the florets, yet not longer than the elongated achenium. Stigmas exceedingly long, almost as in the *Eupatoriums*, sometimes trifid.

§ *Eugymna.—*Flowers discoid, achenium glabrous.*

*Macronema *discoidea;* glandular pubescent, shrubby; young branches tomentose, leaves cuneate-oblong, obtuse; rays none, achenia smooth.

† In allusion to the long filiform styles, (μακρος, *long*, and νημα, *a thread.*)

HAB. Banks of Lewis' River, and other streams of the Oregon. Allied to, but very distinct from the preceding, with the same elongated, hirsute stigmas. A low, branching, somewhat spiny shrub, about half a foot high. Leaves about an inch long, two to three lines wide. Scales of the involucrum lanceolate-linear, part of the outer series resembling the leaves as in the preceding species; florets about twenty-five; achenia very glabrous, slightly striated, linear-oblong.

BIGELOWIA. (Decand.)

OBS.—Involucrum three to four-flowered; branches of the stigma short, scarcely exserted, ligulate, the apex sublanceolate, puberulous.—Low herbs with large radical leaves and scapoid, almost naked stems; branches corymbose.

Bigelowia nudata and *B. virgata*.

HAB. On the borders of sandy, shallow ponds, from Virginia to Florida. The *B. nudata* as far north as New Jersey.

*CHRYSOTHAMNUS.

BIGELOWIA, but with the receptaculum naked. Capitulum five to eight-flowered; branches of the stigma filiform, cylindric, exserted, acute, pubescent nearly their whole length.—Very branching shrubs of the western interior and Rocky Mountain plains, with entire, equal, linear leaves, and fastigiately clustered flowers. Most of the species more or less resinous, and with a heavy aromatic odour.—(Named from their affinity to *Chrysocoma*, and brilliant golden yellow flowers.)

*Chrysothamnus *pumilus;* shrubby, dwarf, smooth or pulverulently pubescent; leaves narrow linear, acute, partly three-nerved; involucrum about five-flowered.

HAB. On the borders of Lewis' River and the Rocky Mountain plains. A low shrub, much branched from below, about six inches high; flowers in terminal, fastigiate clusters. Involucrum smooth or glutinous. β. **Euthamioides;* involucrum ovate, the scales ovate and short. Perhaps a distinct species.

*Chrysothamnus *speciosus;* shrubby and virgately branched; leaves narrow, linear, acute, more or less tomentose; capituli in dense, conglomerate, terminal clusters, five-flowered; style hirsute, elongated; pappus copious, scarcely scabrous.

Hab. In the Rocky Mountain plains, near Lewis' River, common. Flowering in August. β. *albicaulis;* stem densely and whitely tomentose; perhaps a distinct species. Showy shrubs, three or four feet high, with numerous virgate branches, like the common Broom. Leaves one-nerved, scarcely half a line wide, one and a half to two inches long. Flowers abundant, brilliant yellow.

Chrysothamnus dracunculoides. Bigelowia dracunculoides, Decand., Vol. V. p. 329.

Hab. Rocky Mountain plains, near the banks of the Platte and Missouri. A shrub three to five feet high, with a heavy, unpleasant, though somewhat aromatic odour.

Chrysothamnus viscidiflorus. Crinitaria viscidiflora, Hook. Flor. Bor. Am., Vol. II., p. 24. With this plant I am unacquainted, but it agrees well with the present genus.

† *Capitulum six to eight-flowered; stigma ligulate.*

Chrysothamnus lanceolatus; shrubby, nearly smooth; leaves linear-lanceolate, acute, three-nerved, somewhat glutinous; capituli corymbosely clustered, six to eight-flowered; stigma ligulate, pubescent at the apex.

Hab. In the Rocky Mountains, toward the sources of the Platte, and on the banks of Lewis' River of the Oregon. A moderate-sized shrub, with broader leaves than usual, one to one and a half inches long, by three to four lines wide, slightly puberulous. Involucrum of about four series of ovate, concave, acute scales. Stigma exserted, flat, with an ovate puberulous apex, something like that of the true *Bigelowias.* Pappus white, not abundant, scabrous. Florets pale yellow.

CHRYSOMA.

(Nutt., Journn. Acad. Nat. Sci. Philad., Vol. VII., p. 67.)

Capitulum heterogamous, about five-flowered; liguli feminine, one to three, short and oval. Receptacle narrow, naked, alveolate, the central point elevated. Involucrum imbricate, the scales carinate, the inner ones longer. Achenium oblong, compressed, smooth, or somewhat pubescent. Pappus simple, pilose, scabrous, the rays numerous.—Shrubby, suffruticose or perennial? plants, with entire (or serrated) rigid, lanceolate leaves, opaque, or pellucidly punctate. Flowers in fastigiate, corymbose clusters, wholly yellow.—Allied to *Bigelowia,* but distinguished by the presence of liguli; to *Euthamia,* but the liguli only about two; from *Solidago* in the same manner, and also by the whole habit.

Chrysoma solidaginoides; shrubby; leaves oblong-lanceolate, obtuse, entire, pellucidly punctate; involucrum angular, rays one or two, achenium pubescent. *Solidago semiflosculosa,* MICH., Vol. II., p. 116.

HAB. East Florida. (Mr. Ware.) A shrub apparently four or five feet high, with stout, smooth branches. Leaves almost coriaceous, semipervirent? Branchlets slender, paniculate, fastigiate. Discal florets three; rays one or two.

*Chrysoma *pumila;* root woody, stem slender, simple, corymbose, the flowers in subsessile clusters; leaves rigid, somewhat coriaceous, linear-lanceolate, acute, entire, three-nerved, attenuated below, sessile; rays two or three; achenium smooth.

HAB. In open situations, on shelving rocks towards the western declivity of the Rocky Mountains. The whole plant about a span high, more or less viscid and resinous, with clusters of stems from the same woody root. Leaves two to three inches long, about a quarter of an inch wide, rather coriaceous, (sempervirent?) corymb regular, composed of sessile clusters by threes. Involucrum subcylindric, somewhat viscid. Discal florets three; rays usually two.

Chrysoma uniligulata; leaves lanceolate, at either end acuminate, serrate; panicle compound, many-flowered; involucrum narrow oblong, five-flowered; ligula one. *Bigelowia? uniligulata,* DECAND., Vol. V., p. 329.

HAB. In New Jersey, (probably near the sea-coast.) (Mr. B. D. Greene.)

EUTHAMIA.

(As a section of *Solidago,* NUTT., Gen. Am., Vol. II., p. 162. DECAND. Prod., Vol. V., p. 341.)

Flowers heterogamous; liguli minute, twice as numerous as the discal, subcampanulate florets. Capituli small, oblong or ovate; involucrum imbricate, the scales agglutinated. Receptacle deeply alveolate, fringed. Achenia oblong-ovoid, villous, contracted at the summit; pappus comose, consisting of a small number of scabrous hairs.—Perennial, much-branching herbs, with entire linear leaves; flowers corymbose in sessile clusters, yellow.—Allied to *Nidorella* and *Brachyris,* rather than to *Solidago.*

Euthamia graminifolia; angles of the stem and veins of the leaves minutely hirsute; leaves lanceolate-linear, three to five-nerved; corymb compound; discal florets eight to ten; liguli fifteen to twenty, shorter than the disk.

HAB. From Canada to Florida.

Euthamia tenuifolia; smooth, upper part of the stem angular; leaves narrow-linear, mostly one-nerved, minutely punctate, somewhat rough on the margin; corymb diffuse, flowers solitary and sessile, in threes; discal florets five to six, liguli about the length of the disk, ten to twelve. *β. microcephala;* leaves very slender, capituli generally pedicellate, smaller. *γ. glutinosa;* capituli turbinate, pedicellate, resinously agglutinated.

HAB. From New Jersey to East Florida. β. Alabama. γ. East Florida.

*Euthamia *occidentale;* very smooth and virgately branched, the branches and stem terete, or scarcely angled; flowers large, in simple, terminal, contracted clusters; leaves lanceolate-linear, narrow, scabrous on the margin, mostly one-nerved, or obscurely three-nerved; discal florets about fourteen to fifteen, radial twenty-two or more.

HAB. Banks of the Oregon and Wahlamet, and Lewis' River, in the Rocky Mountains; chiefly on the sand and gravel bars, as well as islands. A tall, very smooth species, bearing very few large flowers, chiefly in small, contracted, terminal clusters, and seldom, if ever, in threes, rarely corymbose. Scales of the involucrum linear-lanceolate, acute.

SOLIDAGO. (Linn.)

* *Racemes secund.*

Solidago canadensis.

HAB. On Wappatoo Island and the Banks of the Oregon and Wahlamet.

*Solidago procera. β. *salicifolia;* leaves linear-lanceolate, subserrate, smooth, scabrous on the margin, obsoletely three-nerved, flowers larger.

HAB. With the above.

Solidago serotina.

HAB. With the above. Achenium smooth.

*Solidago *Pitcheri,* (NUTT. in Acad. Nat. Sci., Vol. VII., p. 101.) Very smooth and robust, leaves cuneate-elliptic, or cuneate-oblong, acute, sharply serrate, three-nerved, above lanceolate; racemes secund, contracted, pyramidal or corymbose; scales of the involucrum linear-lanceolate, somewhat obtuse; discal and radial florets about ten each; the liguli shorter than the disk; achenium pubescent.

HAB. On the banks of the Oregon and Wahlamet; in Arkansa, (Pitcher;) also near Salem, N.

Carolina. A stout species, three to four feet high, allied to *S. serotina*, but with a cuneate leaf, and pubescent achenium.

*Solidago *elongata;* stem puberulous; leaves oblong-lanceolate, cuneate, acute, sparingly and irregularly serrate, scabrous on the margin, below obscurely three-nerved; panicle elongated; racemes erect, or somewhat recurved; rays narrow, as long as the disk, ten to sixteen; achenium pubescent. *β.* Leaves longer, and the racemes more secund.

Hab. Wappatoo Island and the plains of the Oregon. Remarkable for the great elongation of the panicle, often half a foot long, narrowly pyramidal, three to four inches wide in the widest part. Rays very narrow, numerous, two-toothed; discal florets eight to twelve; pedicels and rachis pubescent. Receptacle deeply alveolate. It has the aspect of *S. puberula*, but the stem is very slenderly and minutely pubescent.

Solidago Missouriensis; (Nutt. in Journ. Acad. Nat. Sci., Vol. V., p. 7.) Rocky Mountains. From specimens which I obtained since publishing this species, I find that it belongs to the first section of the genus, having the lower leaves three-nerved, often distantly serrulate, and the whole plant, with its thickish polished leaves, perfectly smooth, though a little scabrous on the margin. Discal florets about twelve, rays ten, shorter than the disk. Achenium slightly pubescent.

Hab. Missouri, Arkansas, the Rocky Mountains, and near Chapel-Hill, North Carolina.

Solidago radula; (Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 102.) Arkansa. This species has some affinity with *S. rugosa*, but the leaves have no rugosity, and are cuneate-oblong, above ovate-lanceolate, the lower serrated distantly towards the apex. Scales of the involucrum oblong-ovate, very smooth and brownish. Rays about six, the length of the disk. Nearly allied to the *S. scabrida*, Decand.

** *Racemes erect.*

Solidago hirsuta; (Nutt. in Journ. Acad. Nat. Sci., Vol. VII., p. 103.) Very similar to *S. bicolor*, but the rays are yellow and smaller, and the leaves lanceolate or oblong-lanceolate.

*Solidago *nana;* somewhat cinereous and pulverulently pubescent, dwarf, many stems from the same root; lower and radical leaves spathulate, obtuse, entire, or subserrulate at the apex, stem leaves linear, narrowed below; ramuli fastigiate, subcorymbose; bractes linear; involucrum nearly smooth, scales ovate; rays about seven, oblong, as long as the disk; achenium pubescent.

HAB. In the Rocky Mountain range, near Lewis' River of the Shoshonee. About a span high, with a large, black, almost woody root. Stem leaves small, radical ones about one and a half inches by half an inch wide; scales of the involucrum unusually broad, pubescent on the margin, rays conspicuous. Apparently allied to *S. nemoralis*, though very distinct and alpine.

*Solidago *Californica;* villous and cinereous; leaves nearly all equal and somewhat crowded, oblong-lanceolate and acute at each end, near the apex sometimes very slightly serrulate; panicle elongated, nearly equal; scales of the involucrum lanceolate, acute, somewhat pubescent; rays about nine; achenium pubescent.

HAB. Near St. Barbara, in Upper California. Two to three feet high. Discal florets about nine, as well as the rays. Allied to the preceding, but softly villous and acute leaved; the stem leaves are also nearly as large as the radical ones, about an inch or an inch and a half long, by less than half an inch wide.

*Solidago *glutinosa;* smooth; above, as well as the involucrum, viscid, with a yellow resin; stem angular; leaves oblong-lanceolate, sessile, narrowed below, serrulate, acute, scabrous on the margin; panicle spiciform, simple or compound; scales of the involucrum ovate-oblong; rays about ten, oblong, bidentate and conspicuous; achenium pubescent.

HAB. On the plains of the Oregon and Wahlamet rivers, not uncommon. Allied to *S. Virga-Aurea*, which it resembles in habit; also to the *S. simplex*. About two feet high, with a brown stem, angular above; lower leaves three or four inches long, by about half an inch wide, the radical ones attenuated into long petioles. Upper part of the stem, bractes and involucrum indued with an orange, varnish like resin, of a strong aromatic and rather unpleasant taste. Rays about eight to ten; discal florets about five or six; pappus of the rays a little shorter.

Solidago limonifolia. A narrow leaved variety.

HAB. Coast of Upper California, near St. Barbara.

Solidago multiradiata; v. s. in Herb Schweinitz, from Labrador. It appears to be a depressed specimen of *S. leiocarpum*, DECAND. The only important difference is that the sepals are somewhat wider; the achenium is equally smooth.

*Solidago *corymbosa;* lower leaves oblong-lanceolate, serrated somewhat at the apex, scarcely ciliate, the cauline leaves (very few) entire, ovate-amplexicaule, acute; stem smooth, except towards the summit; flowers in an irregular corymb; rays about ten to twelve, as long as the disk; scales of the involucrum linear-lanceolate, smooth; achenium pubescent.

HAB. The central chain of the Rocky Mountains, in forests. *S. multiradiata*, HOOK., Vol. II., p. 5, not of Aiton. Closely allied to *S. multiradiata*, for which it appears to be taken by Hooker in Flor. Bor. Am., Vol. II., p. 5, but is, in fact, nearer to some varieties of *S. Virga-Aurea*, having pubescent achenia.

*PRIONOPSIS.

(APLOPAPPUS. Section I. LEIACHENIUM, Decand. in part.)

Capitulum hemispherical, many-flowered; rays numerous, (two or more series,) entire, feminine. Discal florets slender and cylindric, mostly abortive. Stigmas of the ray smooth and very slender, scarcely exserted; those of the disk pubescent, rather short, filiform and obtuse, somewhat compressed. Receptacle slightly alveolate, flat. Involucrum imbricated, of many series of somewhat agglutinated, squarrose sepals, with leafy points. Achenium short and smooth, cylindric-ovoid, contracted at the summit; pappus rigidly setose, longer than the florets, scabrous, unequal, about ten of the setæ longer and thicker; pappus of the ray shorter and of fewer rays, deciduous.—A stout, herbaceous biennial, with the habit and entire aspect of *Grindelia glutinosa;* leaves alternate, ovate, obtuse, very conspicuously and distinctly serrate-ciliate; flowers wholly yellow, large, fastigiate; branchlets one-flowered.—(The name from πριων, *a saw*, and οψις, *resemblance*, in allusion to the elegant serratures of the leaves.)

Prionopsis ciliata. Donia ciliata, NUTT. *Aplopappus ciliatus*, DECAND., Vol. V., p. 346. When the fruit is mature the pappus is so deciduous that the achenium may be supposed naked, it being thrown off, or nearly so, by the enlargement of the fruit, with which it does not progress in growth.

APLOPAPPUS. (Cassini.)

Capitulum many-flowered, radiate; liguli feminine, in one series; discal florets hermaphrodite, fertile, five-toothed, tubular. Receptacle rather flat, foveolate, or alveolate, and fringed. Involucrum, scales loosely imbricate, sublinear, acute. Achenia oblong, somewhat terete, or turbinate, densely sericeous. Pappus setose, of several series, unequal; that of the liguli shorter, with the rays less numerous.—South American shrubs, or undershrubs, usually with alternate, sharply serrated, or bristly toothed leaves. Capitulum terminal, often pedunculate. Flowers wholly yellow.

Aplopappus cæspitosus; puberulous, stemless; leaves in rosulate clusters, cuneate-oboval, ciliately serrate, serratures bristly; scape elongated, one-flowered.

HAB. Chili, (Dr. Styles.) Leaves about an inch long, half an inch wide. Scape half a foot long. Capitulum large, hemispherical; rays about forty; pappus bristly, scabrous, brownish; achenium densely sericeous and shining. Sepals linear, acute. Root-stock woody.

*Aplopappus *cuneifolius;* suffruticose, smooth and viscid, dwarf; leaves cuneate, obtuse, serrate, serratures without bristles; stem short, scapoid, one-flowered; sepals very unequal, linear, acuminate; rays about twelve.

HAB. With the preceding, (Dr. Styles.) A much smaller species. Peduncle two to three inches long. Pappus bristly, scabrous. Achenium densely sericeous and short.

§ *GYMNOCOMA. *Flowers discoid; corolla not dilated; stigmas filiform, acute, hirsute.*

*Aplopappus *pinnatifidus;* stemless, smooth and glandular; leaves rosulate, linear, pinnatifid, segments bristly; scape very long, with small subulate leaves; sepals with bristly, acuminate points; florets numerous, discoid.

HAB. Chili, (Dr. Styles.) Achenia silky. Root-stock woody. Allied to *Eriocarpum*, but with a different stigma and habit.

*HOMOPAPPUS.

Capitulum heterogamous, many-flowered, obovate or hemispherical. Rays feminine, about a single series, rarely infertile; discal florets slender, tubular, five-toothed, closed, fertile. Stigmas filiform, acute, hirsute. Receptacle alveolate, flat, dentate. Involucrum imbricate, in several series, scales more or less agglutinated, oblong, or ovate, with foliaceous, spreading tips. Achenium linear, angular, subcylindric, mostly smooth, (pubescent in the doubtful sections ACTINAPHORIA and MYRIANTHUS.) Pappus setose, scabrous, nearly equal, and similar in the rays.—Perennial, dwarf herbs, of an inelegant aspect, with alternate, nearly entire, or sharply serrated, spathulate, rigid, coriaceous leaves; capituli mostly sessile, terminal, and clustered in the axills of the leaves, rarely fastigiate. Flowers wholly yellow, and rather large, as in Chrysopsis. Allied to *Solidago*, particularly to *S. confertiflora;* and *S. spathulata*, of Mexico, appears to be a genuine species. From Aplopappus it differs much in habit, involucrum, achenium, &c.—(The name is given in allusion to the similarity of the pappus in the ray and disk.)

*Homopappus *paniculatus;* smooth, leaves spathulate-lanceolate, acute, cauline amplexicaule, rarely here and there subserrulate; branches subfastigiate; capituli in subterminal clusters, sessile; involucrum obconic; rays eight to ten, about twice the length of the disk; achenium slightly hirsute at the summit; scales of the involucrum ovate-oblong, obtuse.

HAB. Plains of the Oregon, not far from Walla-Walla, particularly the prairie called the Grand Ronde. About a foot high, growing in considerable quantities in wet places. Leaves three to four inches long, by half an inch to an inch wide, the radical much attenuated. Florets twenty-five or thirty, the pappus about their length; scales of the involucrum closely imbricated in three or four series, the scales rigid and membranaceous on the margins, with green, foliaceous, subsquarrose tips. The involucrum almost resembles that of a *Pteronia*. Pappus brown and rigid; achenium rather long.

*Homopappus *glomeratus;* smooth; leaves spathulate-lanceolate, very acute, generally entire, cauline amplexicaule, linear-lanceolate, or oblong; capituli axillary, and clustered towards the summit of the simple stem, or its branches, sessile, roundish and subcylindric, glutinous and squarrose; rays about eight to ten; achenium very smooth, subcylindric.

HAB. With the above, to which it is closely allied, but the involucrum is nearly round, and the achenium perfectly smooth, pale and shining, linear and subcylindric, somewhat compressed, and narrowed at each extremity. Sometimes (perhaps when the stem has been injured at the summit) it branches fastigiately, but it usually presents an interrupted spike, with leaves interposed between the clusters, which are about three together.

*Homopappus *argutus;* smooth; leaves spathulate-lanceolate, subacuminate, sharply serrate, cauline amplexicaule; capituli clustered, sessile, axillary and terminal; scales of the glutinous involucrum subsquarrose, lanceolate, acute; rays ten to twelve; achenium smooth.

HAB. With the above, and on the plains of the Oregon. About a foot high, very similar to the preceding, but with the leaves strongly serrated. Pappus rufous, very rigid; involucrum obconic. These three species have a strong resemblance to *Grindelia*, are all more or less glutinous and resinous, so as to have a bitterish taste; the leaves in the present species are often sprinkled with resinous atoms.

Homopappus? spathulatus. *Solidago spathulata*, DECAND., Vol. V., p. 339. I have not seen this plant, but from the character given, and the large number of florets, it appears to belong to this genus. Is the pappus setose?

Homopappus? squarrosus. *Aplopappus squarrosus*, HOOK. and ARNOT. Bot. Beech., p. 146.

§ I. *MYRIANTHUS.—*Capitulum nearly spherical, with many narrow rays; discal florets all fertile; pappus barbellate towards the apex, persistent; achenium compressed, angular; involucrum foliaceous.*—With the habit of the preceding.

*Homopappus *racemosus;* smooth, summit of the simple stem and involucrum pubescent; leaves lanceolate, serrate, acute; above oblong-lanceolate, amplexicaule, often nearly entire; capituli few, racemose, (three to seven); scales of the involucrum oblong, leafy, rather obtuse, sometimes lanceolate; rays fifteen to twenty; achenium subsericeous.

HAB. Plains of the Wahlamet. About twelve to eighteen inches high. Leaves coriaceous, smooth, except the uppermost, narrow lanceolate, or oblong-lanceolate, acute, attenuated below in the radical ones. Serratures pungently acute. Flowers pedicellate. Involucrum hemispherical, scales imbricated in about three series. Pappus rigid, scabrous, fulvous, somewhat barbellated towards the extremities. Achenium as in the preceding, but smaller, (as well as the plant,) shining, pale testaceous, covered with sparse hairs, which do not conceal the striatures.

Homopappus uniflorus. *Donia uniflora*, HOOKER, Vol. II., p. 25, t. 124. Rays apparently about twenty-five.

Subgenus.—*ACTINAPHORIA.†

Rays numerous, fertile or infertile. Stigma filiform, acuminate, pubescent. Achenium linear-oblong, subsericeous; pappus of one or two series of scabrous hairs, often barbellate towards the tips, some of them thinner and

† From *ακτιν*, *a ray*, and *αφωρια*, *sterile*, in allusion to the infertile rays.

shorter than the rest.—Perennial, alpine, tuberous rooted plants, with somewhat the habit of *Arnica.* Stem and lanceolate, serrated leaves smooth or lanuginous, the former one or few-flowered, subracemose.

*Homopappus *Inuloides;* leaves lanceolate, subserrulate, softly lanuginous; stem one or few-flowered; sepals nearly equal, lanuginous; rays three-toothed, forty to fifty; achenium subsericeous.

Hab. In the moist, open, grassy plains of the Rocky Mountains, towards the sources of the Platte. From three or four inches to a foot high. The root a dark, turbinate tuber, clad, at the summit, with numerous fibrous, reticulated vestiges of former years' growth. Leaves lanceolate, often sparingly cartilaginously serrulate, the primary ones smooth; the rest of the plant, as well as the involucrum, softly lanuginous with a long, white, loose, woolly pubescence. Stem leaves sessile, the lower much attenuated below. Capitulum hemispherical; the involucrum flat, and its sepals nearly equal. Rays oblong, three-toothed, shorter than the disk, between forty and fifty; the discal florets one hundred and twenty, or more, small, tubular, shortly five-toothed; style generally included. Leaves two to four inches long, a quarter to half an inch wide.

*Homopappus *multiflorus;* stem and petioles deciduously lanuginous; flowers racemose, branchlets one or few-flowered; leaves lanceolate, serrate, acute, almost coriaceous, the cauline linear, small and sessile; capituli hemispherical, pedicellate; sepals oblong, in about two rows; rays twenty to twenty-five; achenium subsericeous. *Donia lanceolata?* Hook., Vol. II., p. 25.

Hab. Prairies on the east and west side of the Rocky Mountains. From six inches to two feet high. Allied to the preceding, but much larger, the leaves at length, or from the first smooth, sharply and pungently serrulate; rays oblong, slightly three-toothed, longer than the wide disk. Involucrum almost flat, slightly pubescent, a little leafy externally, shorter than the pappus, which is slender. Flowers about the size of a Daisy. Several stems from the same root, with leaves sometimes so small as to appear almost as naked as scapes. Radical leaves four to five inches long, attenuated into long petioles. Root tap-shaped, crowned with numerous fibrous vestiges of former leaves. Stem sometimes only three-flowered, sometimes with many one to two-flowered branches, from near the base to the summit; occasionally subdecumbent.

PYRROCOMA. (Hooker.)

*Pyrrocoma *radiata;* smooth, leaves spathulate-obovate, cauline ovate-lanceolate, apiculate, serrate, amplexicaule, radical attenuated, entire, as well as the lower ones; flowers few, very large, fastigiate, axillary and terminal, subcorymbose, sometimes glomerate and sessile; rays about twenty-five; discal florets very numerous.

HAB. Plains of Oregon, near Walla-Walla. A low, robust plant, about twelve to eighteen inches high. Leaves rigid and coriaceous, four or five inches long, the lower one and a half to two inches broad. Capituli nearly as large as those of *Inula Helenium.* Involucrum almost exactly like that of *Liatris sphæroidea,* foliaceous, scarcely at all squarrose, the sepals ovate, acute, the lower bracteoles serrate; rays narrow; discal florets narrow tubular, not expanding nor exserted beyond the pappus. Stigma obtuse, flat, pubescent. Rays very narrow, shorter than the disk. Pappus rufous, shining, stiff and bristly, distinctly barbellate and thickened at the extremities, in two or more series, somewhat unequal, persistent, very like that of the genus *Pteronia.* Achenium very long, about the length of the pappus, oblong-linear, somewhat narrowed at each end, smooth, pale and shining, convex externally, internally somewhat angular.

*STENOTUS.

Capitulum heterogamous, many-flowered, hemispherical or ovate. Rays in a single series, rather distant. Discal florets tubular, cyathiform, border five-cleft, spreading. Branches of the stigma filiform, flat, puberulous, exserted. Receptacle alveolate, dentate. Involucrum imbricate, scales ovate, erect, rigid, with broad membranaceous margins, (rarely bracteolate.) Achenium oblong, compressed, sericeous. Pappus setaceous, shorter than the florets, unequal, scabrous.—Low alpine perennials, with almost woody roots, and alternate, linear, entire, coriaceous, mostly smooth leaves; stems numerous from the same cæspitose caudex, dwarf and scapoid, one to three-flowered; flowers often large, wholly yellow. Although, in the general character, this genus approaches the preceding and Aplopappus, the habit is peculiar and wholly different from either.—(The name from στενοτης, *narrowness,* in allusion to the narrowness of the leaves, &c.)

Stenotus acaulis; very dwarf and cæspitose; leaves lanceolate-linear, pungently acute, scabrous and almost cinereous, three-nerved; scapoid stem one-flowered; involucrum hemispherical, scales membranaceous, acute; rays about twelve; achenium sericeous. *Chrysopsis acaule;* NUTT. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 33, t. iii., fig. 1.

HAB. Near the borders of Little Godin River, in the Rocky Mountains. Flowering in June.

A small, tufted alpine, only three or four inches high. Stems like scapes, bearing one or two small leaves.

Stenotus cæspitosus; somewhat cæspitose or tufted; leaves linear-sublanceolate, smooth, three-nerved, scabrous on the margin; stems scapoid, one to four-flowered; involucrum hemispherical, the membranaceous scales ovate, acute; rays about twelve; achenium sericeous. *Chrysopsis cæspitosus;* Journ. Acad., Vol. VII., p. 34.

HAB. Towards the sources of the Missouri and the Platte, in the range of the Rocky Mountains. More than twice as large as the preceding. Root somewhat ligneous. Leaves very acute, those of the stem two or three in number, wide, sessile, and somewhat lanceolate; peduncles very long. Pappus white; achenium brightly and closely sericeous, linear-oblong. Stigmas much exserted. Very nearly allied to the preceding.

*Stenotus * Armerioides;* somewhat cæspitose or tufted, caudex ligneous; leaves linear, slightly lanceolate, more or less glutinous, as well as the involucrum, scabrous on the margin; stems almost wholly naked, scapoid, one to three-flowered, peduncles very long, scales of the short involucrum broadly membranaceous, oval, obtuse; rays about twelve; stigma lanceolate; achenium densely sericeous, about the length of the short white pappus.

HAB. Towards the sources of the Platte, in the Rocky Mountain range, on shelving rocks. About a span high, with a large, distinctly woody root, of great length. Leaves three or four inches long, little more than a line wide, rigid and coriaceous, resinously viscid, in a slight degree three-nerved, all linear, about two leaves on the stem; peduncles two to three inches long; the stems appearing entirely like scapes. Involucrum imbricated in about two series, much shorter than the florets. Stigma unusually thick and large, puberulous. Achenium very thickly covered with silky hairs, as in the true species of Aplopappus. The plant, at first glance, has much the appearance of an Armeria. Allied to the preceding, but perfectly distinct.

§ I. * OONOPSIS.—*Involucrum small, ovate; achenium linear, pappus fulvous.*

*Stenotus * multicaulis;* dwarf, subcæspitose, many-stemmed; leaves linear, radical obtuse, cauline acute; stems slender, one to three-flowered; flowers sessile; involucrum ovate, lanuginous, scales acuminate; rays about eight; achenium pubescent, linear.

HAB. On rocks, on the western declivity of the Rocky Mountains. A remarkable species, forming dense tufts, with leaves two to three inches long and about a line wide, the primary ones obtuse, the rest acute, the upper ones pubescent. Stems many, scarcely rising more than an inch above the leaves, slender like peduncles, terminating in one to three fastigiate flowers, which are sessile, or immediately seated upon the uppermost leaf; involucrum small and ovate, composed of two rows of ovate, acuminate sepals, the tips somewhat herbaceous and projecting. Rays oblong, about eight, feminine, slightly three-toothed, longer than the narrow disk; discal florets tubular, cyathiform, the summit five-cleft. Stigma lanceolate, pubescent; achenium narrow, slightly pubescent when mature, linear-subcylindric? Pappus short, scanty, scabrous, brownish.

*PENTACHÆTA.

Capitulum heterogamous, many-flowered, hemispherical. Rays feminine in two or three series, oblong. Discal florets tubular, oblique, ringent and five-cleft at the summit. Receptacle punctate, naked, convex. Involucrum loosely imbricate; scales linear, flat, acute, with broad membranaceous margins, in two or three series. Achenium turbinate, angular, hirsute; pappus consisting, in ray and disk, of five scabrous bristles, united at the base, which is not deciduous.—A small and slender annual of Upper California, branching from the base, branches divaricate, one-flowered, fastigiate. Leaves alternate, entire, nearly glabrous and filiform. Flowers wholly bright yellow; the rays slightly three-toothed.—(The name alludes to the pappus of five bristles.)

Pentachæta aurea.

Hab. In dry plains near the sea, in the vicinity of St. Diego, Upper California. Flowering in April. A very elegant, though often minute plant, from two or three inches to a foot high, branching usually from the base in an umbellate manner, the branches one-flowered. Leaves, on their margin, as well as the upper part of the stem, somewhat sparingly pilose, the hairs rather long and soft. Flower about the size of a Daisy, almost orange-yellow, with twenty to fifty rays, much longer than the disk. Involucrum that of the true Aplopappus, the scales exactly similar with each other, linear-lanceolate and sharply acuminate, membranaceous, and somewhat lacerate on the margin, the centre green and one-nerved. Anthers without setæ at base. Discal florets somewhat curved and ringent, or deeper cleft above. Stigmas filiform, very hirsute, acute or acuminate, at length much exserted. Stigmas of the rays long and smooth; the ray simple, or not labiate. In habit this plant appears to approach some of the Chilian species of Chætanthera. It seems, also, though remotely, allied to Chætopappa, but is wholly distinct from all the other Chrysocomeæ, with which it is associated. Allied to the Mutisiaceæ, but with the stigma of Aster.

Subtribe.—*BACCHARIDEÆ.*

Baccharis **salicifolia;* shrubby, smooth, branches angular, leaves mostly oblong, or oblong-lanceolate, subdenticulate, uppermost nearly linear, entire, viscid; capituli sessile, clustered, involucrum ovate, as well as the smooth scales.

Hab. Banks of the Arkansa, nearly allied to *B. glomeruliflora.* More or less resinously punctate. Leaves very obscurely three-nerved, attenuated into a petiole.

Baccharis pilularis; Decand., Vol. V., p. 407.

Hab. Near St. Diego, Upper California, and Monterrey. In my specimens of the fertile plant the leaves are often strongly denticulate, three-fourths of an inch long, by half an inch in width; the capituli solitary, or by threes, at the ends of the branchlets, and sometimes, also, aggregated into a considerable panicle. Achenia smooth, with ten grooves, the pappus of moderate length. A shrub three or four feet high. It appears to be subject to the attack of some insect, which causes excrescences on the branches, and hence, I suppose, arises the specific name.

Baccharis Pingræa; Decand., Vol. V., p. 159.

Hab. In the vicinity of St. Diego, Upper California. Young leaves and branchlets somewhat glutinous. Achenium with very few striatures.

Subtribe.—*TARCHONANTHEÆ.*

*DIAPERIA.

Capitulum many-flowered, heterogamous, flowers all tubular, the rays feminine, slender, in several series; discal florets two or three, masculine, with a crenate, four-toothed border. Receptacle flat, wholly paleaceous, the palea obtuse, exterior chaffy, the interior lanuginous, separately involving the discal florets. Involucrum consisting of mere leafy, irregular bractes. Achenium compressed, oboval, smooth, and without pappus.—A small, tomentose annual, with entire, sessile leaves, the stem simple, branching simply from the base, or terminating in a proliferous capitulum; the involucrum irregular; flowers in sessile clusters, made up of conglomerations of five capituli, imbedded in a dense cottony tomentum, interspersed with leafy bractes; capituli cylindric-ovate.—(The name from Διαπεραω, *to pass through.* In allusion to the proliferous inflorescence.)

Diaperia prolifera. *Evax prolifera;* NUTT. in DECAND., Vol. V., p. 459.

HAB. On the banks of Red River, near the confluence of the Kiamesha. About two to four inches high. Stem mostly simple, though sometimes branching from the summit of the root. Primary capitulum one half to three-fourths of an inch in diameter, sending out from its disk one to three branches, each terminating in a similar smaller capitulum. There appears to be no proper involucrum, the outermost scales presenting the slender, filiform, female florets. The achenium seems similar with that of *Evax pygmæa.*

Diaperia? multicaulis. *Evax multicaulis;* DECAND. Prod. V., p. 459. This plant I have not seen, but imagine it may belong to the present genus.

*STYLOCLINE.

Capitulum many-flowered, heterogamous; flowers all tubular; radial feminine, in many series, filiform, (with a mere vestige of corolla,) mostly concealed in a central cleft of the subcarinated, concave, chaffy scale of the receptacle; central masculine florets three or four, four-toothed, minute. Receptacle naked, slender, columnar, wholly bracteolate, the apex producing a few long, chaffy hairs. Involucrum imbricate, of a simple series of (about five) concave, dilated, ovate scales; fructiferous scales broad ovate, membranaceous, with an herbaceous centre, the back and base below densely laniferous. Achenium minute, oblique, cylindric-oblong, very acute at the base, smooth and shining, (apparently a naked seed!?)—Annual herbs of Upper California, with the whole aspect of Gnaphalium; decumbent and diffusely branched from the base, canescently lanuginous, with small, linear, entire, sessile leaves. Flowers in axillary and terminal sessile clusters, of a yellowish white, the scales diaphanous and shining. Seeds, or achenia enclosed in the base of the scales, which are deciduous.—(The name from στυλος, *a column,* and γυνη, *a female*; in allusion to the very singular columnar receptacle.)

*Stylocline *Gnaphaloides.*

HAB. Near Monterrey, Upper California. Stem much branched, diffusely spreading, decumbent, about six inches high, branching from the neck of the root, more or less canescently tomentose. Leaves small, oblong, linear, sessile, three or four lines long, about a line wide. Flowers in terminal sessile clusters, partly sheathed by a number of approximating leaves. Capitulum ovate, made up of imbricated, rhomboidal-ovate, concave, receptacular scales; the involucrum of a very few similar, empty scales. Scales membranaceous, diaphanous, shining, yellowish-white, with a greenish oblong centre, internally with a cleft fold, usually enclosing the greater part of the floret, and always the seed, on the back, at and towards the base, densely tomentose. The receptacle, from which the fructiferous scales readily become detached, appears to be a narrow punctate cylinder, or rachis, like that of a spike, round which the scales are imbricated. Stigmas bifid, filiform, very slender. Of the floret it is difficult to detect more than a mere hyaline rudiment. Seed (rather than achenium) dark brown, minute, cylindric-oblong, somewhat compressed, obtuse, smooth and shining, very acute at base, with only a single thin integument and its lining, as in a naked seed. Somewhat allied to Evax and Micropus, but at the same time very distinct.

MICROPUS. (Linn.)

Capitulum few-flowered, heterogamous, flowers all tubular; rays about five, feminine, filiform; discal florets three to five, masculine, five-toothed. Involucrum about five-leaved, conspicuous or minute. Receptacle small, bracteolate, except the centre, the bractes at length cartilaginous, folded inwards closely over the achenium, gibbous and compressed at the sides, (sometimes rostrate,) tomentose. Achenium obovate, flatly compressed, naked, without pappus, and deciduous with the bractes.—Small annuals of Europe and North America, arachnoidly tomentose, resembling Filago or Gnaphalium. Leaves alternate, capituli clustered. The presence of an involucrum, and the supposed involucrum being bractes, this genus approaches *Evax*.

§ III. * Rhyncholepis.—*Involucrum five-leaved, paleaceous, fructiferous scales rostrate, with chaffy points.*

*Micropus *angustifolius;* ⊙ erect, simple or branching from the base, tall and slender, tomentose; leaves linear, acute, above linear-lanceolate; clusters of flowers lateral and terminal, densely lanuginous; discal florets about five, masculine three to five.

Hab. St. Barbara, Upper California. Six to eight inches high, leaves erect and somewhat crowded, about an inch long and a line wide. Stem often simple. The capituli like dense, round masses of wool. Female florets almost obsolete. Stigma scarcely exserted. Achenium smooth and compressed.

*PSILOCARPHUS.

Capituli many-flowered, heterogamous; flowers all tubular; rays in several series, filiform, feminine; discal florets hermaphrodite, sterile, about five. Involucrum none, or mere foliaceous, irregular bractes. Receptacle convex, elevated, bracteolate, except the centre, bractes gibbous, subcylindric, reticulately membranaceous, folded inwards over the female florets and achenia. Achenium cylindric-oblong, smooth and shining, loosely infolded and deciduous with the bracteoles.—Dwarf annuals of North-Western America, with the whole aspect of Micropus, diffusely branched, and canescently tomentose; flowers glomerate, lateral and terminal.—(The name from ψιλος, *slender*, and καρφος, *chaff*. In allusion to the membranous bracteal scales.)

*Psilocarphus *globiferus;* canescently tomentose, beneath more densely; prostrate and diffusely branched, leaves oblong-linear, the floral ones broader, obtuse; capituli lateral and terminal; female florets twenty-five to twenty-eight; masculine five to eight; scales of the receptacle gibbous, rostrate, involute.—*Micropus globiferus?* Decand. and Bertero, Vol. V., p. 460.

Hab. Round St. Barbara, Upper California. Flowering in April. Not an inch high, spreading out five or six inches, beneath covered with a long, soft, white wool, above less densely canescent, centre of the receptacle naked, convex and elevated; masculine florets very minute. Fructiferous scales reticulately membranaceous, not in the least rigid, subcylindric, gibbous, with a short rostrum.

*Psilocarphus *brevissimus;* canescently and very softly tomentose; stem minute and very dwarf, producing mostly a single capitulum; leaves oblong-lanceolate, acute; female florets about eight; fructiferous scale ovate-oblong, without beak; achenium almost linear.—*Micropus minimus?* Decand., Vol. V., p. 461.

Hab. Plains of the Oregon River, in inundated tracts. Extremely dwarf, (perhaps not always so.) About four lines high, the solitary capitulum, though rather large, sessile on about the third set of leaves, and so downy as to look like a pellet of cotton, the fruit-bearing scale nearly quite straight, scarcely gibbous, larger than usual; the achenium narrow, but longer than in the preceding, to which it, in fact, is closely allied. It does not appear to branch at all, and therefore is scarcely the *Micropus minimus;* which, however, as well as the *M. globiferus,* no doubt belongs to the present genus.

*Psilocarphus *Oregonus;* every where canescently tomentose, procumbent, and diffusely branched; leaves linear, acute, with minute sphaceolous tips; female florets about twenty-five; masculine five; fructiferous scales uncinate.

Hab. In inundated places near the Oregon and outlet of the Wahlamet. Nearly allied to *P. globiferus*, but with much narrower leaves, and none of the long arachnoid hairs of that species so conspicuous on the under side; the scales of the receptacle are also smaller.

*Psilocarphus *tenellus;* ascending, slender and much branched, below smooth; leaves spathulate-linear, narrow; capituli mostly terminal, subtended by approximating, canescently tomentose, spathulate-oblong, acute leaves; feminine florets about twenty-five; masculine about five; achenium minute, the scales with uncinate tips.

Hab. Near St. Barbara, Upper California. Flowering in April. About two inches high, slenderly and diffusely branched. Very distinct from the preceding, having very narrow, smooth leaves below, and almost an involucrum of broader canescent leaves above. Flowers minute.

Tribe IV.—*SENECIONIDEÆ.*

Division III.—Silphieæ.

SILPHIUM. (Linn.)

*Silphium *radula;* exceedingly scabrous; stem terete, leaves alternate, cordate-ovate, acuminate, semiamplexicaule, the lower ones subserrate; flowers few, corymbose, rays about thirty; outer sepals ovate, the inner wide, ovate, obtuse; wing of the smooth achenium very wide, the awns confluent.

Hab. Plains of Arkansa. Allied to *S. Asteriscus.* Three or four feet high, leaves three or four inches long, by one and a half inches wide. Capitulum large, the larger sepals three-fourths of an inch wide.

*Silphium *speciosum;* stem terete, grooved, smooth and glaucous; capituli corymbose; leaves opposite, the uppermost alternate, cordate-ovate, acuminate, amplexicaule, the lower subserrate, above, as well as the outer sepals, lanceolate, or ovate-lanceolate, the inner broad ovate, acute; rays about twenty-eight to thirty; wing of the smooth achenium very wide, the awns confluent.

Hab. With the above, to which it is nearly allied, though distinct in the leaves being strictly opposite, the stem glaucous, &c. A very showy species, as large, or larger than the preceding.

*Silphium *lanceolatum;* stem terete, above hirsute, somewhat scabrous; leaves opposite, lanceolate, acuminate, shortly petiolate, repandly dentate, above nearly entire and sessile; corymb few-flowered, contracted; outer sepals lanceolate, acute, the inner ovate; rays about twelve.

HAB. Near Millidgeville, Georgia. (Dr. Boykin, who favoured me with the specimen.) Leaves three to four inches long, about an inch wide, much acuminated. Allied to *S. Asteriscus.*

Silphium reniforme; radical leaves reniform-cordate, acute, repand, smooth, beneath very scabrous; stem naked, divaricate; sepals oval, obtuse, smooth; rays about eight.—*S. reniforme;* RAFINESQUE. Nearly allied to *S. terebinthinaceum*, but with different leaves.

BERLANDIERA. (Decand.)

§ I. *SILPHIASTRUM.

Discal florets sterile, with a simple clavate stigma. Achenium subelliptic, compressed, externally convex and angular, entire at the summit, and without winged margins or pappus.—Perennial, herbaceous plants of the southern states. More or less softly tomentose or villous; leaves deeply toothed, or sinuately pinnatifid, alternate; capituli solitary or corymbose; liguli yellow, bifid at the apex, externally puberulous, with a very short tube, about ten-nerved, with smooth, elongated, bifid, ligulate, obtuse stigmas. Achenium villous on the inner side.—With the whole aspect of Silphium, but the achenium like that of Encelia compared with that of Helianthus.

*Berlandiera *longifolia;* stem and peduncles lanuginous; leaves ovate-lanceolate, dentate, shortly petiolate, beneath softly villous, not canescent; corymb contracted; capituli pedunculate; involucrum imbricated in nearly a simple series, the sepals ovate; rays eight.—*Silphium reticulatum?* PURSH, but nothing certain can be ascertained from his description.

HAB. On the plains of Red River, Arkansa; rare. About two feet high. Leaves three to four inches long, an inch and a half to two inches wide, rather coarsely toothed, acute, approximate. Sepals leafy, broad ovate. Rays about eight. Peduncles and stem clothed with dense, long and soft hairs, but not canescent or tomentose. Nearly allied to *B. Texana.*

*Berlandiera *pumila;* stem and leaves beneath canescently tomentose; leaves short, cordate-ovate, crenate, sessile, somewhat obtuse; fastigiate branches and summit of the stem corymbose; peduncles long and naked; involucrum in two series, the inner dilated, ovate, obtuse; rays about twelve, deeply bifid.—*Silphium pumilum;* MICH. Flor. Bor. Am., Vol. II., p. 146. Eighteen inches to two feet high; leaves about as wide as long, an inch to an inch and a half long, whitish beneath. Stem perfectly white and softly tomentose, the pubescence matted and appressed. Primary corymb about four or five-flowered, the peduncles naked, three to four inches long; several branches near the summit of the stem, and two or three from the base of the first corymb. Rays about twelve, twice as long as the disk, deeply bifid, with ten discoloured, longitudinal lines or nerves. Achenium at first villous at the summit, the tufts extending like minute scales, but there appears to me no awns at any time, and the summit of the achenium is entire.

Berlandiera tomentosa; stem low and simple, subdecumbent, not canescent, terminating in one, two, or few flowers, above naked; leaves petiolate, oblong-ovate, and cordate-ovate, slenderly crenate, beneath tomentose; rays about eight, more than twice the length of the involucrum, slightly bifid; involucrum in about two series, villous.—*Silphium tomentosum;* PURSH., Vol. II., p. 579.

HAB. West Florida, near Tallahasse. Flowering in March. Less than a foot high, very few leaves on the stem, (two or three,) though softly villous beneath, the leaves are strongly reticulated. Stem terminating in two or three flowers. Sometimes a lateral flower comes out at a later period. Achenium villous and entire, without any vestige of awn.

Berlandiera subacaule; decumbent, stem very short, one or few-flowered, peduncles very long; leaves oblong, pinnatifidly lobed, obtuse, below attenuated, slightly hirsute, scabrous on the margin; involucrum puberulous, imbricated in about two series, inner sepals dilated and obtuse; rays about eight, not much longer than the disk, slightly bifid.

HAB. East Florida. About eight to ten inches high; the peduncle more than a span long. Scales of the receptacle very narrow. Achenium villous internally, entire, scarcely angled on the back. Discal stigmas entire, minute; two inner palea adnate to the base of the achenium, with which they secede.

ENGLEMANNIA. (Gray. MSS.)

*Englemannia *pinnatifida.*

HAB. The plains of Red River. Hirsute and scabrous, radical leaves bipinnatifid, cauline pinnatifid, semiamplexicaule, lower segments longest, linear-lanceolate, dentate, acute, the uppermost nearly entire and small. Stem tall, terete, considerably branched, scabrous; flowers paniculate, numerous, corymbose. Scales of the involucrum diminishing in size to the peduncle; peduncle long and slender. Scales or sepals yellowish-white, rigid and cartilaginous, strongly ciliate, those which embrace the achenium subcarinate, and splitting at length in the centre down to the base; points of the scales abruptly terminating in narrow, bracteolate, leafy, hirsute, spreading points. Rays eight, about twice the length of the disk, mostly entire, the tube short and narrow. Stigmas of the ray long, ligulate, smooth, bifid. Achenium blackish, convex and strongly carinated on the back, oboval, scabrous and hairy towards the summit, without any vestige of winged margin, crowned by a minute cup, terminated on either side by two very small and hairy awns. Achenium falling off with the scale to which it is attached, and to each of which adheres two receptacular palea, with the stalk like rudiments of the male flowers.

Division V.—Ambrosieæ. (Decand.)

Ambrosia *bidentata.*

Hab. Arkansa plains. The uppermost leaves frequently four-toothed on either side, near the base; male involucrum entire, six to eight flowered, with a projecting caudate segment.

Ambrosia trifida.

Hab. Arkansa; in inundated places.

*Ambrosia *longistylis;* scabrous, stem (apparently) simple; leaves pinnatifid, segments oblong-linear, bractes entire; female flowers axillary, conglomerate, with exceedingly long styles, (about an inch;) fruit cornute, spiny at the summit; male flowers about thirty, in a slightly toothed involucrum; the receptacle filiformly paleaceous; cusps of the anthers filiform.

Hab. Rocky Mountains. ☉. Allied to Franseria.

FRANSERIA. (Cavan.)

*Franseria *bipinnatifida;* ♃, herbaceous, decumbent and diffusely branched, canescent and sericeous; leaves bipinnatifid, ultimate segments linear, short, obtuse and confluent; male calyx ten to twelve-cleft, many-flowered.—*F. Chamissonis, β. bipinnatisecta?* Lessing, Decand., Vol. V., p. 524.

Hab. Sea-coast of Upper California, (St. Barbara, St. Diego, &c.,) common. Stem diffuse, spreading in a circle of two or three feet, solid, but not woody, brownish. Male florets about thirty; fruit in clusters or racemes, very spiny and pungent, the involucrum pyramidal-ovate; spines flat, often brown, or yellowish. Stigmas filiform, rather long and acute. Anthers, (in the manner of the genus,) with filiformly acute tips.

*Franseria *pumila;* ♃, sericeously canescent, root creeping; stem erect; very low and short; leaves tripinnatifid, ultimate segments short, linear-oblong, confluent; male calyx about five-cleft; spines of the fruit not exserted.

HAB. Near St. Diego, Upper California. Not more than six inches high, very softly and copiously pubescent; segments of the leaves crowded. Stem slender, simple, scarcely extending beyond the bosom of the radical leaves; male spike about two inches long; involucrum about ten or twelve-flowered, five-toothed; receptacle with linear palea, pubescent at the tips.

*Franseria *discolor;* ♃, root creeping; leaves interruptedly bipinnatifid, above nearly smooth, canescently and closely tomentose, segments subovate, acute, confluent in the wide rachis; stem short, with the lateral branches decumbent.

HAB. In the Rocky Mountains, near the Colorado of the West. A very remarkable and distinct, as well as elegant species. Stem about a span long, slightly pubescent; leaves on long petioles, with a lanceolate outline, acute, about six inches long, white beneath, green above, the pinnatifid segments lanceolate, the rachis incisely toothed. Male florets rather numerous; receptacle with narrow, pubescent palea; involucrum about five or six-toothed; female flowers few, fruit spiny.

*Franseria *cuneifolia;* ♃, softly sericeous and somewhat canescent; stem simple, decumbent, pilose; leaves cuneate-oval, dentate, long petiolate, three to five-nerved at base; male florets very numerous, the scales hirsute at the tips; spines of the fruit rigid, sublanceolate; male involucrum ten to twelve-toothed. —*F. Chamissonis?* LESSING, DECAND., Vol. V., p. 524.

HAB. Outlet of the Oregon, near the sea. A very remarkable species. Stem succulent, about two feet long, many from the same root; leaves about an inch wide, two and a half to three inches long, the peduncle as long as the leaf. Fruit axillary, crowded, and, as in *F. bipinnatifida*, glandular, with resinous atoms. Achenium large, oblong-oval.—In all the preceding species the corolla is five-toothed.

§ * AMBROSIDIUM.—⊙ *Palea of the receptacle very slender and deciduous.*

*Franseria *montana;* ⊙, scabrous, and somewhat canescent with appressed hairs; stem branching, flowers paniculate, racemes lateral and terminal; leaves bipinnatifid, confluent towards the summit, segments oblong or subovate, abruptly acute; involucrum five to eight-cleft, naked, about ten to twenty-flowered; fruit ovoid, thickly covered with long, smooth, flat spines.

HAB. In the Rocky Mountains, near the Colorado of the West. One to two feet high; stem scabrous, leaves softish to the touch, with closely appressed hairs; chaff of the involucrum deciduous, or wanting, rachis of the leaves wide.

Franseria Hookeriana. Ambrosia acanthocarpa; HOOK. Flor. Bor. Am., Vol. I., p. 309. Distinguished from the preceding chiefly by the few linear segments of the leaves, which are nearly smooth above, all of them linear, with the fruit lanceolate, acute, and having much fewer spines; there are only vestiges of palea on the receptacle; most part of the plant is clothed with sparse, white hairs, wholly absent in the preceding.

Division VI.—Iveæ. (Decand.)

Iva *ciliata.*

Hab. Arkansa. The old plant becomes extremely scabrous; achenia turgid, oboval.

Iva axillaris; leaves mostly alternate, somewhat carnose, linear-oblong, or cuneate-oblong, obtuse, nearly smooth, one-nerved; capituli solitary, axillary, nutant; involucrum of about five nearly separate, ovate sepals. Hook. Flor. Bor. Am., Vol. II., p. 309, t. 106.

Hab. On the borders of the Platte and Missouri.

*Iva *foliolosa;* lower leaves opposite, the upper alternate and smaller, all, as well as the stem, more or less appressed pilose, three-nerved, lanceolate or oblong-lanceolate, subacute; flowers towards the summit of the stem, solitary, axillary, nodding; involucrum campanulate, five-lobed.

Hab. On the Rocky Mountain plains. *I. axillaris*, β., Hook. Flor. Bor. Am., Vol. II., p. 309. Probably Pursh's description is made up of both these species, though on the Missouri I saw only the preceding, of which a specimen was communicated to the Lambertian Herbarium. The present plant has a very different leaf and involucrum, and often presents, as it were, a leafy spike, as mentioned by Hooker.

Iva angustifolia.

Hab. Arkansa. Capitulum minute, about four-flowered, three masculine, one feminine. Flowers in a paniculated, leafy spike.

*Iva *microcephala;* slender and virgately branched, very smooth; leaves narrow linear, almost filiform, entire and fleshy; capituli axillary, very small; sepals about five, distinct; florets about six, three of them female.

Hab. In Florida. (Dr. Baldwin.) A remarkable species for the minuteness of its flowers and leaves, the latter about half an inch long, half a line wide. The capitulum not much larger than an ordinary pin's head.

§ I. *Picrotus.

Flowers dioicous, one plant producing masculine flowers only with minute rudiments of fruit, the other with monoecious capituli, the radial florets without corolla, the stigmas exserted, slender and filiform. Receptacle naked.

Achenium oboval, compressed, but somewhat turgid.—Tall annuals with opposite, ovate, serrated leaves, hirsutely canescent beneath; the flowers in terminal, naked, spiked panicles; in the fertile plant the spikes are filiform and interrupted.—Almost intermediate with *Ambrosia* and *Iva*.—(The name from πικροτης, *bitterness;* in allusion to the qualities of the plant.)

Iva * *paniculata.*

Hab. In the Rocky Mountains, by streams, in alluvial wastes. A rather tall annual, with long, petiolated leaves; the stem simple, terminating in a naked, branching, pyramidal panicle of greenish, inconspicuous flowers. Involucrum about five-leaved, obtuse; male capitulum about fifteen-flowered, with minute rudiments of female flowers; in the fertile capitulum the female flowers are about eight.

Iva xanthifolia; ☉, leaves lanceolate-ovate, serrate, acuminate, long petiolate, appressed pilose, and canescent beneath; capituli somewhat spiked; sepals ovate, acuminate.—Nutt. Gen. Am., Vol. II., p. 185. Decand., Vol. V., p. 529. Nearly allied to the preceding.

Division.—Parthenieæ.

*BOLOPHYTA.

Capituli many-flowered, heterogamous; rays feminine in one series, about five, ligulate, nearly tubular, very short, truncated and crenulate; radial florets tubular, five-toothed, masculine, with a simple stigma. Involucrum hemispherical, biserial, external scales ovate, internal suborbicular. Receptacle conic, paleaceous, the palea sheathing, wider and pubescent at the summits. Stigmas of the ray short, smooth and obtuse. Achenium compressed, somewhat obcordate, with a cartilaginous margin, to which it is ingrafted on either side with the two anterior paleæ, and with which, and the contiguous scale of the involucrum, it is at length deciduous. Pappus none, the achenium crowned with the small, persisting ligula.—An alpine, cæspitose, stemless, small perennial, with a long, almost ligneous root, crowned with dense and numerous vestiges of former leaves, based by tufts of hairs; leaves spathulate-linear, narrow and entire, canescent with appressed, strigose hairs; flowers solitary, sessile, or short pedunculate, scarcely arising beyond the summit of the root, and hid among the leaves.—Nearly allied to *Parthenium*, though of the most dissimilar habit, and perfectly distinct.—(The name from *βωλος, a clod*, and *φυτον, a plant;* in allusion to the depressed and cæspitose growth.)

Bolophyta alpina.

Hab. In the Rocky Mountain range; latitude about 42°, and seven thousand feet above the level of the sea. On shelving rocks, on the summit of a lofty hill, near the place called the "Three Butes" by the Canadians, towards the sources of the Platte. Flowering in June. Root fusiform, stout and very long, sending off several closely-matted crowns of leaves. Leaves about an inch or an inch and a half high, scarcely a line wide, linear and acute, attenuated below, coming out in rosulate clusters, equally pilose on either side, without any visible vessels but the mid-rib, so that the leaf appears nearly the same on either side. Capitulum sessile, or upon a very short and thick peduncle, somewhat larger than that of *Parthenium integrifolium*, but still very similar. Scales of the involucrum ten, five external, ciliate and pubescent at the summit; receptacular scales similar but narrow, also pubescent at the tips, each enfolding a male floret, with the five-toothed summit visible. Anthers dark brown, united, enclosing a very small style, with a simple, obtuse, scarcely pubescent stigma. Radial florets ochroleucous, (as well as the discal) short and tubular, appearing truncate, the border a little spreading and slightly crenulate, with scarcely any anterior cleft. Stigmas not exserted beyond the short ligula. Achenium black when ripe, with a whitish border.

Parthenium integrifolium.

Hab. In Arkansa.

Subtribe II.—*HELIANTHEÆ.* (*Less. Decand.*)

Division I.—Heliopsideæ. (Decand.)

Zinnia **grandiflora;* ♃? dwarf; leaves linear lanceolate, connate, scabrous on the margin; stem much branched from the base; rays (yellow) very large, orbicular-oval; scales of the involucrum rounded; paleæ fimbriate; discal fruit with a single awn.

Hab. In the Rocky Mountains, towards Mexico.—A very distinct and splendid species, apparently perennial. The only specimen I have (presented me by my friend, Dr. Torrey,) is scarcely more than five inches high; the stem somewhat hirsute; leaves about an inch long, two to three lines wide, three-nerved below; branches one-flowered; involucrum of about three series of dilated, roundish scales. Rays yellow, orbicular, or widely oval, appearing cordate at base, and there plaited, three-fourths of an inch wide; style of the ray filiform, smooth, exserted, bifid. Disk apparently orange.

BALSAMORHIZA. (*Hooker*, under HELIOPSIS.)

Capitulum many-flowered, heterogamous; rays feminine, ligulate, in one series, with infertile filaments of stamens; discal florets hermaphrodite, tubular, the summit five-cleft, reflected. Involucrum imbricate in two or three series, foliaceous, longer than the disk. Receptacle convex, the palea lanceolate, foliaceous, pungently acute, subcarinate, and embracing the fruit. Achenium subquadrangular, in the ray compressed, smooth, wholly naked, with a small epigynous disk. Stigmas filiform, hirsute, subobtuse.—Low, robust, perennial herbs of the western alpine steppes, and plains of Oregon and California. Leaves entire, or pinnately dissected, nearly all radical. Stems scapoid, one or few-flowered, the lower pair of small leaves opposite; above alternate; capituli wholly yellow, resembling that of *Helianthus*. Nearly allied to Heliopsis, but without proper stems, and wholly dissimilar in habit. Root fusiform, stout, black, and very long, terebinthine, internally darkish. Used by the aborigines of the west as an article of diet, after subterraneous stoving, when it acquires a sweet flavor, like that of the parsnip.

§ I. EUBALSAMORHIZA.—*Leaves pinnatifid, scapes or stems one-flowered; rays ten to fourteen.*

Balsamorhiza Hookerii; softly and almost sericeously pubescent; leaves more or less bipinnatifid and incise, segments linear; involucrum subtriserial; sepals narrow-lanceolate, acuminate, loosely imbricate, external ones spreading. *Heliopsis balsamorhiza;* HOOKER, Flor. Bor. Am., p. 310.

HAB. Plains of the Oregon, common. Twelve to eighteen inches high. Summit of the cylindric, naked tap-root surrounded by long, brown, membranous bud sheathes. The root, when cut, exuding drops of a very limpid resin.

Balsamorhiza terebinthacea. Heliopsis terebinthacea; HOOK. Flor. Bor. Am., p. 310. With this, if more than a variety of the preceding, I am unacquainted. The leaves of the preceding vary sufficiently.

*Balsamorhiza * hirsuta;* somewhat hirsute, not canescent; leaves all bipinnatifid, except at the summit; segments oblong, incise, margin very scabrous;

scape hifoliate; capitulum large, subglobose, imbricated in about four series, lanuginous at base; sepals lanceolate, acute, ciliate; root clad with persistent fibres.

Hab. Dry plains east of Walla-Walla, near the Blue Mountains, and in the Grand Ronde prairie. Nearly allied to the preceding, but with a very different pubescence; also a more robust and dwarf plant, with a much larger capitulum. I have not seen it in flower, only in seed. Leaves about a foot long, two to three inches wide, very lanuginous at the base of the petiole, which is very flat. Sepals nearly all equal, closely imbricated. Florets of the ray very numerous. Stigmas long and hirsute. Leaves green, not at all canescent and soft, as in the preceding.

*Balsamorhiza *incana;* canescently tomentose; scape scarcely longer than the leaves, bifoliate at base; leaves deeply pinnatifid; segments oblong or ovate, entire or denticulate externally; involucrum densely tomentose, bi or triseriate.

Hab. In the Rocky Mountains. About six to eight inches high. A beautiful and very showy species, with flowers as large as *Inula Helenium*, of a deep yellow, the whole herbage white with soft down. The leaflets oblique, often bilobed. Rays twelve to fourteen, with infertile filaments, as in the preceding species. Scales of the receptacle very short. Stigmas hirsute, filiform, and exserted.

*Balsamorhiza *macrophylla;* smooth; scape about the length of the leaves, bifoliate at base; leaves deeply pinnatifid, confluent above; segments sublanceolate, acute, entire, or with one or two large teeth at base; involucrum about triserial; sepals lanceolate, the lower ones leafy and reflected; paleæ nearly equal in length with the florets.

Hab. Towards the sources of the Colorado of the west, in the Rocky Mountains; rare. Remarkable for its large, smooth leaves, scabrous on the margin, and scattered with glandular atoms. Petioles very long, with the leaf near a foot in length, segments three inches long, half to three-fourths of an inch wide.

§ II. *Artorhiza.—*Leaves entire, deltoid or cordate; involucrum very leafy at base; rays numerous. Receptacle flat.*

Balsamorhiza sagittata. Buphthalmum sagittatum? Pursh., Vol. II., p. 564. *Espeletia sagittata;* Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 39. Canescently tomentose; stem low, about one to three-flowered; radical leaves cordate-ovate, entire, somewhat three-nerved at base; cauline leaves linear, attenuated below; external leaves of the involucrum longer than the inner, spreading, lanceolate, densely tomentose; rays numerous, (twenty to twenty-four.)

Hab. In the Rocky Mountains, by Flat-Head River, towards the sources of the Oregon.

Flower large and showy, about three to four inches in diameter, while the scapoid stem is not more than a span high. Stigmas very hirsute, filiform. Rays feminine, with infertile filaments.

Balsamorhiza helianthoides. Espeletia helianthoides; Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 39. Certainly not congeneric with Humboldt's genus. Allied closely to the preceding, but with a different pubescence and closely imbricated, lanceolate, acuminate sepals. Rays with infertile filaments, about fifteen.

*Balsamorhiza * deltoidea;* slightly hirsute and puberulous; leaves deltoid-cordate, acuminate, somewhat undulate; stem one to three-flowered, upper leaves alternate, linear-oblong; sepals linear-lanceolate, the outermost longest and leafy, spreading; rays twelve to twenty.

Hab. Near the outlet of the Wahlamet, common, in wet, open places. Flowering in June. Much like an *Helianthus*, and nearly allied to the preceding, but not tomentose, wholly green, and the leaves more triangular, two to three inches across, four or five inches long, on very long petioles. Stem leaves small, oblong, scarcely opposite, long petiolate. Rays with infertile filaments.

WYETHIA. (Nutt., Journ. Acad. Philad., Vol. VII., [1834.])

Alarçonia, *Decand.* in part.

Capitulum many-flowered, heterogamous; rays numerous, feminine, with rudiments of stamens, (filaments;) radial florets tubular, the summit five-cleft, revolute. Stigmas ligulate, filiform, hirsute on the under side, not conic at the apex. Involucrum hemispherical, foliaceous, loosely imbricated in two or three nearly equal series, longer than the disk, the inner leaves wider. Receptacle convex, paleaceous, the palea foliaceous, carinate, embracing the fruit. Achenium subquadrangular, striated or grooved, in the ray compressed. Pappus a small, cartilaginous, multifid, unequal crown, naked, or with one to four stout awns arising from the angles.—Dwarf or robust, Helianthoid plants, with long tap roots, and simple, mostly one-flowered, leafy stems, the leaves large. Flower large, ray and disk yellow.

Wyethia Helianthoides; very dwarf, somewhat hirsute, one-flowered; stem leaves and sepals ciliate; leaves lanceolate, entire, scabrous on the margin, attenuated below into a petiole; outer sepals of the involucrum linear, the inner lanceolate; pappus scales obtuse, with or without a single subulate awn; achenium grooved, hirsute at the summit; stigma slender.

HAB. In the Kamas plains, near Flat-Head River, towards the sources of the Columbia, and in the plains near the Blue Mountains of Oregon. About a span high. Stem simple, one-flowered, smooth below, almost lanuginous at summit; sepals lanuginous and ciliate on and near the margin. Scales of the receptacle lanceolate, hirsute, pungent, nearly the length of the discal florets, sometimes with a short tooth on either side. Achenium angular, but so much grooved as to appear nearly terete. Pappus variable, the multifid crown pubescent, of eight or ten unequal segments, always present; in others there is, besides, on one of the angles, a slender awn. Rays eighteen to twenty, entire, pale yellow, with infertile filaments.

*Wyethia *angustifolia;* very dwarf, softly pubescent; stem one-flowered; sepals pilose, ciliate, the outer broadest, lanceolate; leaves spathulate or spathulate-lanceolate, entire; pappus scales acute, lacerate, with a single awn at one of the angles; achenium quadrangular, nearly even, smooth; stigma very long, flat and revolute. *Alarçonia angustifolia;* DECAND. l. c.

HAB. Round Monterrey, Upper California. A dwarf species like the last, with a disproportionately large capitulum; the rays deep yellow, about twelve, distinctly three-toothed, with filaments of stamens. Stigmas remarkable for their length, ligulate, smooth above, hirsute below with golden hair. Radial floret contracted at base. About a span high, lower part of the stem, near its base, smooth.

*Wyethia *robusta;* somewhat scabrous and pubescent, particularly the base of the stem, which is one-flowered; leaves all lanceolate, acute, radical subserrate, stem leaves sessile; sepals nearly all equal, lanceolate or linear-lanceolate, acute; achenium quadrangular, nearly even, with one to four unequal awns; stigma long and flat.

HAB. Plains of the Oregon, near the confluence of the Wahlamet, common, in wet places. Flowering in June. Eighteen inches to two feet high; always with a single flower. Radical leaves a foot long, attenuated, and very hairy on the petiole, as well as more or less so on the mid-rib, nearly entire, or irregularly serrate, acute. Rays twelve to eighteen, twice as long as the disk, and exceedingly like that of an Helianthus. Achenium sharply quadrangular, even, except a groove on one side, slightly pubescent at the summit; crown of pappus in eight or ten divisions, lacerate, often presenting from one to four awns, unequal, but not all of them on the angles. Receptacle convex.

Wyethia amplexicaulis; smooth, shining, and somewhat glutinous; leaves lanceolate, acute, entire or subserrulate, cauline ones amplexicaule; stem three to five-flowered, flowers axillary and terminal, pedunculate; sepals broad ovate;

achenium subquadrangular or triangular, grooved; pappus acute, one or two of the segments carried out into awns. *Espeletia amplexicaulis;* NUTT. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 38.

HAB. In the Rocky Mountains. Flowering in June. Since publishing an account of this plant in the seventh volume of the Journal of the Academy of Natural Sciences in Philadelphia, I have, myself, met with it in the Rocky Mountains, towards the sources of the Platte, from which specimens I find that, though differing some in habit, it belongs to the genus Wyethia. Stem sometimes two or more feet high, robust, and very smooth even to the margin of the leaf; the lower, or radical leaves, at length coriaceous, attain a foot in length, are attenuated below, and, though often entire, are sometimes serrulate; lower stem leaves sessile, the upper semiamplexicaule; flowers in a sort of short, approximating raceme; sepals very broad; rays ten to fifteen; achenia and palea smooth. Stigmas slender, hirsute externally.

§ I. ALARÇONIA. *Pappus without awns.*

Wyethia Helenioides. Alarçonia Helenioides; DECAND., Vol. V., p. 537. Collected in Upper California, by Douglas. Nearly allied to *W. Californica,* but evidently a much larger plant. OBS.—The leaves of all the species are alternate.

HELIOPSIS. (*Persoon.*)

Capitulum many-flowered, heterogamous; rays ligulate, feminine, in one series; florets of the disk hermaphrodite, tubular, five-toothed. Stigmas slender, filiform, pubescent at the summit, and terminating in a smooth, acute cone. Involucrum somewhat biserial, shorter than the disk; sepals foliaceous at the summit, cartilaginous, closely imbricated and coalescent below. Receptacle conic, palea membranaceous, embracing, much shorter than the florets. Achenium quadrangular, smooth, without pappus, but with a raised border, and a small, epigynous disk.—Tall perennial herbs of North America, with ovate, opposite, petiolate, dentate leaves. Capituli solitary, pedunculate; flowers yellow, with elongated rays.

Heliopsis scabra.

HAB. Arkansa; common. With the stem sometimes nearly smooth.

*Heliopsis *gracilis;* smooth, leaves oblong-ovate, at either end acuminate, incisely serrate; peduncles very long and slender; involucrum subsquarrose; sepals lanceolate, pubescent on the margin.

Hab. In Georgia. (Dr. Juet.) Flowers pale yellow, small. Nearly allied to *H. lævis*, but as distinct as *H. scabra*, and differing from both in the involucrum.

Division Rudbeckieæ.

Echinacea *pallida*. *E. angustifolia;* Decand., Vol. V., p. 554. *Rudbeckia pallida;* Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 77.

Hab. In Arkansa. Flowers pale rose, almost white.

Echinacea atrorubens. *Rudbeckia atrorubens;* Nutt. in Journ. Acad. Philad., Vol. VII., p. 80.

Echinacea * *sanguinea;* hirsute; but not canescent; stem mostly one-flowered, scabrous below, smooth above, sometimes branching from near the base; radical leaves elliptic, the rest lanceolate, acute, petiolate, mostly entire; flower very long pedunculate; sepals oblong-lanceolate; rays narrow and dependent, shortly bidentate.

Hab. The plains of Red River, near the confluence of the Kiamesha. A very elegant and distinct species, with dark red rays. Allied to *E. pallida*, but the leaves less whitely hirsute, the rays narrower and deep coloured, &c. Lower part of the stem leafy, leaves moderately attenuated below, three-nerved, narrow lanceolate, apparently entire. Rays about fifteen. Capitulum hemispheric, but not conic. About two feet high; the naked part of the stem, or peduncle, about two-thirds the whole length.

RUDBECKIA. (Cassini.)

Rudbeckia * *strigosa;* ♃. Stem hispid, somewhat smooth above, branching from below, the branches one-flowered, fastigiate; leaves sessile, amplexicaule, ovate sublanceolate, below oblong serrulate, softly strigose with appressed hairs, and somewhat cinereous; peduncles elongated; rays about eight, oblong, rather short; sepals spreading, in two rows, oblong-lanceolate; disk hemispherical.

Hab. Alabama. (Dr. Juet.) A rather remarkable species, almost hoary with a close clothing of softish, appressed, and rather long hairs; the serratures minute, except on the lowest leaves. Allied to *R. hirta* and to *R. mollis*, of Elliott, but the rays are broad and short, not more than eight. Chaff of the receptacle linear, rather obtuse.

Rudbeckia * *maxima;* smooth, robust and glaucous, very tall; leaves all entire, very broad and large, radical ovate petiolate; lower stem leaves obovate, abruptly acuminate, subserrate; upper ones broad ovate, amplexicaule; stem one or few-flowered; peduncle very long, sulcate; rays reflected, numerous, (fifteen to twenty;) disk columnar.

HAB. On the open plains of Red River, near the confluence of the Kiamesha. Flowering in June. A gigantic plant, growing in extensive masses, with large, glaucous, somewhat coriaceous leaves, but little inferior in size to those of the Cabbage, in its wild state. Leaves somewhat oval, three to four inches wide, except the upper ones, which diminish to a quarter part the size of the lower ones: its whole aspect and clasping leaves appear very similar to that of *Dracopis*. Six to nine feet high! and all the parts (the flower not excepted) of the same gigantic dimensions, although growing in a poor and exhausted soil. Rays oblong, nearly entire; discal column one and a half to two inches long, three-fourths of an inch wide. Paleæ oblong, sheathing. Leaves of the involucrum in nearly a simple series, foliaceous.

Rudbeckia globosa, NUTT. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 79, is *Obeliscaria Tagetes* of Decandolle. *Rudbeckia Tagetes,* JAMES, which name has the priority.—OBELISCARIA appears to be almost a mere section of Rudbeckia. The *O. pinnata* is indeed closely related to *Rudbeckia digitata,* if, indeed, the latter be any thing more than a variety of *R. laciniata.* The distinguishing character of a compressed achenium is merely comparative, and glides insensibly into the unequal quadrangular one.

§ * AKOSMIA.†—*Rays wanting; pappus a minute, crenate cup; receptacle elevated, conic.*

*Rudbeckia * occidentalis;* smooth and robust; leaves ovate-lanceolate, acuminate, entire, or repandly toothed, sometimes irregularly lobed, scabrous on the margin, three-nerved; uppermost sessile, lanceolate, entire; flowers few, long pedunculate, without rays; disk conic; sepals lanceolate, acuminate, in nearly a single series.

HAB. Rocky Mountains and woods of the Oregon, particularly in the Blue Mountain range, by small streams. Allied to *R. laciniata,* of which it has almost the achenium and paleæ. About three feet high. Leaves four to six inches long, much acuminated, the upper sometimes irregularly two-lobed, two to three inches wide, attenuated below, but sessile. Disk dark purple; paleæ linear, sheathing, somewhat obtuse; achenium quadrangular. The only western species we have seen.

† From ακοσμος, *without ornament;* in allusion to the want of rays.

*ECHINOMERIA.

Capitulum hemispherical, many-flowered, homogamous or heterogamous; rays neutral, (yellow,) spreading, rather short, (about eight;) discal florets hermaphrodite, with the border five-cleft, the tube contracted, shorter than the border. Involucrum in about three series, the sepals nearly equal, lanceolate and discoloured, similar with the palea. Receptacle convex, alveolate, denticulate, paleaceous, the paleæ lanceolate, carinate and embracing, acuminate, and deciduous, about as long as the florets. Branches of the stigma subulate, hirsute. Achenium tetragonal, compressed, crowned with a minute, deciduous, chaffy pappus, two of the angles somewhat toothed.—A perennial, opposite-leaved herb, with the aspect of an *Helianthus*. Stem very hairy below, almost naked and scapiform above, one-flowered; capitulum blackish-purple, mostly without rays, which, when present, are yellow. (The name in allusion to its affinity to the genus Echinacea.)

Echinomeria apetala. *Rudbeckia apetala;* (Yates and Torrey.) Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 77. *Helianthus apetalus;* Leconte, in Herb. Schweinitz.

Hab. In the pine barrens of Georgia, near ponds and pools. Perennial. Radical leaves widely ovate and short, sessile, somewhat hirsute, three-nerved and denticulate. Leaves opposite, crowded towards the base of the stem, which is very hairy; the rest of the stem, for about two feet, nearly smooth, and like a scape, almost leafless; one or two upper minute leaves linear and alternate, a lower pair lanceolate, opposite and sessile. Capitulum hemispherical, resembling almost wholly that of *Helianthus atrorubens*, but mostly without rays. Sepals in three rows, nearly equal, lanceolate, acuminate, nearly smooth, dark purple, faintly three-nerved; paleæ acuminate, narrow lanceolate, mostly with a narrow, acute tooth on either side. Achenium with two obtuse angles, rather rough, with pale spots, at first with the rudiments of four unequal, blunt teeth, and an inner, irregular crown of pilose, minute, unequal paleæ, all of which disappear with the ripe fruit, when the two obtuse angles only present short, obtuse dentures. It is difficult to say whether this plant more resembles Helianthus or Echinacea, it is so entirely intermediate with those genera; the aspect is that of the latter, but the paleæ are not pungent, and the rays yellow.

Continuation of Mr. Nuttall's Paper. Read December 18, 1840.

ENCELIA. (Adanson.)

ENCELIA * *Californica;* suffruticose, erect, and much branched; branches elongated, one-flowered, puberulous; leaves ovate-lanceolate, acute, entire, or coarsely toothed towards the base, nearly smooth, three-nerved, rather crowded, scabrous on the margin; involucrum villous, triserial.

HAB. On dry hills, near St. Barbara, Upper California. Flowering in April; common. A rather showy, low, brittle shrub, with the flowers of an Helianthus; the rays neuter, fifteen to twenty, three-toothed, and somewhat plaited. Leaves alternate, attenuated into a marginated petiole; young stems and shoots canescent with an almost pulverulent pubescence; peduncle rather long. Stigmas lanceolate-ovate; palea membranaceous, sheathing; the achenium, which is flat, obconic, without pappus, slightly emarginate and sericeous on the summit and margin. Florets of the disk dark brown, smooth. The whole plant possesses the odor of *Gailardia bicolor.*

Division COREOPSIDEÆ. (*Less.*)

COREOPSIS. (LINN.)

To Decandolle's description of the genus I may remark that the paleæ of the receptacle are deciduous.

EUCOREOPSIS.—*Achenium flatly compressed, winged, apex bidentate.*

1. *Coreopsis dephinifolia;* LAMARCK. 2. *Coreopsis tenuifolia;* EHRET, WILLD. Sp. pl. l. c. 3. *Coreopsis Wrayi;* NUTT. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 76. Nearly allied to *C. dephinifolia.*

CHRYSOMELEA.—*Achenia suborbicular, bidentate, winged, at length convex and incurved.—Leaves entire or pinnately dissected.*

† *Leaves entire or auriculate.*

3. *Coreopsis lanceolata;* LINN. 4. *Coreopsis crassifolia;* AITON. 5. *Coreopsis integrifolia;* POIRET. (*C. Œmleri;* ELLIOTT.)

6. *Coreopsis auriculata;* Linn. 7. *Coreopsis diversifolia;* Decand., Vol. V., p. 571.

† † *Leaves pseudopinnate.*

8. *Coreopsis grandiflora;* (Nutt. MSS. Sent by that name to Mr. Barclay.) Hab. Banks and plains of the Arkansa. *C. longipes;* Hooker, Bot. Beech. l. c.

9. *Coreopsis * heterophylla;* ♃, smooth; stem erect, branching, grooved; radical leaves entire, spathulate-oval or trifid; stem leaves opposite, sessile, ciliate at base, biternately dissected, above three-parted; segments narrow linear, entire; peduncles elongated, one-flowered; external sepals lanceolate, shorter than the inner; rays unequally four-lobed; achenium suborbicular, winged, shortly toothed.

Hab. With the preceding, to which it is intimately allied; the flower smaller and the leaflets narrower. Achenium, as in the preceding, with an internal tubercle at the summit and base within.

10. *Coreopsis * Boykiniana;* ♃, smooth and erect, the summit trichotomous; stem angular and grooved; leaves opposite, entire, linear-lanceolate, long petiolate, acute, one or two upper cauline pair unequally trifid and petiolate; peduncles one-flowered, very long; external sepals lanceolate, acute, about half the length of the inner; rays four-lobed; achenium even, with a broad wing, shortly bidentate.

Hab. Near Millidgeville, in Georgia; collected by my friend, Dr. Boykin, after whom I have great pleasure in naming it. Achenium very similar to that of the two preceding, and internally bituberculate with a broader winged margin. Flower large, rays eight. Involucrum enlarging with the fruit; paleæ narrow and deciduous. A distinct species, though allied to the preceding.

§ * Gyrophyllum.—*Rays entire, or slightly toothed. Achenium oblong-compressed, straight, winged, often with an obsolete, minute, chaffy crown, scarcely bidentate when mature.—Leaves trifid, mostly equal, and appearing verticillated or stellate.*

11. *Coreopsis senifolia;* Michaux. 12. *Coreopsis stellata;* Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 76.

13. *Coreopsis rigida;* Nutt. Gen. Am., Vol. II., p. 180. Smooth, or nearly so; leaves equally trifid, or sometimes with the central segment also three-cleft; leaflets lanceolate-linear, entire, scabrous on the margin; outer sepals of the involucrum linear, about twelve!

14. *Coreopsis palmata;* NUTT. Outer sepals linear, about twelve; rays eight, nearly entire. Achenium oblong, flat, alated; in an immature state with two minute teeth. A strict congener with the preceding. 15. *Coreopsis tripteris,* LINN. *Chrysostemma tripteris;* LESSING. Syn. 227. DECAND., Vol. V., p. 567.—PERAMIBUS of Rafinesque is thus far, to me, a nonentity!

§ * EUBLEPHARIS.—*Achenium oblong-compressed, straight, carinated, with a ciliate-serrated callous margin and base, the apex with two short awns, scarcely longer than the serratures; rays three-lobed, the middle lobe longer.—Leaves alternate, entire, linear; corymb unequal, dichotomal. Probably a genus?*

16. *Coreopsis gladiata;* WALTER.

HAB. Georgia and Fayette, North Carolina. Outer involucrum short; radical leaves spathulate-oblong, obtuse, somewhat fleshy; cauline narrow linear, remote and few; flowering branches nearly naked.

§ * RABDOCAULIS.—*Achenium linear-oblong, straight, compressed, minutely ciliated on the margin, with a pappus of two erect, somewhat scabrous bristles. Rays almost equally three-lobed.—Leaves entire, opposite and alternate; outer involucrum small.*

17. *Coreopsis angustifolia;* AITON. Leaves alternate, the radical lanceolate, long petiolate, carnose, cauline linear, remote; corymb dichotomous, few-flowered.

18. *Coreopsis linifolia;* NUTT. From a specimen collected in Alabama by my friend, Dr. Juet, I find that the lower oblong leaves are *alternate* and remote. The flowers disposed in an irregular corymb; outer involucrum about one-third the length of the inner. Inner sepals ovate-lanceolate, acute. Rays about eight, deeply three-lobed. Achenium linear-oblong, straight, compressed, minutely ciliated on the margin, with a pappus of two erect, long, equal bristles. The plant three to four feet high. Stem leaves opposite, linear, about a line wide, one to two inches long, and very remote, so that the stem appears almost like a naked twig. Flower conspicuous, yellow, with a brown disk.

19. *Coreopsis nudata;* NUTT. Awns of the achenium pubescent, very short; stigmas obtuse, pubescent at the extremity. The whole plant almost destitute of visible leaves.

§ Calliopsis.—*Achenium compressed, flat, naked, incurved; stigma truncated, the tip only pubescent. Exterior involucrum very short. Rays two-coloured; leaves bipinnately dissected.*

20. *Coreopsis tinctoria;* Nutt. 21. *Coreopsis cardaminifolia;* Decand. (under Calliopsis.) 22. *Coreopsis Atkinsoniana;* Hooker.

23. *Coreopsis rosea;* smooth, stem trichotomous; leaves linear, narrow and acute, opposite, entire, rarely trifid; rays unequally three-toothed, (rose-red;) peduncles slender, rather long; achenium immarginate, entire, naked, curved.

Hab. New Jersey, near the sea-coast. Stigmas truncated, scarcely pubescent.

*DIODONTA. (Coreopsis of authors.)

Coreopsis, but with the outer involucrum as long, or longer than the inner, from eight to twenty-four leaved, the inner about eight-leaved. Achenium cuneate, compressed, flatly four-sided, immarginate, with two cornute, acute, hispid, but not retrorse teeth. Rays nearly entire.—Annuals or biennials, usually with pseudopinnated, opposite leaves, mostly serrated, rarely entire. Intermediate between Coreopsis and Bidens, andwith much the habit of the latter.—(Named in allusion to the pappus.)

Diodonta coronata. Coreopsis coronata; Linn., (fide Gray.) *Coreopsis trichospermd;* Mich. Awns as long as the discal florets, pilose with erect hairs.

Diodonta mitis. Coreopsis mitis; Mich. Flor. Bor. Am., Vol. II., p. 140. *Coreopsis ambigua;* Nutt. in Journ. Acad. Nat. Sci. Philad., VII., p. 76. Awns short, scarcely exserted.

Hab. In Alabama.

Diodonta aurea. Coreopsis aurea; Ait. Hort. Kew., Ed. 1, Vol. III., p. 252.

Diodonta aristosa. Coreopsis aristosa; Mich. Flor. Bor. Am., Vol. II., p. 140. Awns very long and divaricate.

*Diodonta *leptophylla;* smooth, erect, dichotomously branched; leaves pseudopinnate, with few, linear, and mostly entire segments, the terminal one elongated; peduncle dichotomal, very long; achenium short, cuneate, scabrous, with two short, rather smooth horns.

HAB. Georgia. (Dr. Baldwyn.) A small species, about a foot high, with long, narrow, linear entire leaflets, sometimes with here and there a distant gash. Flower rather small, rays nearly entire.

§ I. * MEDUSEÆ.—*Outer involucrum very long and squarrose, of twenty to twenty-four leaves! the inner eight-leaved. Achenium ciliate, terminated by two very short teeth.*

Diodonta involucrata. Coreopsis involucrata; NUTT. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 74. Very remarkable for the singular involucrum, which, while all the other parts of the plant are smooth, has its segments strongly ciliated with rigid hairs. I have not seen the mature achenium.

§? II. * HETERODONTA.

BIDENS, but with the outer, foliaceous involucrum three to four-leaved, the inner about six-leaved, elongated. Rays two or three, very short, not exserted. Stigma smooth, with a small conic point. Achenium linear, flatly compressed, without angles at the sides or summit, hirsute, immarginate. Pappus of two long, diverging, hispid bristles, with the hairs *erect*, not retrorse! radial, abortive fruit, with very short awns.—A dwarf, much branched annual? with opposite, lanceolate-linear, incisely serrated leaves, attenuated at each extremity. Flowers solitary, terminal; scales of the involucrum yellowish. Discal florets shorter than the awns, campanulate with a very slender tube.—(The name in allusion to the erect, instead of reverted bristles of the teeth of the achenium.)

*Diodonta * Bidentoides.*

HAB. The vicinity of Philadelphia? With entirely the aspect of the dwarf variety of *Bidens cernua*, but with the capitulum almost obconic-oblong. Height two or three inches, spreading out five or six inches; leaves attenuated into long petioles, somewhat connate at base.

A second species of this section, or rather genus, occurs in the south-west, and will be described by Mr. Gray.

* COSMIDIUM. (§. COSMIDIUM of Coreopsis, GRAY.)

COREOPSIS, but with the discal florets long, tubular and campanulate, deeply five-cleft. Achenium subcylindric, usually tubercular and indurated, with two wide, acute, concave, foliaceous teeth, retrorsely ciliated on the margin. Paleæ of the receptacle oblong, membranaceous, embracing the fruit.—Perennial, smooth herbs, with capillary, or linear, opposite, pseudopinnated leaves, and few-flowered, dichotomal branched stems; flowers few, long pedunculate, yellow, with a brown disk; the ray in the second species said to be wanting.

Cosmidium filifolium. *Coreopsis filifolia;* HOOKER.

HAB. In Arkansa plains, near the outlet of the Kiamesha, Red River. Flowering in May. Perennial and very smooth, about two feet high, with a rather slender, terete stem. Leaves opposite and fasciculate, petioles connate at base, pseudo-bipinnate, with long, linear, capillary, grooved segments; secondary divisions and uppermost leaves trifid, ultimate pairs simple; branches trichotomal, uppermost dichotomal; the flowers few, upon very long peduncles. Outer and inner calyx each eight-leaved; exterior segments linear-lanceolate, acuminate, a little shorter than the inner, which are lanceolate-oblong. Rays about eight, almost equally three-lobed, sulphur yellow, neuter. Discal florets dark brown, with a slender tube, the upper part campanulate, and cleft nearly to its base, in five linear, reflected segments, the tube of anthers brownish-black, and exserted, with distinct ovate cusps. Stigmas hirsute with golden hair, each terminating in a slender conic point. Achenium subcylindric, pale brown, somewhat curved, tubercular or rough, somewhat carinated internally, indurated into a nut, with a thickish shell, almost as in *Sclerocarpus*, with here and there a few scattered hairs, terminated above in two sublanceolate, concave, large teeth, edged with golden yellow, reflected hairs; the proper seed with its integuments within the indurated envelope. Paleæ wide, oblong and membranaceous, obtuse, with a dark rib in the centre, and embracing the back of the achenium, but not extending over the front.

Cosmidium gracile; glaucous; leaves pinnately dissected in five divisions, segments narrow linear, entire; capituli discoid? bractes scarcely one-third the length of the involucrum. *Bidens gracilis;* TORREY, in Ann. Lyceum, New York, Vol. II., p. 215.

HAB. Rocky Mountains. (JAMES.)

LEPTOSYNE. (DECAND.)

COREOPSIS, but with the rays *styliferous.* Receptacle conic, paleaceous; paleæ oblong, obtuse, flat, three-nerved. Achenium obovate, compressed, somewhat curved, scabrous, with at length a broad, fungous margin and centre, the centre terminated by a minute, entire cup; the radial fruit imperfect, and nearly smooth. Stigma abrupt, pubescent, terminated by a minute cone. Rays about twelve to fourteen, retuse, and almost equally three-toothed.—A nearly smooth, stemless biennial, with opposite, pseudopinnate, almost capillary leaves; scapes or peduncles one-flowered, very long. Ray and disk yellow.

Leptosyne Californica.

Hab. Near St. Diego, Upper California. Flowering in the beginning of May. About a foot high; scapes numerous, terete. Outer involucrum eight-leaved, linear, pubescent at base, as long as the inner, of which the divisions are ovate, and likewise eight. Rays about twelve to fourteen, styliferous, shortly three-lobed, the stigmas filiform, smooth; with an imperfect, flat, and smooth achenium. Receptacle elevated as the fruit becomes mature; paleæ flat, oblong-oval, or ovate, obtuse, membranaceous, deciduous, three-nerved in the centre; the achenium at first rather thin, scabrous, and scattered with short, glandular hairs, at length curved, with a thick, spongy margin, and often a similar, enlarged centre; the seed itself narrow-oblong. Allied to the section *Chrysomelea* of *Coreopsis;* but the peculiar character of the achenium and styliferous rays remove it.

* TUCKERMANNIA.

Capitulum many-flowered, heterogamous; rays feminine, fifteen to twenty, fertile; discal florets hermaphrodite, tubular, five-toothed. Stigmas exserted, the summit flat, beneath pubescent and obtuse, terminating in a very short cone. Receptacle paleaceous, flat; the paleæ oblong, membranaceous and nerveless. Involucrum double, the exterior shorter, leafy, six to eight-parted, the interior eight to ten-parted. Achenia elliptic, alated, flatly compressed and naked, smooth, without pappus, and, as well as the wing, dark brown.—A succulent, perennial plant of Upper California. Leaves alternate, bipinnatifid, smooth and fleshy; the segments linear and divaricate. Stem one to three-flowered, scapoid, the pedicel very long and naked. Flower large, resembling that of a *Silphium;* disk and ray yellow. Rays three-toothed at the apex, longer than the disk.—(Named in respect to Mr. E. Tuckerman, Jr., who has devoted his attention to the neglected Cryptogamous plants of the United States.)

*Tuckermannia * maritima.*

Hab. On shelving rocks, near the sea, at St. Diego, in Upper California. A very showy and curious plant. Flowering in May. After the period of flowering it remains for a month or two in a dormant state, shedding its leaves, and appearing like a tuberous or bulbous plant, inert. Cultivated in Philadelphia, it flowered both in the spring and autumn. Leaves nearly all towards the root, lucid and thick; the scape, or peduncle, a foot or more in length, with (generally in a wild state) but a single flower, three or four inches in diameter. Rays about fifteen to twenty, or more, with filiform, smooth stigmas, three-toothed at the apex; chaff of the receptacle composed of oblong, membranaceous, flat and pointed scales. Rays, and several rows of the discal florets, fertile. Discal florets smooth, cylindric, and, as it were, articulated at the commencement of the tube; the teeth acute and flaccid. Stigmas exserted. Achenium dark brown, with the empty or winged margin of the *same* colour.—Remotely allied to *Coreopsis*, particularly the section *Calliopsis*, but with numerous fertile rays, minutely three-toothed, and a conspicuous, receptacular chaff, &c.; also to *Leptosyne*, but with perfect fruit in the ray, a flat receptacle, and a very different achenium, &c.

ACTINOMERIS. (Nutt.)

Actinomeris *nudicaulis.* *Helianthus aristatus;* Elliott, Vol. II., p. 428. Decand., Vol. V., p. 591. Leaves opposite, sessile, oblong or oval-lanceolate, scabrous, subserrulate, obtuse; flowers in a trichotomous panicle; calyx short, biserial; rays ten to twelve, lanceolate, entire; awns of the achenium rather short, the winged margin narrow.

Hab. In Georgia.

§ * Achæta.—*Awns of the achenium none; pappus a shallow, elliptic cup.—Leaves opposite, decurrent, corymb few-flowered; rays three or four, with rudimental achenia.*

Actinomeris pauciflora; (Nutt.) hirsute, leaves elliptic, obtuse, decurrent; peduncle two-flowered, very long.

Hab. East Florida. (Mr. Ware.)

LEIGHIA. (Cassini.)

Leighia uniflora; shortly pubescent, herbaceous; stem mostly one-flowered, terete; leaves below opposite, oblong-lanceolate, acute, sessile and narrowed below, entire, three-nerved, above alternate; flower large, long pedunculate; involucrum hirsute, squarrose, foliaceous at base; paleæ obtuse.—*Helianthus uniflorus;* Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 37.

Hab. Rocky Mountains, towards the sources of the Missouri. Flowering early in June, (9th.) Perennial, stem simple, generally one-flowered. Leaves three to four inches long, and, as well as the stem, hirsute with short, appressed, soft hairs, scabrous on the margin, one or two pairs opposite, the rest alternate; lower sepals foliaceous, squarrose, the inner linear-lanceolate. Rays fifteen to twenty, twice as long as the disk, two-toothed at the tip, wholly abortive, pale yellow; discal florets cylindric, narrower below, with five erect, blunt, pubescent teeth. Stigmas somewhat ovate, with a short pubescence. Achenium obovate, compressed, ciliated, with two to four subulate, rather wide awns from the angles, and about four minute, intermediate, obtuse squamellæ; the awns scarcely as long as the achenium.

*Leighia *lanceolata;* herbaceous, nearly smooth; stem terete, grooved, about three or more flowered; intermediate leaves opposite, above and below alternate, lanceolate, acuminate at each extremity, entire, petiolate, three-nerved; involucrum foliaceous, subsessile; sepals linear-lanceolate, squamæ retuse; achenium short, obcordate, with two to three slender, persistent awns, twice its length, the intermediate squamellæ minute.

HAB. Rocky Mountain plains and Upper California? Perennial; stem twelve to eighteen inches high, smooth below; lower leaves six to eight inches long, an inch broad, a little pilose. Rays about twelve to fourteen, pubescent beneath, twice as long as the disk, deep yellow. Paleæ retuse, pubescent at the tip. Achenium compressed, alated, smooth, (not ciliated,) short and obcordate, with two or three very long, slender, scabrous, awns from the two compressed angles; squamellæ minute, acute, (in the germ appearing like mere hairs.) Mature seed not seen, in the young state it somewhat resembles that of Actinomeris.

Leighia? Hookeriana. Helianthus Hookerianus; DECAND., Vol. V., p. 590. *H. longifolius;* HOOK. Flor. Bor. Am., Vol. I., p. 313, non. PURSH. Nearly allied to the preceding, but with obtuse leaves, and broad, lanceolate, ciliate sepals. The pappus apparently almost the same.

Leighia longifolia. Helianthus longifolius; PURSH, non. HOOKER. Intermediate squamellæ of the achenium minute, mixed with a terminal tuft of hairs; the rest of the fruit smooth.†

† To complete the history of this genus I will add the following species, collected in some parts of South America, by the late indefatigable Doctor Baldwin.

*Leighia *Baldwiniana;* herbaceous and scabrous, (apparently decumbent;) leaves crowded, linear-oblong, entire, acute, sessile, three-nerved, the nerves running contiguous to the revolute margin; panicle few-flowered, subcorymbose; sepals linear-lanceolate, acuminate, imbricate and squarrose, somewhat triserial; achenium villous.

HAB. South America; much like *Helianthus angustifolius.* Rays ten to twelve, twice as long as the disk. Stigma pubescent, thick and obtuse. Pappus of two awns, and about six pilose, narrow, indistinct scales.

*Leighia *debilis;* herbaceous and decumbent; stem terete, slender, and scabrous, as well as sparsely pilose, above, to the base of the involucrum, hirsute; leaves sessile, opposite, linear-lanceolate, serrate,

HELIANTHUS. (Linn.)

Helianthus lenticularis. DECAND.

HAB. Banks of the Platte and the waters of the west, generally.

*Helianthus *integrifolius;* ⊙, more or less hirsute with appressed hairs; leaves nearly entire, below opposite, above alternate, ovate, or ovate-lanceolate, three-nerved, petiolate, obtuse or acute; stem few-flowered; sepals lanceolate-oblong, or ovate, acute, closely imbricated; rays about twelve, rather short; achenium villous. *β. gracilis;* leaves denticulate, scarcely three-nerved; sepals acuminate.

HAB. With the above, a small and rather dwarf species, sometimes slender, at other times robust, leaves on long petioles. Stem sometimes almost simple (perhaps a different species;) in others branching from the base. Capitulum pedunculate, about one and a half inches in diameter, or smaller. Rays sometimes styliferous, with abortive fruit, bearing three awns; paleæ of the receptacle ovate, abruptly acute; young achenium almost silky; disk brown. Allied to *H. petiolaris*, particularly β. *gracilis*, but with short peduncles and opposite leaves.

*Helianthus *silphioides;* ♃, hirsute and scabrous; leaves petiolate, broad ovate, subcordate, dilated, serrate, acute, below opposite, alternate above; upper part of the stem naked, paniculate, subcorymbose; sepals oval, obtuse, closely imbricate; squamæ of the receptacle acute, somewhat three-toothed; achenium smooth, pubescent at the summit; rays acuminated.

HAB. In the plains of Arkansa, three or four feet high, and robust. Leaves nearly as wide as long, about three inches. Capituli in a branching corymb, branches two and three-flowered. Rays about twelve, acuminated, longer than the *brown* disk. Achenium spotted, subquadrangular, two awned. Discal florets cylindric, rather narrower at base.—Allied to *H. atrorubens*, but a much stouter and broader-leaved plant.

*Helianthus *pumilus;* ♃, hirsutely pilose and scabrous; leaves ovate-lanceolate, opposite, attenuated below, subpetiolate, nearly entire, and three-nerved, upper leaves lanceolate, alternate; involucrum hoary, hispid; sepals imbricated, lanceolate, acute, as well as the receptacular paleæ; achenia smooth.

acute, scabrous and somewhat softly pilose; peduncle one-flowered, terminal; sepals in nearly a simple series, oblong, acute.

HAB. Maldonado. (Dr. Baldwin.) Stem slender and wiry, about a foot long, sending off a few one-flowered branches towards the summit. Rays about ten to twelve, rather short. Achenium nearly smooth, with two awns, and numerous smooth squamellæ. Receptacular paleæ linear-lanceolate, acuminate.

HAB. Rocky Mountains and plains of the Platte. A low, perennial, simple stemmed species, about a foot high, leaves two to three inches long, about an inch wide. Capituli about three to five (apparently) sessile. Rays about sixteen, longer than the disk, paleæ somewhat obtuse, hirsute at the summit, scales of the achenium rather large and wide.

*Helianthus *crassifolius;* ♃, stem simple, herbaceous, subscabrous; leaves nearly all opposite, lanceolate, acuminate at either end, serrate, above smooth, beneath very scabrous, and, as it were, shagreened; stem naked, one to three-flowered, with a few small, linear leaves; involucrum closely imbricated, the scales ovate, slenderly and finely ciliate; achenium subquadrangular, with sometimes four scales, the two central ones smaller.

HAB. Plains of Arkansa. About two feet high, the lower part of the stem very leafy, above nearly naked from the sudden diminution in the size of the leaves, the plant here and there scattered with drops of resin. Leaves half a foot long, or more, about an inch wide, very thick and coriaceous. Rays about twenty, bidentate. Achenium pubescent above; with small scales from the inner angles; discal florets as usual, enlarged and pubescent towards the base. Allied to *H. pauciflorus.*

*Helianthus *squarrosus;* ♃, robust and gigantic; stem scabrous, grooved; leaves lanceolate, or ovate-lanceolate, scabrous at either end, acuminate, sessile, beneath softly villous and somewhat canescent, below opposite and three-nerved, above alternate, margin remotely subserrulate; capitulum upon a long pedicel; calyx squarrose, very widely spreading and coarsely foliaceous; rays numerous, (fifteen to twenty;) palea subtridentate; achenia smooth. *H. tomentosus,* ELLIOTT, non. MICHAUX.

HAB. In Georgia near Columbus: six to eight feet high: flowers three to four inches across. Rays pale yellow, rather narrow. Disk brownish. Leaves a span long, one and a half to two inches wide. A very showy species, and remarkable for its very leafy calyx, inner leaves linear-lanceolate, the outer sometimes half as large as those on the stem.

*Helianthus *debilis;* ♃, stem prostrate, nearly glabrous; leaves alternate, long petiolate, deltoid-ovate, repandly serrulate, glabrous, three-nerved; involucrum closely imbricate; sepals lanceolate acuminate, nearly equal, and almost smooth; capitulum long pedunculate, solitary, terminal; achenium smooth; disk dark brown.

HAB. The sea-coast of East Florida. (Dr. Baldwin.) In the Herbarium of the Academy of Nat. Sci. Philad. as *H. prostratus*, by Schweinitz, but very distinct from that species, having also the two deciduous pappus scales of the genus without any intermediate squamellæ, therefore not a *Vigueria.* Several spreading, prostrate stems, probably from the same root. Stem brown, terete, about a foot long, petiole more than an inch longer than the leaf, which is acute. Rays ten to twelve.

Helianthus Missouriensis; (Schweinitz, MSS.,) extremely scabrous; leaves atenuate, radical spathulate, serrate, cauline oblong obtuse, uppermost linear, acute; stem dichotomous, the branches diverging, one-flowered; sepals ovate, minutely ciliate, closely imbricate; stigma lanceolate, hirsute, golden yellow.

Hab. Plains of Missouri. Closely allied to *H. pauciflorus.*

Division IV.—Bidentideæ. (*Lessing. Decand.*)

BIDENS. (Linn.)

Bidens *quadriaristata.* *β.* * *dentata;* leaves remotely dentate, serrate, outer involucrum about five-leaved, longer than the oval rays.

Hab. Wappatoo Island, at the outlet of the Wahlamet, Oregon.

Bidens Californica.

Hab. St. Diego and St. Barbara, Upper California; common, ⊙. Also in Chili. Rays nearly white, inclining to yellow, often wanting.

§. Campylotheca.—(Genus Campylotheca, Cass. Decand.) *Achenium linear, sometimes curved or contorted, linear and compressed; awns two, small, or wanting.*

Bidens * *mutica;* very smooth and herbaceous; leaves ternately or pinnately divided; leaflets ovate-lanceolate, acuminate, serrate; panicle trichotomous; exterior involucrum a little shorter than the inner; rays about five, twice as long as the disk; achenium straight, sparingly pilose, without awns.

Hab. Ouau, Sandwich Islands. Less than a foot high, the lower leaves quinate, the uppermost nearly simple. Flowers yellow, rather small; the inner and outer involucrum each about five-leaved. Disk dark brown; tube of the florets nearly the length of the border. Branches of the stigma terminated by short conic appendages. The achenium smooth, or with a few scattered hairs, transversely striated, sometimes with a single awn, but mostly without any; branchlets of the panicle about three-flowered, the capituli on long pedicels.

Bidens * *gracilis;* smooth and herbaceous; leaves ternately or pinnately divided, leaflets lanceolate, acuminate, serrate; panicle slender, trichotomous; exterior involucrum a little shorter than the inner; rays about five, scarcely longer than the disk; achenium somewhat curved, with two short awns, having a few retrorse bristles towards the extremity.

HAB. With the above, which it closely resembles, but is a more slender plant, with smaller flowers; terminal leaflet largest, the lateral often small. Achenia a little bristly, sometimes with only one awn, or even without any, in the same capitulum with most of the others possessing awns.

*Bidens *angustifolia;* very smooth and herbaceous; leaves pseudopinnate, in two or three pairs; segments narrow-lanceolate, acuminate, serrate, the lowest leaflet sometimes divided; panicle trichotomous, contracted; sepals nearly equal; rays about five, longer than the disk; achenium ciliate with erect bristles, two-awned, the awns retrorse at the summit.

HAB. With the above, from which it differs in the narrow and pinnated leaves; the fruit has, also, longer awns, and the pedicels are short. The stem twelve to eighteen inches high. Awns of the achenium sometimes unequal, or of different lengths in the same capitulum.

† BIDENS proper.

*Bidens *hirsuta;* herbaceous, and more or less hirsutely pubescent; stem quadrangular, grooved, trichotomous; leaves pseudopinnate, in two or three pairs, the uppermost sometimes ternate, segments lanceolate, acuminate, incisely serrate, lateral divisions with the base obliquely attenuated; rays none; involucellum eight-parted, shorter than the involucrum; achenium subquadrangular, with a wide, circular, basal areole, the angles hirsute or scabrous above; awns three, unequal, strongly retrorse barbellate.

HAB. In Atooi. Two to three feet high, with a thick, hirsute, quadrangular stem, oppositely branched. Leaves much like those of *Agrimonia Eupatoria;* hence, I suspect it is closely allied to *B. Wallichii.* It is, however, destitute of rays. Outer involucrum with the segments connected together at the base; the inner, also, about eight-leaved. Achenium linear, straight, smooth, except the upper edges of the angles, which are ciliate with tubercular, short bristles; awns about three, a third the length of the fruit, with strong, barbellate bristles their whole length. Hairs of the stem broad, flat, membranaceous and acuminate. Branches of the stigma with long, acuminated, slender points.

*MICRODONTA.

Capitulum many-flowered, heterogamous; rays feminine in a single series, (about five,) many-nerved. Discal florets hermaphrodite, tubular-campanulate, five-toothed, the tube short and slender. Receptacle flat, paleaceous; palea oblong, similar with the inner involucrum. Involucrum double, the outer six-leaved, foliaceous, the inner about five-leaved, discoloured, somewhat scarious. Achenia flatly compressed, those of the ray elliptic, minutely bidentate, those of the disk oblong, with two short teeth, and a minute intermediate, paleaceous crown; one or two central florets, with two minutely retrorse bristly awns as long as the floret. Branches of the style terminated by a small abrupt cone.—A dwarf annual of Peru. Stem apparently simple; leaves ternate and opposite, trifid or three-lobed, ciliate. Flowers terminal, yellow.

*Microdonta *nana;* ⊙.

Hab. Near Arequipa, Peru. (Mr. Curson.) The whole plant about two inches high. Stem simple, pilose above, terminating in a single flower. Leaves petiolate, the petiole and a line down the stem ciliate and pilose; the simple leaves oval, three to five-toothed, segments of the trifid leaves narrower, also three-toothed. Segments of the outer involucrum linear-oblong, distinct to the base, longer than the inner, hirsute. Inner involucrum, like that of Bidens, the segments nearly smooth, oblong-oval, many-nerved like the rays. Rays five, oblong, truncate, shortly three-toothed, about twice the length of the inner involucrum, many-nerved, with a rather long narrow tube, stigmas slender, not thickened at the extremity as in the discal florets, and nearly smooth. Discal florets, as well as the rays, yellow, subcampanulate above, the tube contracted rather more than a third the length of the upper part of the floret. Palea flat, very similar to the inner involucrum, and equally wide. The achenium of the ray largest and most perfect, elliptic, truncate, minutely bidentate, naked; those of the disk narrower, but not rostrate, with short, smooth teeth, and a row of minute, intermediate, slender, chaffy scales; one or rarely two, of the central florets producing the usual two awns of a Bidens, but scarcely as long as the achenium, and minutely barbellated with retrorse bristles. I have described from two specimens. The flower, rather large for the diminutive size of the plant. A remarkably distinct genus in the Bidentideæ, the rays being more perfect than the discal florets, and without awns; the attenuation of the discal fruit above, without being properly rostrate, would seem to ally our plant to *Cosmos*, from which, however, it is wholly distinct.

Division V.—Verbesineæ. (Lessing.)

§ I. *Leaves not decurrent.*

Verbesina **villosa;* herbaceous, stem terete, pubescent, leaves alternate, lanceolate, sessile, at both ends acuminate, entire or repandly denticulate, above scabrous, beneath softly villous; corymb compound; rays about three, (white;) sepals softly pubescent, linear, acuminate; achenium subpubescent, without winged margin.

Hab. Plains of Arkansa. Resembles *V. virginica,* though perfectly distinct, and much nearer to *V. acuminata.* A stout, tall plant; leaves half a foot long, two inches wide, cuneately narrowed below, upper part of the stem and peduncles densely villous; flowers clustered; achenium cuneate, without any sensible wing, the two awns slender and somewhat pilose.

Subtribe IV.—TAGETINEÆ.

*RIDDELLIA.

Capitulum many-flowered, heterogamous; rays feminine, three to five, coriaceous, persistent, dilated, equally and obtusely three-lobed, six-nerved; discal florets hermaphrodite, tubular, five-toothed, the dentures glandular. Stigmas subcapitate, obtuse, minutely pubescent. Involucrum cylindric, composed of eight ingrafted leaflets. Achenium slender and conic, prismatic, smooth. Pappus paleaceous, five or six-leaved, segments lanceolate, acuminate, nerveless, similar in the ray. Receptacle naked, minute.—A slenderly branching, aromatic herb, with alternate, oblong-linear, subtomentose leaves; branchlets corymbose, three to five-flowered; persistent rays apparently yellow, (reddish-orange after inflorescence;) involucrum densely sericeous with long hairs.—(Named in respect of Professor Riddell, a botanist, who has explored the interior of Texas.)

*Riddellia * Tagetinæ.*

HAB. The southern range of the Rocky Mountains, towards the sources of the Platte. A very elegant plant, with the habit of a Zinnia, but having the involucrum formed of a single series of united sepals. The rays are very remarkable, appearing as rigid as parchment, and remain perfectly flat after inflorescence, as in Zinnia.

*SOLENOTHECA.

Capitulum few-flowered, heterogamous; rays feminine, very few and small, (two or three.) Involucrum an entire, even, cylindric tube, with a short, five-toothed border. Receptacle naked. Achenium fusiform, compressed, somewhat four-sided, partly stipitated at the base, pubescent. Pappus paleaceous, paleæ elongated, setiform, of equal length, but unequal thickness, ciliated, and almost plumose on the margin.—A small annual of Peru, with slender, spreading branches; leaves opposite and alternate, pinnatifid. Flowers terminal, fastigiate; liguli few and very small. Nearly allied to Tagetes, but with a very different pappus, and a peculiar habit.—(Named from σωλην, *a tube,* and θηκη, *a sheath,* in allusion to the cylindric calyx.)

*Solenotheca *tenella.*

Hab. Near Arequipa, in Peru. (Mr. Curson.) Annual, with a simple, slender root. The whole plant three to four inches high; very smooth. Leaves below opposite, above alternate, deeply pinnatifid; segments two or three pairs, linear, serrate, or merely three-toothed at the summit, less than half a line wide; branches terminating in one or two flowers; capituli pedicellate. Involucrum smooth and cylindric, about half an inch long, a line wide, and a little ventricose towards the base, five-toothed, the teeth shallow. Rays two or three, scarcely exserted, the border somewhat round, greenish-yellow. Tubular florets about five, five-toothed, the dentures connivent. Stigmas ending in a slender, pubescent cone. Pappus longer than the long and slender achenium, very shining, somewhat yellow, achenium subsericeous.

Subtribe V.—HELENIEÆ. (Cassini.)

Division I.—Gaillardieæ.

Gaillardia *pulchella;* (Decand.)

Hab. Arkansa plains; common.

Gaillardia aristata; (Pursh.)

Hab. Arkansa Plains.

Baldwinia *uniflora;* (Nutt.) Stem sometimes three-flowered.

LEPTOPODA. (Nutt.)

Leptopoda **pinnatifida;* (Herb. Schw.,) radical and lower leaves incisely pinnatifid, with remote segments, cauline sessile, narrow-linear, subulate, smooth; stem fistulous, pubescent, one-flowered; sepals nearly in a single series, very short; rays about twenty, linear; achenium pubescent, paleæ of the pappus obtuse and awnless.

Hab. East Florida. (Dr. Baldwin.) About a foot or eighteen inches high, somewhat slender, with very narrow and rather numerous leaves; upper part of the stem naked; flower small; rays about half a line wide, terminating in three small teeth.

Leptopoda Helenium; smooth; leaves entire; radical, oblong-lanceolate, denticulate, lower stem leaves lanceolate-linear, attenuated into long petioles, middle stem leaves only decurrent; naked portion of the stem long; stem one to three-flowered, the apex, before flowering, tomentose; involucrum shorter than the disk; achenium smooth, the pappus slightly lacerate.

Hab. West Florida. Sepals short, lanceolate and unequal; rays more than twenty, wedge-shaped, trifid at the summit, sometimes very wide.

*Leptopoda *denticulata;* smooth; leaves linear-sublanceolate, denticulate, acute, attenuated at the base, cauline broadly decurrent, uppermost sessile, acuminate; sepals as long as the disk, lanceolate-linear; achenium smooth, pappus deeply lacerate.

Hab. In Georgia. *L. Helenium;* Decand., Vol. V., p. 653. Leaves almost all equally narrow. Flower larger than the preceding. Rays more than twenty, broad cuneate, trifid and quadrifid. The peduncle conically enlarged under the capitulum.

*Leptopoda *brevifolia;* smooth; radical leaves spathulate, subsessile, cauline spathulate, denticulate, obtuse, slightly decurrent, uppermost lanceolate, entire, acute; stem smooth, one-flowered; achenium pilose, turbinate; pappus slightly lacerated.

Hab. In South Carolina. A remarkable species, clothed distantly with leaves nearly to the summit; radical ones very short, about an inch, nearly sessile, cauline leaves about two inches long, half an inch wide. Flower large and showy, the rays few, (about twelve,) and much dilated. Sepals lanceolate, shorter than the disk. Discal florets dark brown. Achenium covered with brown, chaffy hairs.

BAHIA. (Decand.) Trichophyllum. (Nutt.)

Bahia integrifolia; (Decand.)

Hab. Oregon and the Blue Mountains. Pappus about ten-leaved, nearly equal.

Bahia multiflora. *Trichophyllum multiflorum;* Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 35.

Bahia lanata; herbaceous and erect; lower leaves often bipinnatifid, segments linear, equal, beneath and the stem canescently tomentose, above greenish; flowers loosely corymbose, peduncles of moderate length. *Trichophyllum lanatum;* Nutt. Gen. Am., l. c.

Hab. With the above, of which it may be, perhaps, only a variety. The stem and leaves are more slender, and the latter not so tomentose above; the peduncles are also fastigiate, and form a loose corymb; in the preceding the peduncles are very long and few. Pappus unequal. The specimens described by Hooker, according to one sent from the author to Schweinitz, are weak ones, in which the bipinnatifid leaves are not developed.

Bahia tenuifolia; (Decand.) Very nearly allied to *B. lanata.* Perhaps only a variety, with narrower leaves and shorter pedicels.

Hab. Common on the banks of the Oregon, in rocky places.

† *Shrubby species, with alternate leaves.*

Bahia confertiflora; (DECAND.)

HAB. St. Barbara, Upper California. A low, branching shrub, about a foot high, with the stem, involucrum, and leaves beneath whitely tomentose. Leaves somewhat ternately pinnatifid, amplexicaule at base, about one to one and a half inches long, the segments about a line wide. Flowers at length loosely pedicellate, at first, when in flower, in sessile clusters. Primary leaves sometimes simply trifid, divisions usually about two long lateral ones, with the terminal ones short. Flowering in April.

*Bahia *trifida;* leaves small, cuneate, amplexicaule, trifid at the summit; corymb contracted, many-flowered; pappus eight-leaved, alternately narrower and longer; stem and under side of the leaves whitely tomentose.

HAB. With the preceding, which it nearly resembles, but the leaves are smaller and rather crowded. Rays and sepals five to seven; stem densely, and, at the summit, often arachnoidly tomentose.

Bahia stœchadifolia; (DECAND.) OBS. Radical leaves sparingly pinnatifid, upper leaves linear, entire, obtuse.

HAB. With the preceding. A very low shrub, leaves linear, crowded below, two inches long, about a line wide, whitely tomentose beneath; corymb contracted. Perfect flower not seen. Pappus eight-leaved, the four at the angles of the fruit narrower and longer. Receptacle deeply alveolate.

Bahia artemisiæfolia; (LESS.)

HAB. St. Francisco, Upper California.

HYMENOPAPPUS. (L'Heritier.)

Hymenopappus tenuifolius.

HAB. Plains of Red River and Missouri.

Hymenopappus filifolius.

HAB. Plains of the Oregon. In my specimens the pappus is rather conspicuous.

*Hymenopappus *luteus;* canescently tomentose; stem slender and dwarf; leaves bipinnatifid, ultimate segments or lobes very short, linear, obtuse; sepals rounded, about twelve; florets yellow; panicle few-flowered, subcorymbose; pedicels moderate; achenium densely lanuginous; pappus short.

HAB. Rocky Mountains, towards the Colorado of the West, particularly on Ham's Fork. Usually less than a foot high. Leaves short, with crowded segments, resembling Milfoil; for the most part whitely tomentose, sometimes nearly green. Root-stock thick, almost woody, very woolly between the leaves. Stem about a span, slender, three to five-flowered, somewhat dichotomal; capituli fastigiate, florets yellow, the border narrower and less deeply cleft than usual. Stigmas pubescent, with a thick, obtuse extremity, ending in a minute cone. Achenium short and striate, covered loosely with long, soft hairs; pappus scales white, lacerated, obtuse, about twenty, scarcely exserted beyond the down.—Nearly allied to Chænactis, but with the florets all regular.

CHÆNACTIS. (Decand.)

Capitulum many-flowered, homogamous; florets tubular, funnelform, the external series with the border dilated, ringent or palmate, five-cleft or five-toothed, with the tube smooth and the dentures pubescent. Involucrum campanulate, composed of two series of erect, linear sepals, (twenty to thirty,) not membranaceous (or scarcely so) on the margin. Receptacle naked, alveolate, the margin sometimes paleaceous, the paleæ similar with the involucrum. Branches of the style hirsute, subulate, (without the conic apex.) Achenia linear-tetragonal, attenuated almost into a pedicel at the base, pubescent with appressed hairs. Pappus of four or five? lanceolate, acute, membranaceous paleæ, in the ray shorter and obtuse.—Californian annuals, with the habit of Hymenopappus. Leaves alternate, pinnately divided, with narrow, entire, linear lobes; branches often naked at the summit, monocephalous. Flowers yellow. Anthers naked at base.

*Chænactis * tenuifolia;* annual or biennial; at length smooth, much branched, flowers fastigiate; leaves bipinnately dissected, segments narrow-linear, or linear-oblong; rays funnel-formed, expanding longer than the disk; achenium nearly smooth; pappus four-leaved; sepals pubescent, linear, acute; margin of the receptacle paleaceous.

Hab. St. Diego, Upper California. Flowering in May. About a foot high. Leaves very similar to those of *Hymenopappus filifolius*, alternate, the young shoots a little tomentose. Involucrum hemispherical, many-flowered, somewhat viscid; pedicels rather short. Style hirsute, subulate. Florets minutely pubescent; the flowers bright yellow. Stem about a foot high. Pappus of the rays shorter and obtuse.—Nearly allied to *C. glabriuscula*, but the rays are not palmatifid. In this species the margin of the receptacle is foliaceous, the radial florets being situated between the outer and inner series of the sepals.

Chænactis Stevioides; (Hooker and Arnott.)

Hab. In the Snake country. The rays palmatifid. Pappus four-leaved. Achenium four-angled, nearly smooth.—A slender, few-flowered annual. Sepals oblong-lanceolate, nearly smooth, about fifteen. Very nearly allied to the preceding. Flowers yellow?

*MACROCARPHUS.

Hymenopappus, but with the leaves of the involucrum linear, numerous, (fifteen to twenty,) equal, in nearly a single series, and almost without membranaceous margins. Receptacle naked. Florets tubular, the shortly five-cleft border pubescent; the outer series somewhat ringent, but not spreading. Branches of the style hirsute, filiform, thicker towards the extremity. Achenium linear, conic, subcylindric, villous, attenuated below; with a chaffy, nerveless pappus of about ten to twelve unequal, lacerated, oblong, obtuse leaflets more than half its length; the pappus of the outer florets shorter.—Biennial herbs of the north-west coast of America, and the Rocky Mountains, with tomentose, bipinnatifid, alternate leaves. Stems dichotomous, corymbose. Capitulum many-flowered, the florets rosaceous, or nearly white, with the tube of anthers exserted, their cusps linear and acute, the base naked.—Intermediate between Chænactis and Hymenopappus; differing from the former in its nearly equal florets, filiform, and not subulate stigma, nearly terete achenium, and a pappus of many long, obtuse leaflets; from the latter in the narrow-leaved involucrum, long leaves of the pappus, and the form of the florets, which are merely tubular, not campanulate.—(Named in allusion to the great length of the pappus.)

Macrocarphus Achilleæfolius; canescently tomentose; branches corymbose, leaves bipinnatifid, lobes short, oblong-obtuse; sepals canescently tomentose, about twenty; chaff of the pappus nearly the length of the elongated, villous achenium. *Chænactis Achilleæfolia;* Hook. and Arn. Bot. Beech., l. c.

Hab. In the Rocky Mountain range, on Ham's Fork of the Colorado; common. Flowering in July and August. Capitulum large, the florets pale rose-red. Robust, biennial, about four to six inches high; the leaflets and lobes crowded, as in Milfoil.

Macrocarphus Douglasii; deciduously and slenderly tomentose; stem branching, corymbose; leaves pinnatifid, lobes entire or subdivided, oblong, obtuse; sepals glandularly and minutely pubescent; radial achenium glandularly scabrous, slightly pubescent, with a nearly equal pappus about half its length.

Hymenopappus Douglasii, Hook., Vol. I., p. 316. Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 30.

Hab. In the Rocky Mountains, towards the sources of the Missouri and the Platte. Allied to the preceding, but a much smoother and more slender plant, and with a different pappus and achenium. The florets, like those of the preceding, are pale rose-coloured. Radial florets with a shorter pappus, and a scabrous, slightly hairy achenium; the central fruit villous.

Polypteris. Obs. Involucrum biserial, equal, subcampanulate. Sepals greenish-white, oval, obtuse, with broad, membranaceous margins, (as in *Hymenopappus;*) tube of the floret filiform, as long, or longer than the campanulate, deeply five-cleft border, the segments of which are smooth, linear and revolute, (and appear to have been white, or ochroleucous.) Stigmas filiform, equal, hirsute, much exserted. Achenium angular, acute below, black, slightly scabrous; pappus of ten to twelve lanceolate, brownish, membranaceous leaves, with a strong mid-rib carried out to a terminal, shortly awned point, the rib externally hirsute. Flowers disposed in corymbose, pedunculated clusters.

*STYLESIA.

Capitulum heterogamous, many-flowered; rays in a single series, (six to eight,) oblong, entire, feminine; discal florets hermaphrodite, the border five-cleft, campanulate, the tube glandularly pilose. Stigmas obtuse, pubescent, revolute, short, terminated with a minute cone. Involucrum turbinate-campanulate; sepals eight, in a single series, ovate, obtuse, membranaceous on the margin, distinct at the base. Receptacle small, naked. Achenium linear-turbinate, narrowed below; when mature, flatly four-sided. Pappus a small chaffy crown, of about eight obtuse, somewhat lacerated, nerveless scales.—Suffruticose plants of Chili, with opposite, multifid leaves, and corymbose, pedunculated flowers, with the rays white and the disk yellow. Allied apparently to *Hymenoxys*, but with a very different habit to *Bahia.*—(Named in honour of Doctor Styles, who made a very interesting collection of Chilian plants, now mostly in the Herbarium of the Academy of Natural Sciences in Philadelphia.)

Stylesia Ambrosioides; upper part of the stem and involucrum villous and glandular; leaves ternately bipinnatifid, petiolate, segments oblong, obtuse;

flowers corymbose; sepals oblong or lanceolate, longer than the disk; achenium linear, elongated, pilose, more than twice as long as the pappus.—*Bahia Ambrosioides;* (LAGASCA.)

HAB. Chili. (Dr. Styles.) A small under shrub, more or less gray and puberulous; leaves opposite, trifid, or twice trifid, the segments oblong and incise; flowers corymbose, with the rays longer than the disk. The discal florets and involucrum almost that of *Hymenopappus*, to which it is intimately related. Flowers by threes, six to nine in a corymb.

*Stylesia *puberula;* minutely pubescent; leaves ternately bipinnatifid, petiolate, segments oblong or cuneate-oblong, somewhat obtuse; flowers corymbose; sepals ovate, glandularly pubescent; achenium obconic, scarcely longer than the pappus.

HAB. Chili. (Dr. Styles.) Nearly allied to the preceding. A shrub, with rather stout branches, the stems very full of leaves in the axills. Flowers corymbose, probably white? Rays five or six. The involucrum nearly hemispherical. Pappus brown, shorter than in the preceding; the achenium, also, not more than half the length of that species. Leaves in three principal divisions, the lowest segment pinnatifid, the upper and terminal merely bifid or trifid.

ACTINELLA. (Persoon.)

Capitulum heterogamous, many-flowered; rays feminine, cuneate, three-toothed. Involucrum hemispherical or subcampanulate, biserial, shorter than the florets; sepals nearly equal. Receptacle naked, convex or conic; discal florets short and tubular, five-toothed, villous at the summit; anthers included. Stigmas revolute, obtuse, externally hispid, inappendiculate, in the ray filiform and smooth. Achenium turbinate, subcylindric, striate, densely pilose. Pappus of about five to twelve membranaceous, aristate paleæ, eroded on their margins.—Herbaceous or suffruticose plants of North and South America. Stemless or branching; leaves entire, incise, or pinnatifid; flowers pedicellate, solitary, mostly yellow.

† *Stem herbaceous, leafless, scapoid; the leaves radical, and mostly entire.*

Actinella acaulis; NUTT. Gen. Am., Vol. II., p. 173. *Galardia acaulis;* PURSH, Vol. II., p. 743. *Cephalophora acaulis;* DECAND., Vol V., p. 663. Leaves softly and sericeously villous, canescent, in cæspitose tufts. Root long, thick and fusiform; scapes sometimes, though very rarely, with a single leaf. Rays ten to twelve. Receptacle convex.

HAB. Hills towards the sources of the Platte, in chalky soil.

Actinella scaposa. β. * *linearis;* slenderly villous; leaves narrow-linear, sublanceolate, much attenuated below, all entire, with dark punctures; scape very long and slender, with one capitulum; sepals linear-oblong, obtuse, twenty or more in two series.

HAB. Texas. (Professor Riddell.) Rays about twelve, twice as long as the disk; pappus five-leaved, white and thinly membranaceous, nerveless, oblong, abruptly apiculate; achenium slenderly villous. Receptacle convex. Probably a distinct species, as the leaves are never apparently pinnatifid, as in the true *A. scaposa.*

Actinella * *glabra;* leaves narrow-linear, sublanceolate, attenuated below, broadly sheathing and ciliate at base, covered with dark, impressed punctures; scape one-leaved, one-flowered; involucrum campanulate, biserial, lanuginous, sepals about twelve, ovate, obtuse; receptacle conic.

HAB. Missouri, (near the Shawnee villages.) I have only seen a single specimen, after flowering. It appears to be much allied to the preceding species, but with a different involucrum and receptacle. Root perennial, with persistent vestiges of leaves, growing probably in tufts. Scape with a slender linear leaf about half way up to the flower.

Actinella * *Torreyana;* densely cæspitose; leaves linear, punctate, sparsely pilose, but green, and darkly punctate, with a callous, rather obtuse point; axills, scape and involucrum very loosely lanuginous; sepals oblong-ovate, obtuse, with membranaceous margins; pappus five-leaved, hyaline, and slenderly apiculate; receptacle conic. *Actinea integrifolia;* TORREY, in Annals Lyceum Hist. Nat. N. York., Vol. II., p. 213, non KUNTH.

HAB. On the lofty hills or mountains, called the "Three Butes" of the upper Platte, on shelving rocks. Flowering in June. An alpine species of very dwarf stature, two to three inches high. Rays ten or twelve deeply three-toothed, strongly veined, rather wide and large.

Actinella * *lanata;* densely cæspitose; leaves linear, subacute, softly and copiously pilose, as well as the axills; scape and involucrum nearly impunctate; the primary leaves oblong-spathulate, coriaceous; outer sepals lanceolate, or lanceolate-ovate, without membranaceous margins; pappus five-leaved, scales lanceolate, with long and distinct awns; receptacle conic.

HAB. With the above, which it very closely resembles, but is much more pubescent, with longer awns to the pappus and a different involucrum.

† † *Caulescent; leaves pinnatifid, filiform.*

Actinella Richardsoni; caulescent, nearly smooth; leaves alternate, petiolate, pinnatifid; segments few, filiform-linear, rigid, punctate; branches mostly one-flowered; sepals ovate, the outer series coalescent at the base; pappus about five to seven-leaved, aristate; receptacle conic.

HAB. Upper Canada, Carlton-House, on the Sascatchewan. A strict congener with the preceding, of which several species have also the pellucid bitter resinous glands on the corolla. *Picradenia, Richardsoni,* HOOKER, Flor. Bor. Am., p. 317, t. 108.

OBS. *Actinella heterophylla,* the type of the present genus, which we can by no means join with *Cephalophora,* is a suffruticose, somewhat minutely hirsute, much branched, apparently decumbent plant; the leaves linear, alternate, rather crowded, some of them irregularly and incisely lobed, the lobes seldom more than a single pair; they are also covered with impressed, globular glands, which communicate to the plant, as in Picradenia, an intense bitter taste; the branches terminate each in a single, long, pedicellated capitulum; the involucrum is very short, consisting of a double series of tomentose, narrow sepals, the outer lanceolate. Receptacle convex. Achenium turbinate, subcylindric, covered with dense and shining brown hair. The pappus a crown of ten to twelve narrow-lanceolate, membranaceous scales, each with a strong, brown, central nerve going out into a long, slender awn. Rays numerous, cuneate, three-toothed, apparently ochroleucous, or white, externally brownish, as in the flowers of *Gaillardia.* A branch of this plant almost wholly resembles a specimen of the *A. scaposa;* the genus differs from our plants only in the greater number of its pappus scales, which, in *Picradenia,* are, however, five to seven.

BURRIELIA. (Decand.)

Burrielia gracilis; ⊙, above minutely hirsute; below smooth; stem often branching from the base; flowers fastigiate; leaves long and linear; rays and sepals ten to fourteen, the rays longer than the disk; achenium minutely scabrous.

HAB. Near St. Barbara, Upper California. Six inches high, branched both below and above. Pappus scales four, lanceolate, with long awns; achenium of the ray flattened, with two aristate pappus scales. Receptacle conic.

*Burrielia *longifolia;* ⊙, leaves long, linear, and very narrow, smooth; stem branching from the base, few-flowered; sepals and rays ten to fourteen, the latter oval, shorter than the disk; achenium nearly smooth.

HAB. With the preceding, to which it is closely allied. Leaves scarcely half a line wide, two inches long; rays much shorter than in the preceding. Pappus four-leaved, awned, that of the ray two. Four to six inches high, nearly smooth, except the young shoots and involucrum. Receptaculum conic.

*Burrielia *parviflora;* somewhat pubescent; very much branched and many-flowered; leaves long and almost filiform; rays and sepals about eight; rays oblong, very short; achenium minutely scabrous.

HAB. With the above. Leaves scarcely a quarter of a line wide. Stem much branched from the base; peduncles slender and very long. Involucrum smooth, divisions lanceolate. Receptacle conic. Pappus three or four-leaved, long-awned, in the ray two-leaved and similar. OBS. In all these species the discal florets are campanulate with a narrow tube, the border with five acute erect teeth, scarcely, if at all, pubescent.

§. I. *AMPHIACHÆNIA.—*Pappus none.*

*Burrielia *hirsuta;* erect, hirsute; leaves very long, linear and acute, sometimes here and there incise; peduncles elongated; sepals and rays ten to twelve; rays oval, as long as the disk.

HAB. St. Barbara, Upper California. Achenia compressed and scabrous. Six to twelve inches high, below smooth, with the radical leaves very narrow. Stem leaves, about two inches long, and a line wide. Scarcely distinguishable from *B. gracilis*, except by the absence of pappus.

*PTILOMERIS.

Capitulum heterogamous, many-flowered; rays feminine, elongated, slightly three-toothed. Involucrum subcampanulate, many-leaved, in nearly a simple series, (ten to fifteen.) Sepals lanceolate, embracing the radial achenia. Receptacle conic, naked or villous. Achenium slenderly conic, angular, hirsute, attenuated at base. Pappus extremely various, many-leaved, paleaceous, (eight to twelve,) or none! apex awned or obtuse, fimbriate; in the ray smaller, formed simply of a short, multifid crown, or with the addition of one or two awns. Discal florets hermaphrodite, campanulate, five-toothed, externally, as well as the tube, glandularly pubescent. Stigma obtuse, short, reflected, and pubescent.—Annual herbs of California; much branched; leaves opposite, once or twice pinnatifid with long, capillary segments; flowers terminal, pedicellate, golden yellow. The whole plant clothed with a slender, soft, glandular pubescence, which is aromatic. Allied to *Burrielia* in habit, but with the pappus in a numerous series, and the leaves plumosely torn; also to *Lasthenia*, but with conspicuous, regular rays, and an involucrum of separate sepals. It likewise approaches the MADIEÆ, by the embracing sepals, but the marginal achenia are provided with pappus. The most paradoxical character the plants of this genus present, however, is in the absolute conformity, or nearly so, of all the species with each other, while they differ in the receptacle and in the pappus, or by its total absence!—(Named in allusion to the slender feather-like foliage.)

Ptilomeris * *aristata;* paleæ of the pappus eight to twelve, awned; the ray with two awns and a small crown of minute leaflets; receptacle conic, naked, and alveolate.

HAB. Near St. Diego, Upper California. Flowering in April. Every part of the plant minutely and glandularly pubescent; branching from the base, sometimes, in weak specimens only towards the summit, branches few-flowered, flowers fastigiate. Leaves opposite, once or twice deeply pinnatifid, the rachis alated and rather broad towards the base, segments almost capillary, long and acute, (often an inch or more) and as fine as in Fennel. Involucrum ten to fifteen leaved, rays the same number; sepals lanceolate, acute, equal, foliaceous; rays as long as the disk, oblong, slightly two or three-toothed, the middle tooth smaller. Flowers bright yellow, a little smaller than those of the common wild daisy. This, and the rest, from their abundant bright flowers, are very ornamental, and of easy cultivation. In a green-house, in Philadelphia, I had this and the following species to grow and flower luxuriantly, but they have since been lost through neglect.

Ptilomeris * *coronaria;* palea of the pappus eight to twelve-awned; the ray generally without awns, and with a small crown of diminutive, awnless leaflets; receptacle conic, densely villous and alveolate.

HAB. With the preceding, from which it can only be distinguished by the specific characters.

Ptilomeris * *mutica;* paleæ of the pappus six to eight-leaved, obtuse and fimbriate at the summit, that in the radial florets smaller; receptacle conic, sparsely pilose.

HAB. With the preceding, from which it can only be distinguished by the pappus. The rays, as in the whole genus, are embraced by the sepals.

§. I. * PTILOPSIS.—*Pappus none.*

Ptilomeris * *Anthemoides;* pappus none; epigynous disk very minute.

HAB. With the above, and in no way, apparently, distinguishable from the preceding but by the achenium. If any thing, the involucrum in this is a little more campanulate.

*DICHÆTA.

Capitulum many-flowered, heterogamous; rays feminine, oblong, two-toothed. Discal florets hermaphrodite, five-toothed, with a campanulate summit, smooth. Stigmas subcapitate, obtuse, pubescent. Involucrum subcampanulate, five to twelve-leaved, in a single series; sepals ovate, ciliate, the same number with the rays. Receptacle conic, narrow and elevated, papillose. Achenium narrow and acutely conic, angular. Pappus in ray and disk similar, of about eight obtuse, small, fimbriated scales, and two, rarely three or four, intermediate, separate awns.—Annuals, with opposite, entire, or laciniately pinnatifid leaves; flowers terminal, pedicellate, yellow, almost exactly like those of *Burrielia*, but the plant subaquatic, and with a very different pappus.—(The name from the intermediate pappus of mostly two awns.)

*Dichæta *tenella;* erect, stem simple, pilose; leaves linear, mostly entire, the lower ones somewhat laciniated; rays and sepals five to eight.

Hab. On the margins of ponds and wet places. St. Barbara, Upper California. Flowering in April. A slender, diminutive plant three or four inches high. Leaves an inch or more long, about a line wide. Rays scarcely as long as the disk.

*Dichæta *uliginosa;* decumbent and branching; stem, peduncles, and often the involucrum hairy; leaves laciniately pinnatifid, with a broad rachis, the segments linear; rays about eight to twelve, shorter than the disk.

Hab. With the above, but a much larger plant, and almost aquatic. Awns of the pappus sometimes three or four. Leaves two to three inches long with a broad rachis, sending off very unequal, linear, narrow, acute segments.

LASTHENIA. (Cassini.)

§. Hologymne.—Rays oblong, conspicuous, as long as the disk. Achenia compressed, linear-oblong, glandularly scabrous, and without pappus.—Annual, subaquatic, or terrestrial herbs, with opposite, entire, linear leaves. Flowers yellow, terminal, pedicellate.

Lasthenia glabrata, Decand., Vol. V., p. 665. Decumbent or erect, and branching from the base; smooth, except the pedicels; rays twelve to fifteen, oval, bidentate, as long as the disk; sepals united into a hemispherical cup, toothed at its margin; receptacle conic, papillose.

HELENIUM. (Linn.)

*Helenium *grandiflorum;* glabrous; leaves elliptic-lanceolate, acute or acuminate, widely decurrent, the lower ones subserrate; stem branching at the summit; pedicels very long and fastigiate; the linear, acuminate sepals numerous, and as long as the large, globular disk; rays flat, three to four-cleft; pappus white, fimbriate, awned, half the length of the discal florets.

Hab. Banks of the Oregon and Wahlamet; common. A stout plant, with very large, yellow flowers, much like *H. autumnale*, but never growing so tall, seldom exceeding a foot to eighteen inches, with leaves one to two inches wide, and three to four inches long, very irregularly serrated, often entire; with the rays longer than the disk, and never tubular. Achenium striated with strigose hairs on the ribs, the pappus white, with long awns, and lacerated or fringed at the sides. Remarkable for its large flowers, dwarf size, and very long pedicels meeting in a sort of corymb. Stigmas exserted, smooth. Rays very long, and pubescent externally.

*Helenium *montanum;* minutely pulverulent, pubescent; leaves lanceolate, decurrent, subserrate; flowers corymbose, on short pedicels; sepals linear, shorter than the disk; rays flat, mostly three-toothed; pappus acuminate, long-awned, half the length of the floret.

Hab. In the Rocky Mountain range, on the borders of Lewis' River, &c., twelve to eighteen inches high, the upper part hoary with pubescence. It has much the appearance of a dwarf variety of *H. autumnale*, but is more pubescent, smaller flowered, and with a much longer awned pappus.

*Helenium *parviflorum;* smooth; the stem much branched and divaricate, slightly angular; leaves lanceolate, or oblong-lanceolate, here and there subserrulate, scarcely decurrent; involucrum shorter than the disk; sepals filiform; rays flat, three-toothed, narrow; achenium rather smooth; pappus awned, half the length of the floret; flowers scattered, solitary or by pairs.

Hab. In Georgia. A very distinct and well marked species, scarcely at all bitter to the taste. Flowers scattered, not fastigiate, scarcely half the size of those of *H. autumnale*, to which this species has an affinity, the leaves are also generally entire and scarcely decurrent. Rays slightly pubescent externally.

§. II. Tetrodus. (Decand.) *Discal florets four-toothed.*

*Helenium *nudiflorum;* glabrous; leaves remote, above small, lanceolate, decurrent, entire; stem tall, the summit divaricate and almost naked, few-flowered; involucrum shorter than the globular, dark brown disk; rays few, flat, three-toothed; pappus lanceolate, brown and awned, about one-third the length of the discal floret.

HAB. The plains of Red River, Arkansa. A very elegant species, with deep orange or dark purple brown rays, pubescent externally. Stem three or four feet high, spreading and somewhat naked at the summit, pedicels long and grooved, involucrum a little pubescent.

*Helenium *micranthum;* nearly smooth; radical leaves narrow, linear-lanceolate, entire; lower leaves oblong-lanceolate, sparingly denticulate, decurrent, upper ones lanceolate, entire; stem slender, dichotomous; branchlets one to two-flowered, peduncles moderate; involucrum hirsute, shorter than the spherical, brown disk; pappus about a third the length of the discal floret, hyaline, apiculate; rays three-cleft, flat.

HAB. South Carolina. Allied to *H. nudiflorum*, but the capitulum about half the size, and the rays shorter, as well as the pappus, which is white, smaller and not awned. In *H. quadridentatum* the radical leaves are bipinnatifid.

Helenium Mexicanum. (H. B. and KUNTH.)

HAB. Louisiana. (Teinturier.)

Division II.—GALINSOGEÆ. (Decand.)

*PTILONELLA. (BLEPHARIPAPPUS in part.)

Capitulum few-flowered, radiate; rays about three, ligulate, feminine, dilated and deeply three-lobed. Discal florets tubular-campanulate, five-toothed, hermaphrodite, the centre ones sterile. Branches of the style short, obtuse, rather smooth and exserted, the style hirsute; those of the rays smooth. Receptacle small, paleaceous, palea half-embracing, membranaceous. Involucrum subcampanulate, about eight-leaved, equal, the sepals half-sheathing, oblong. Achenium turbinate, villous, crowned with a short circle of plumose or ciliated pappus about a third its length; abortive central achenia narrow-linear, with a pappus of fewer and less divided rays; (rays filiform, from eighteen to twenty.)—An annual, much-branched, aromatic, slightly hirsute and scabrous-leaved plant. Stem smooth. Leaves alternate, narrow, crowded, linear, entire. Flowers lateral and terminal, fastigiate, *white*, with dark purple anthers and stigmas. Allied, though remotely, to *Blepharipappus,* which ought to be referred to the MADIEÆ.—(Named from its minute, feathery pappus.)

Ptilonella scabra. Blepharipappus scaber, HOOK. Flor. Bor. Am., Vol. I., p. 316.

HAB. The prairies of Oregon, east of Walla-Walla. Erect, about a foot high, towards the summit dividing into numerous filiform, virgate branches, somewhat corymbose at their summits. Leaves numerous, minutely scabrous, linear, somewhat obtuse, attenuated below, sessile, from a quarter of an inch to an inch long, scarcely half a line wide. Stem smooth and shining. Involucrum and upper leaves glandular and viscid. Sepals oblong-lanceolate, a little hirsute. Rays two or three, white, widely dilated, about as long as the involucrum, with filiform, smooth stigmas. Discal florets about eight, also white; anthers and stigmas blackish purple. Infertile achenium nearly smooth, empty and barren, with a coarser pappus of about twelve filiform fimbriate scales. Radial florets sheathed by the sepals to their summits.

OBS. As this plant is wholly at variance with the published generic and specific character of *Blepharipappus glandulosus*, I have presumed to separate it as a genus.

Division III.—MADIEÆ. (Decand.)

MADIA. (Molini.)

Madia sativa.

HAB. In the plains of Oregon towards the sea, particularly on Wappatoo Island, at the outlet of the Wahlamet.

*Madia *capitata;* very hairy and viscid; leaves linear, amplexicaule; flowers mostly in terminal clusters.

HAB. With the above, and in the Rocky Mountains, of which, except the inflorescence, it appears little more than a variety. Achenium black, smooth, granulated, rather flat, and somewhat four-sided. Rays trifid, rather conspicuous.

MADARIA. (Decand.)

*Madaria *racemosa;* stem simple, erect; flowers axillary, racemose, on exserted pedicels; leaves narrow-linear, sessile, hirsute, radical serrulate; above, with the involucrum, pilose and glandular.

HAB. Plains of the Wahlamet, near the falls. Nearly allied, apparently, to *M. corymbosa*, but the flowers are not in a corymb, though sometimes fastigiate. Rays about fifteen, yellow, often with a dark brown spot at the base of each, deeply trifid, twice as long as the disk. Sepals sheathing, with the summit free and foliaceous; discal florets dark brown, masculine. Receptacle convex, villous.

*MADORELLA.

Madia, but with the achenium compressed, and without angles, or nearly so. Rays pubescent at the base, trifid, as long as the involucrum. Discal florets subcylindric, with a pubescent tube. Stigmas filiform, acute, slenderly and glandularly pubescent. Receptacular paleæ in a single series.—Biennials, with slender, virgate stems; capituli subglobose, naked, pedunculate; leaves entire, linear. Flowers pale yellow.—Nearly allied to *Madia*, but with a different habit and stigma.

*Madorella *racemosa;* hirsute, the involucrum also glandular; leaves linear, acute, the lowest ones opposite, radical ones only subserrulate; flowers axillary and terminal, racemose.

Hab. On the banks of the Oregon, near the estuary of the Wahlamet. Stem slender, rigid and twiggy, involucrum of about twelve carinate embracing sepals, with leafy tips. Rays rather long, trifid, their styles filiform, nearly smooth, and equal. Discal florets five-toothed, pale yellow, numerous, all fertile: a single row of leafy scales outside the discal florets, the rest of the receptacle naked. Achenium smooth, finely granulated as in Madia.

*Madorella *dissitiflora;* hairy and viscid; stem slender, virgately branched; flowers axillary, lateral and terminal, shortly pedicellate; leaves linear sessile, on the branches very short.

Hab. In the Blue Mountains and plains of the Oregon. A slender, often much branched twiggy plant, with naked flowers, and a very viscid, almost spherical involucrum. Achenium granulated, flat, slightly and obsoletely angular. Rays small, trifid, pale yellow.

*MADARIOPSIS.

Madaria, but with the discal florets fertile, and a very strongly *tuberculated* achenium in both ray and disk; that of the ray curved, and unequally three-sided, with a small, oblique rostrum and an acumination at base; the central achenia unequally five-sided, compressed, the surface without the granular lines of *Madia*. Several rows of exterior discal florets, with a curved tube. Rays white, or ochroleucous, at length red, with a pubescent tube scarcely longer than the disk.

Madariopsis **Chilensis;* biennial, glandular and hirsute; leaves linear, entire, sessile; flowers disposed in an irregular, small corymb, or raceme.

HAB. Chili. (Dr. Styles.) Probably near Valparaiso. Apparently biennial; twelve to eighteen inches high. Stem simple. Radical leaves very hirsute, those of the stem are also thickly clothed with glanduliferous hairs; sepals embracing the fruit, the summits free, very hirsute on the back as well as glandular, villous on the margin, twelve to fourteen, with the same number of trifid rays. Interradial involucrum shorter than the outer, composed of separate lanceolate leaves. The habit is exactly that of *Madaria racemosa,* or nearly so, but the achenia are black, and remarkably tubercular; those of the disk numerous, the exterior ones curved. Stigmas short, slightly pubescent, and somewhat acute.—I introduce this plant to complete, as far as I am able, the history of the section MADIEÆ.

*ANISOCARPUS.

Capitulum many-flowered, heterogamous; rays feminine, about twelve, ligulate, flat, exserted, smooth, the apex dilated and trifid. Discal florets smooth, hermaphrodite, sterile, five-toothed, campanulate. Stigmas filiform, acute, hirsute, exserted. Involucrum subglobose, the sepals in a single series, carinate, embracing the fruit, the points free and acute. Receptacle flat, smooth, with a single row of scales between the ray and disk, the centre naked. Achenium of the ray compressed, granulated, naked, without angles; those of the disk abortive, linear, crowned with a small, chaffy pappus of five to eight short, lacerated, or fimbriated scales.—Hirsute, perennial herbs, with linear leaves, entire or denticulated, below opposite, above alternate. Flowers yellow, rather conspicuous, in a paniculated, few-flowered corymb.—Nearly allied to *Madaria,* of which it has entirely the aspect, but the flowers less conspicuous. Approaches Calycadenia by the fruit, but very different in habit, and with the rays of Madia.—(The name from *'ανισος, unequal,* and *καρπος, fruit.* Alluding to the different characters of the achenium in the ray and disk.)

Anisocarpus * *Madioides.*

HAB. On the banks of the Oregon, among rocks, in shady forests, at the outlet of the Wahlamet; rather rare. Hirsute with long and short hairs, the stem and involucrum also glandular. Radical leaves oblong, linear, or oblong-lanceolate, remotely serrulate, rather crowded, three or four inches long, about half an inch wide. Stem simple, most hairy at the base. Stem leaves linear, sessile, entire, acute, diminishing in size upwards; the stem above attenuated, about eighteen inches or two feet high; the flowers racemose, and in strong plants corymbose or with fastigiate few-flowered branches. Involucrum that of *madaria;* rays shorter, deep yellow, rather showy. Achenium black and smooth, similar to that of Madaria, but without angles. Pappus of the central florets almost like that of Bahia, obtuse and fringed.

*HARPÆCARPUS.

Capitulum many-flowered, radiate; rays feminine, in a single series, about five to eight, truncated, very short, and two-lobed, scarcely as long as the filiform style. Discal floret one! tubular, five-toothed, hermaphrodite, fertile. Style scarcely exserted, short, nearly smooth, and somewhat obtuse. Involucrum spherical, five to eight-leaved, the sepals carinate, closely investing the achenium, and falling off in connexion with the mature fruit. Receptacle very narrow, containing within the ray a foliaceous, pubescent, and glandular involucrum of five wholly united leaves, surrounding the single hermaphrodite floret! Achenium of the ray compressed, smooth, falcate and granulated, produced at the base and summit; central achenium nearly straight and somewhat angular, naked.—Hirsute annuals of Oregon. Stem simple, corymbosely paniculate. Capituli long pedicellate, glandular; flowers minute, yellow. Leaves linear, entire, the lower ones opposite. A very distinct genus, though still closely allied to *Madia;* but the falcate achenia fall off invested by the deciduous sepals; and the only hermaphrodite central floret, like a true proliferous flower, is entirely separated by an involucrum similar to that of the ray, and united into an entire, five-toothed cup. The whole plant of an aromatic odour.—(The name from 'αρπη, *a sickle,* and καρπος, *fruit;* in allusion to the form of the fruit.)

Harpæcarpus Madarioides.

HAB. On Rocky plains in depressions, at the outlet of the Wahlamet. Common; flowering in May. From a few inches to two feet high. Hirsute with rather long hairs. Leaves about a line wide, one to two inches long, acute, entire, except the radical ones, which are sometimes slightly denticulate. Capitulum glandular, depressed spherical, somewhat smaller than a grain of black pepper. Pedicels various, in the fruiting state two to three inches long, in other smaller specimens the flowers are nearly sessile, except the terminal ones. Flowers pale yellow.

*AMIDA.

(A transposition of *Madia,* in allusion to its affinity to that genus.)

Capitulum heterogamous or homogamous, few-flowered; rays none, or one or two, irregular, very small, ligulate, three-toothed. Discal florets hermaphrodite, cylindric, one to five. Stigma included, small and obtuse. Receptacle naked, very small. Involucrum oblong or ovate, of two to five oblong, or lanceolate sepals, embracing the deciduous fruit. Achenium oblong, compressed, four-sided, naked, and granulated; in the radial florets sheathed with the sepals.—Viscidly glandular annuals, with entire leaves, the lower ones opposite; flowers small, in terminal clusters, bracteolate, bractes and sepals covered with conspicuous, pilose glands. Allied to *Madia,* and remarkable for its singular depauperation.

*Amida *gracilis;* hirsute and scabrous, with close-pressed hairs; sepals convex, very glandular.

HAB. Rocky Mountain plains and prairies of the Oregon. The whole plant fragrant from glandular exudation. About a foot high. The stem simple, sometimes branching towards the summit, slender and rigid. Leaves narrow-linear, rather crowded, hirsute, and scabrous, the hairs close-pressed. Flowers small, yellow, in irregular axillar and terminal clusters; involucrum sometimes with only one or two flowers, at other times with five. Rays often wanting.

*Amida *hirsuta;* hirsutely pilose with spreading hairs; leaves linear, scabrous, and ciliated on the margin; sepals hirsute and glandular, carinated.

HAB. With the above, from which it is distinguished by its pubescence and larger capituli with broader sepals. The rays are also larger and more regular in their association.

*LAGOPHYLLA.

Capitulum few-flowered, radiate; rays feminine, about five, ligulate, flat, dilated, three-lobed, externally pubescent. Discal florets hermaphrodite, sterile, five to six. Stigmas hirsute, filiform, equal. Involucrum five-leaved, similar with the leaves, lanceolate, flat, closely sheathing the fruit, the apex free. Receptacle minute, with a verticil of five leaves within the ray, and surrounding the sterile florets. Achenium cuneate, convex externally, and carinated within, perfectly even, (without any granulations,) the rudiments in the central florets merely filiform.—An exceedingly branched herb, with a smooth stem. Leaves alternate, small, linear-oblong, imbricately crowded on the branchlets and around the capitulum, remarkable for their abundant, soft, white, silky hairs, thickly spreading from the margin, so as to resemble almost the foot of a hare. Capitulum terminal, sessile among the leaves. Rays wide and conspicuous, three-lobed, very evanescent, and convolute when withered. Allied to *Madia*, but with a very different habit and distinct achenium, almost exactly like that of Parthenium.—(Named from the leaves being clad with long, soft hairs.)

Lagophylla **ramosissima;* ♃?

HAB. In the prairies near Walla-Walla, in Oregon. Stem two or three feet high, exceedingly branched; smooth and shining, brownish. Leaves deciduous from the lower part of the stem and branches; upper branchlets very numerous, alternate, short and one-flowered, crowded with small linear-oblong leaves. Leaves about a third of an inch long, less than a line wide. Rays pale yellow, and large, but very evanescent, only expanding, apparently, in the sun-shine. Achenium black and shining, three-sided by an internal carination, without any of the elegant granulations visible on the seeds of Madia. Slightly bitter from minute glands on the surface of the leaves.

HARTMANNIA. (Decand.)

Hartmannia **glomerata;* ⊙, hirsute; leaves alternate, pinnatifid, sessile, upper ones entire; stem branching above; flowers in terminal clusters; rays about five, dilated oval, trifid at the summit; achenium gibbous, muricate and rugose, in the ray naked, in the disk infertile with a six to eight-leaved, acute, paleaceous pappus.

HAB. St. Pedro, Upper California. Common; flowering in April. Involucrum viscid and fragrant, as well as the bractes and upper leaves. A very elegant species with abundance of bright yellow flowers, in dense clusters; sepals and bractes lanceolate, acute; sterile flowers six to eight, surrounded by a nearly entire pentangular involucrum. Pappus six to eight, acute, lacerated scales, nearly half the length of the floret. The plant six to eighteen inches high, and more or less hirsute.

*OSMADENIA.

Capitulum many-flowered, radiate; rays feminine, about five, long tubular, with the border equally three-cleft to its base. Discal florets hermaphrodite, tubular and attenuated, the border deeply five-toothed and glandularly pubescent, the teeth linear and acuminate. Stigmas exserted, hirsute and filiform, subacute. Involucrum ovate, five-leaved, sepals lanceolate, embracing the achenium. Receptacle naked, alveolate, excepting a verticillated, pentangular, five-toothed cup, interposed between the ray and disk. Achenium of the ray obovate, three-sided, rugose and naked, with a minute rostrum; that of the disk turbinate, crowned with a pappus of four or five long, scabrous awns, and the same, or a smaller number of intermediate, minute, obtuse, fimbriated scales.—An elegant and delicate annual, of a powerful, and most agreeable odour; stem divaricately branching from near the base, branches almost capillary; flowers solitary, terminal, fastigiate, white in both ray and disk; involucrum viscidly glandular, subtended by three acerose bractes. Leaves alternate, linear, hirsute, entire. Allied to *Calycadenia*, but with the discal florets perfect, the palea of the receptacle united, and the pappus double.—(The name from *οσμη, odour*, and *αδην*, a *gland;* in allusion to the fragrance of its glandular exudation.)

Osmadenia * *tenella*.

Hab. St. Diego, Upper California. Flowering in May. Root simple, tap-shaped, slender. Radical and lower stem leaves crowded, somewhat hirsute and strongly ciliate, two or three inches long, less than half a line wide, and revolute on the margin. Branches very divaricate; upper stem leaves rather distant and acute, rigid, almost acerose. Stem six inches to a foot high, nearly smooth and brown, spreading out usually more than its height. Three or four leaf-like narrow bractes usually beneath the involucrum. Sepals lanceolate, shorter than the internal leaf-like involucrum. Rays about the length of the involucrum, flat, cleft into three lanceolate segments down to the base, the tube very slender, about the length of the border, nearly smooth. Stigmas of the ray very long, filiform, equal and smooth. Stamens yellow. Achenium of the ray without pappus, black, smooth, and shining, rugose, obovate, short, and three-sided, with a minute, projecting epigynous disk, and a prominent narrow cicatrice at the base. Discal florets six to eight, the achenium cylindric, turbinate, thinly villous, crowned with a pappus of four or five acuminated, thick, scabrous, rigid awns, twice its length, between which are interposed alternately, and internally as many, or a fewer number, of obtuse fimbriated scales, less than a fourth their length; the florets longer than the pappus, narrow tubular, with remarkably long, linear, acuminated, glandular teeth; the stigmas exserted, long filiform, hirsute, rather acute.

MADAROGLOSSA. (Decand.)

Capitulum many-flowered, radiate; liguli feminine in a single series, the apex trifid. Discal florets hermaphrodite, tubular, five-toothed, pubescent. Stigmas filiform, hirsute, acuminated, at length exserted. Receptacle naked, villous, with a single row of paleæ between the ray and disk. Involucrum hemispherical, sepals lanceolate, in a single series, (eight to twelve,) the base embracing the achenium, the summit free and foliaceous. Achenia of the ray smooth, linear-oblong, externally convex, acute, almost stipitate at base, without granulations, crowned with a circular, areolar cicatrice; those of the disk numerous, villous, acutely conic and narrow, crowned with a paleaceous-pilose, subscabrous pappus, simple, or plumose towards the base, of eighteen to twenty-five setæ.—Herbaceous, annual or biennial, usually hirsute plants, with alternate, pinnatifid, or incise, linear leaves; branches one-flowered, fastigiate, the apex naked or pedicellate. Flowers yellow, or parti-coloured yellow and white in the ray, disk yellow; anthers dark brown.

*Madaroglossa *elegans;* decumbent, somewhat hirsute, much branched from the base; radical leaves pinnatifid, linear-lanceolate; stem leaves amplexicaule, incise, the uppermost entire; pedicels somewhat glandular and villous; rays ten to twelve, (apparently) of one colour; receptacle villous; pappus of eighteen to twenty setæ, densely plumose towards the base.

Hab. St. Barbara, Upper California. Nearly allied to *M. heterotricha;* but in that species the leaves are entire.

*Madaroglossa *carnosa;* ⊙, stem decumbent, pilose towards the summit, as well as the involucrum; leaves linear-oblong, succulent and smooth, incisely dentate; capituli subsessile, solitary; sepals linear, obtuse, softly pubescent; rays very small; achenia pubescent in both ray and disk; pappus loosely plumose, of about eighteen to twenty setæ.

Hab. St. Diego, Upper California. A dwarf, inconspicuous flowered species, three or four inches high, with thick, somewhat succulent leaves. Rays two or three-toothed, minute. Sepals about twenty, in two series; the rays between the two series, with the achenium included in the sepals, and without pappus. Achenium linear, villous, attenuated at base, subquadrangular. Anthers with black, acute, linear cusps. Stigmas hirsute, subulate, a little exserted, spreading. Pappus as long as the florets. A very distinct and peculiar species, and apparently rare, growing in the sands of the sea-coast. Flowering about May.

§. Callichroa. (Genus Callichroa, Fisher and Meyer.)

Receptacle flat, villous, or fimbrilliferous. Pappus of about twenty-five setaceous, scabrous paleæ in a single series.

Obs. So nearly are these plants allied to the preceding section, or true Madaroglossa, that it is nearly impossible to distinguish *M. hirsuta* from *M. elegans* in any way but by the pappus.

*Madaroglossa *hirsuta;* hirsute, decumbent, much branched from the base; radical leaves pinnatifid, linear-lanceolate; stem leaves amplexicaule, incise, the uppermost entire; pedicels somewhat glandular and villous; rays eight to twelve; pappus simple, subhirsute, shorter than the achenium.

Hab. St. Barbara and Monterrey, Upper California. Spreading sometimes one or two feet on the ground, with decumbent, ascending branches. Rays longer than the disk, the extremities white, the base yellow. The whole plant has an aromatic scent, somewhat similar to that of the garden Marygold, (*Calendula.*) Achenia of the disk sericeous, with a rigid pappus nearly its length; the floret also pubescent, and partly hirsute on the border.

*Madaroglossa *angustifolia;* subhirsute and glandular, nearly erect; leaves linear, incisely pinnatifid, sessile, above entire; pedicels glandular and villous; rays eight to twelve; pappus simple, subhirsute, as long, or longer than the achenium.

Hab. With the above, which it greatly resembles, but is smaller, with narrower leaves and a different pappus. Rays also partly white and yellow at base.

Subtribe VI. ANTHEMIDEÆ.

Division i. Euanthemideæ. (Decand.)

Achillea *lanulosa*, Nutt. in Journ. Acad., l. c.

Hab. Frequent in the valleys and plains of the Rocky Mountains, and in Oregon.

Division ii. Chrysanthemeæ. (Decand.)

Egletes *Arkansana*. *Leucopsideum Arkansanum*, Decand., Vol. VI., p. 43.

Hab. Banks of the Arkansa. This plant appears to be wholly congeneric with *E. Domingensis:* differing principally from that species by the greater length of the rays.

VENEGASIA. (Decand.)

Capitulum many-flowered, radiate; rays feminine, numerous, fertile. Discal florets hermaphrodite, tubular-campanulate, five-toothed, the tube glandularly hirsute. Stigmas obtuse, puberulous, terminating in an obscure and very short cone. Receptacle naked, punctate, the margin paleaceous. Involucrum loosely imbricated in about two series of large, rounded, foliaceous sepals. Achenium of the ray and disk similar, naked, without pappus, oblong, grooved, scabrous and four-sided.—An undershrub of Upper California, with all the aspect of a *Silphium*. Puberulous; leaves alternate, deltoid-cordate, dentate; branches one-flowered, leafy; flowers yellow.

Venegasia Carpesioides, Decand., Vol. VI., p. 43.

Hab. In rocky situations near the sea, around St. Barbara, &c., Upper California. Lower part of the stem shrubby, the upper part considerably branched, puberulous, and scattered with numerous small, shining glands, of a slightly bitter taste, and with something the aroma of the garden Marygold. Petioles about an inch long. Leaves deltoid-cordate, mostly serrate, acute, (sometimes nearly entire,) with three principal, slender, spreading nerves; about two inches long, and two to three wide. Involucrum very similar to that of a Silphium, composed of two or three series of dilated, roundish, cordate leaves, somewhat spreading, but closely imbricated at base, which, internally, is covered with a matted tomentum. On the margin of the receptacle there occurs one or two rows of large, oblong, partly membranaceous paleæ, somewhat torn on their margins. Rays about fifteen, oblong, entire, longer than the disk; the whole flower about two inches in diameter, with both ray and disk yellow. Achenia about the size of Caroway seeds, black, with a rather large and prominent epigynous disk.

Division III. Cotuleæ. (Lessing.)

*AROMIA.

Capitulum many-flowered, discoidal, heterogamous; rays feminine, minute, truncated, (five or six,) bidentate; discal florets very short and rather round, about a third the length of the achenium, glandular, minutely five-toothed, closed. Stigmas short, subcapitate or obtuse. Receptacle naked. Involucrum subhemispherical, of a single row of angular, oval, imbricated sepals, about five in number. Achenium subhirsute, linear, obconic, compressed, partly four-sided. Pappus paleaceous, formed of a small crown of twelve, or more, linear, obtuse segments, partly united at base.—A very aromatic annual or biennial plant of Upper California, branching from the base; leaves alternate, ternately dissected, the segments almost filiform. Flowers corymbose, yellow, without any projecting rays. Upper part of the plant glutinous and aromatic, the scent something like that of the officinal Chamomile, but more agreeable.—(The name from αρωμα, *aroma;* in allusion to the agreeable and powerful odour of the plant.)

*Aromia * tenuifolia.*

HAB. Near the coast of St. Diego, Upper California. Smooth, but glutinous above, bitter to the taste; when luxuriant, branching from the base, at other times more towards the summit, stems and branches fastigiate. Leaves filiformly linear, rather long petiolate, mostly trifid at the summit, some partly pseudopinnate, with a few shorter segments than the terminal ones; uppermost leaves entire. Capituli numerous, small and inconspicuous, yellow, rather less in bulk than a grain of black pepper, roundish-obovate, or narrower at the base, nearly sessile; corymb trichotomous. Rays, or feminine florets minute, not at all exserted, and scarcely distinguishable from the discal florets, but by the projecting stigmas. Receptacle narrow. Discal florets ten to twelve. Pappus about a third the length of the achenium, which is about a line long. Flowering in the month of May. Stem six to ten inches high. Leaflets about as narrow as those of *Pinus strobus*, two to three inches long.—Although artificially placed in this section, the present plant presents no affinity with any genus included in it.

* LEPIDANTHUS.

Capitulum homogamous; florets tubular, minute, three to four, rarely five-toothed, the tube alated. Receptacle naked, acutely conic, higher than the involucrum. Involucrum hemispherical, biserial; sepals oval, obtuse, broadly scariose, and nearly equal. Stigmas exserted, short, filiform, obtuse. Achenium naked, subquadrangular, flattened at the summit, with a large epigynous disk.—A somewhat decumbent, much-branched annual, with alternate, pseudobipinnate, linear leaves, the terminal segments trifid; branches one-flowered. Involucrum with all the sepals scariose; disk conic, elevated above the involucrum. Allied to *Pyrethrum* by the alated tube of the discal florets, but distinct in other respects.—(The name alludes to the scaly appearance of the involucrum.)

Lepidanthus suaveolens.

Hab. In Oregon. Generally in open wastes, or by the banks of streams. *Santolina suaveolens*, Pursh, Vol. II., p. 520. Decand, Prod. Vol. VI., p. 37. *Tanacetum matricarioides*, Less. Syn. Gen. Compos. *Artemisia matricarioides*, Less. in Linnæa, Vol. VI., p. 240. *Tanacetum? suaveolens*, Hook. Flor. Bor. Am., Vol. I., p. 327. *Pyrethrum breviradiatum*, (Herb. Schweinitz, from Ledebour,) from Unalashka, where it was also collected by Chamisso. These specimens are apparently depauperated with very few sessile flowers.—For several years it came up as a weed in the garden of the late Mr. M'Mahon, near Philadelphia, where it was raised from seeds brought by Captain Lewis.

Division v.—Artemisieæ. (Lessing, Decand.)

ARTEMISIA. (Linn.)

Section i. Dracunculus.

Artemisia Nuttalliana, (Besser.) *A. cernua*, Nutt. Gen. Am., Vol. II., p. 143, (1818.) *A. Dracunculus*, Pursh, Vol. II., p. 521. *A. Dracunculoides*, idem. in Suppl., Vol. II., p. 742.

Hab. Common in the open prairies, from the immediate vicinity of St. Louis to the Rocky Mountains.

Section ii. Seriphidium. (Bess.) *Receptacle naked; capitulum homogamous.*

*Artemisia *Plattensis;* ♄; leaves softly and sericeously villous, cinereous, filiform-linear, revolute on the margin, simple and trifid towards the summit; capituli very small, tomentose, ovate, nodding and pedicellate, disposed in a loose and regularly simple-branched panicle.

Hab. Upper plains of the Platte, and nearly to the Kansa agency. A whitish silky leaved shrub, three or four feet high, much branched, the branches slender and virgate. Flowers very small. Sepals ovate, unequal, none of them scariose. The scent similar to that of *A. Abrotanum*, nearly allied to *A. filifolia* of Torrey, but the flowers are loosely paniculate.

*Artemisia *foliosa;* ♄; leaves covered with a very short, dense tomentum, green or canescent, filiform-linear, revolute on the margin, simple and trifid towards the summit; axills leafy; capituli roundish, tomentose, sessile, clustered in a narrow panicle with an angular rachis; scales oval or round, the inner scariose.

Hab. Common round Monterrey, in Upper California. Nearly allied to the last, but distinct in its inflorescence. Leaves about one and a half inches long, the undivided part resembling a petiole, rather longer than the trifid summit; axills full of small leaves, at least before the flowering period; branches long and virgate. I have only seen winter vestiges of the flowers; these are apparently five or six in a capitulum. Leaves rather rigid. A shrub four or five feet high.

*Artemisia *trifida;* ♄, canescently sericeous; leaves linear, trifid towards the summit, flat and obtuse, the upper ones entire; panicle simple, leafy; flowers sessile, conglomerated; capitulum small, cylindric-ovate; outer sepals lanceolate, pubescent, the inner oblong and scariose.

HAB. Plains of the Rocky Mountains and Oregon. A very dwarf species compared with the preceding, six or eight inches high; the leaflets are also broader, the flowering branches also cylindric, and the capitulum smaller, but still larger than in *A. Plattensis.* From the plains of Lewis' River, in the Rocky Mountains, I have a variety, β. **rigida,* in which the leaves are shining and silky, rigidly three-forked and acute; but of this I have no flowers. It is, perhaps, a distinct species.

*Artemisia *arbuscula;* dwarf and shrubby; canescently sericeous; leaves short, cuneate, trifid; segments oblong-linear, obtuse, flat, the lateral lobes sometimes bifid or trifid, uppermost simple; capituli racemose, globose-ovate, closely sessile, erect, solitary, or in three-flowered, pedicellated clusters; branches slender, outer sepals tomentose, the inner oblong and scariose; florets about ten, smooth.

HAB. On the arid plains of Upper California, on Lewis' River. A very diminutive shrub, four to six inches high, with a rather thick, woody stem; branches virgate. Allied to the preceding, but very distinct; the capituli twice as large, the leaves short, the limb longer than the undivided base, and the divisions much broader, &c. Allied to *A. mendozana.*

*Artemisia *tridentata;* ♄; canescently tomentose; leaves cuneate, three-toothed at the summit, upper ones entire and obtuse; flowers paniculate; capitulum sessile, ovate and tomentose, small; inner sepals scariose, linear-oblong.

HAB. Plains of the Oregon, and Lewis' River. A low, but rather stout shrub, white with a close tomentum. Leaves rather more than an inch long, about two lines wide, more or less deeply three-toothed, sometimes entire, the upper ones always so. Panicle much branched, the flowers small. (I have not seen them in a perfect state, and therefore class this species by its apparent affinity with the last.) Somewhat allied to *A. Chinensis.*

Artemisia Columbiensis, (NUTT. Gen. Am.;) ♄; canescently tomentose; leaves long and acute, lanceolate-linear, all entire, not revolute, and equally pubescent; panicle simple, subracemose; capituli ovate, erect, small, sessile; sepals tomentose, the outer lanceolate, the inner oblong, obtuse, scariose on the margins; florets five to six, smooth.

HAB. On the plains of the Missouri, and along the Platte to the mountains. Certainly distinct from the *A. cana* of PURSH.

§. *TANACEUM.—*Receptacle convex, pilose or lanigerous. Achenium acutely costate, terminated by a membranaceous, somewhat lobed margin.*—Shrubs, with trifid or twice trifidly-pinnately dissected leaves. Capituli as in Abrotanum.

Artemisia Fischeriana, and variety *β. vegetior* (of BESSER,) probably a distinct species.

HAB. The Bay of St. Francisco, Upper California. If the variety β. agrees in the character of the receptacle with the species to which it is referred, I have not seen the plant.

*Artemisia *abrotanoides;* ♄; canescent and pulverulently pubescent; leaves pseudopinnate towards the extremity, with a few (two pair) of filiform segments; upper leaves entire; panicle simple; capituli hemispherical, large, nodding, on bracteolate pedicels; sepals oval, broadly scariose on the margin.

HAB. Near St. Barbara, Upper California. Receptacle somewhat pilose. A shrub with much the appearance of *A. Abrotanum*. Common. Branches whitely canescent.

§. III. ABROTANUM. (Bess., Decand.) *Flowers heterogamous, all fertile.*

*Artemisia *pedatifida;* very dwarf and suffruticose, somewhat canescently tomentose; leaves towards the summit trifid, or more or less subdivided into bifid, or trifid, linear, and very narrow segments; stems numerous, subcæspitose, simple, terminating in a short, few-flowered spike; capituli ovate, sessile, subtended by simple or trifid leaves; inner scales scariose; florets smooth, about ten.

HAB. Arid plains of Lewis' River, Rocky Mountains. Flowering in August. A very distinct and peculiar species, with a stout, woody, exfoliating root, sending out tufts of low stems, about three or four inches high, terminating in spikes of from about four to ten flowers; capituli towards the summit, conglomerated by threes; leaflets almost filiform-linear, but flat, often only trifid, but also with the lateral lobes bifid or trifid.

*Artemisia *pumila;* herbaceous, very dwarf; leaves linear, sublanceolate, nearly smooth or pubescent, tomentose beneath, trifid or incisely subpinnatifid with few apiculated segments; axills pseudostipular, the stipules simply subulate, or two or three-cleft; flowers in a simple, leafy spike, sessile, axillary, solitary, or in clusters of two or three; capituli roundish-ovate; inner segments of the involucrum oval and scariose; flowers polygamous.

Hab. In the Rocky Mountains, Lewis' River, by ponds, or in depressions. About six or eight inches high. Leaves about a quarter of an inch wide, the upper ones simple, all acuminate; an inch or more long. Raceme few flowered; flowers sessile, exterior sepals ovate. Some plants with the flowers apparently all feminine, others all masculine, and a third set have about ten tubular, hermaphrodite florets, and three or four female ones, all smooth.

Artemisia longifolia, (Nutt. Gen. Am.) In this species, which is wholly herbaceous, the leaves are long, linear and acuminate, revolute on the margin, tomentose beneath; though often entire, they are also as often trifid, or forked towards the summit, the central segment, also, now and then subdivided; the segments all linear, about half a line wide; the simple leaves not apparently nerved.

Artemisia Ludoviciana, (Nutt. Gen. Am.)

Hab. Along the plains of the Platte, to the Rocky Mountains. From half a foot to three or four feet high; herbaceous, whitely tomentose on both sides; the lower leaves laciniated, lanceolate, upper entire; capitulum roundish-ovate. β. **latiloba;* leaves tomentose, whitely so beneath, the lower dilated and pinnatifidly lobed, the upper trifid and cuneate, uppermost, oblong-lanceolate, rather acute; flowers in a close, narrow panicle, sessile; capituli globose-ovate, tomentose, the inner scales scariose; florets numerous, smooth, apparently polygamous.—Hab. With the above, in the Rocky Mountains: if not the *A. cana* of Pursh it may perhaps prove new. I have seen a second specimen in Dr. Torrey's herbarium, which differs in being less tomentose above.

*Artemisia *heterophylla;* stem stout, and herbaceous; capituli and the upper surface of the leaves smooth; leaves long lanceolate, acuminate, irregularly and sparingly laciniate, above entire, beneath whitely tomentose; capituli compoundly and closely paniculate, cylindric-ovate, and small; sepals oblong, scariose, few-flowered.

Hab. In the Rocky Mountains, by streams. A tall plant, somewhat allied to *A. vulgaris*, but still more to *A. integrifolia*. Remarkable for its small, sessile, erect capituli, which are very numerous; the plant is also gigantic, three or four feet high.

*Artemisia *incompta;* herbaceous; smooth, except the under surface of the leaves, which is a little tomentose; leaves almost simply pinnatifid, trifid or laciniate, sessile, the segments rather broad, linear and acute; flowers paniculated; capituli subglobose, pedicellate, erect; sepals ovate and scariose; florets numerous, smooth.

Hab. In the central chain of the Rocky Mountains, in Thornberg's Pass, near the great passage to the plains of the Oregon. At first sight it somewhat resembles some variety of *A. vulgaris*, but is very distinct. Remarkable for its smoothness. Height one to two feet; segments of the leaves a line wide.

Artemisia biennis, (WILLD.)

HAB. On the plains of the Platte, and in the Rocky Mountains.

Artemisia pychnostachya, (DECAND.;) herbaceous, every where softly and canescently lanuginous; leaves pseudopetiolate, bipinnately dissected; segments fastigiate, oblong, acute, simple, or partly subdivided; panicle racemose, very long, and of nearly equal breadth, many-flowered; capitulum sessile, subglobose, erect, about ten-flowered; sepals lanceolate, all lanuginous.

HAB. On the sea-coast of Monterrey, Upper California. A species with almost the foliage of *A. Absinthium*, but very soft and lanuginous with somewhat spreading hairs. Perennial, with a running root. Panicle two or more feet long; branches short, the flowers clustered. (I have only seen the winter vestiges of this curious species.)

Artemisia **Pacifica;* herbaceous, soft, and canescently sericeous; leaves pseudopetiolate, bipinnately dissected, the segments often trifid, oblong or linear, acute; stem leaves pinnately dissected, pseudostipulate on the infertile shoots; stem and ovate, pedicellate capitulum, smooth.

HAB. Shores of the Pacific, at the outlet of the Oregon, in sandy places. Considerably allied to *A. canadensis*, but more tomentose, with broader and fewer segments to the leaves, the radical and lower leaves very much as in the last species. Perhaps *A. desertorum*, γ. *Scouleriana* of HOOK. Flor. Bor. Am., p. 325.

TANACETUM. (Lessing.)

Tanacetum Huronense, NUTT. Gen. Am., Vol. II., p. 141. *T. Douglasii*, DECAND. Prod., Vol. VI., p. 128. *Omalanthus camphoratus*, HOOK. Flor. Bor., Vol. I., p. 321. *O. camphoratus?* LESS.

HAB. Coast of the Pacific to California; common. Rays and disk pale yellow, the former scarcely exserted.

Tanacetum **boreale;* softly hairy; leaves and segments also bipinnatifid, apiculate, rachis leafy, the leaflets pinnatifid; corymb few-flowered, (four to five;) sepals lanceolate, the inner with brown, scariose margins; rays conspicuous, three-lobed.

HAB. Arctic America, (HOOKER.) Apparently not the *T. pauciflorum*, in which the flowers are said to be all hermaphrodite, and the plant very smooth.

*SPHÆROMERIA.

Capitulum many-flowered, discoid, heterogamous; florets all tubular, the radial feminine, (about five,) truncate, two or three-toothed; discal florets hermaphrodite, shortly five-toothed; style bifid, stigmas truncate, and minutely fringed at the apex. Receptaculum papillose, naked. Involucrum roundish-ovate, imbricate; sepals from five to ten in a single or double series, obtuse, and broadly scariose on the margin. Achenium turbinate and smooth, three to five-angled, with a vesicular testa, terminated with a small, paleaceous, unequal cup of three to five, or more, acute scales.—Low alpine, cæspitose or suffruticose perennials, canescently tomentose, with simple scapoid stems, terminating in a single spherical, or somewhat round lobed cluster of capituli. Leaves alternate, cuneate, pseudopetiolate, once or twice trifid, with the segments linear and entire; florets yellow. Allied to *Artemisia*, and with the same aroma, but with a different habit.—(The name in allusion to its capitate inflorescence.)

*Sphæromeria *capitata;* dwarf and cæspitose, canescently sericeous; leaves once or twice trifid towards the summit, sheathing at the base, segments linear-oblong; leaves of the scapoid stem simple; capituli conglomerated into a spherical head; involucrum about five-leaved.

Hab. On a high hill, near the Red Butes of the Platte, towards its northern sources on the Sweet Water. Flowering in June. Growing on the summit of a rocky hill, in round tufts of densely matted herbage, soft, silky and hoary with pubescence; scapes or scapoid stems slender, three or four inches high, the spherical cluster about the size of a small cherry. Scales of the involucrum oval, concave, hairy on the margin. Radial florets short and truncated, two or three-toothed, becoming enlarged and indurated at base. Discal florets about eight or ten, mostly infertile, with rudimental achenia. Style of the ray bifid, obtuse, cleft half way down, minutely pencillate at tip. Achenium somewhat three-sided, the angles terminating in a minute crown of acute pappus. The seed (at least in a young state,) enveloped in a utricular loose testa. The odour of the plant agreeable, almost like that of chamomile.

*Sphæromeria *argentea;* suffruticose and somewhat cæspitose, whitely and closely tomentose; leaves cuneate, entire, or three-cleft at the summit, the uppermost also minute and undivided; stem simple, terminating in a single, rather round cluster of capituli; involucrum biserial, ten-leaved.

Hab. In the Rocky Mountains, near the sources of the Platte, and Colorado of the West. Flowering in July.—A very elegant and diminutive shrub, with the taste and odour of wormwood, but more agreeably aromatic; the flowers bright yellow. Leaves about half an inch long, one to two lines wide. Stem about four inches high, very slender, like a leafy peduncle, terminating in a round, or hemispherical cluster of three to five capituli. Outer scales of the involucrum ovate. Radial florets about five. Achenia about five-angled, with an unequal pappus of five or more parts, longest on the angles; testa loose and utricular. Receptacle papillose. Discal florets numerous. Stigma truncate, and minutely pencillate.

SOLIVA. (Ruiz and Pavon.)

Soliva **daucifolia;* hirsute, diffuse, dichotomous; leaves long petiolate, bipinnately divided, the lobes mostly three-parted, segments linear, sublanceolate, acute; capituli sessile in the forks of the stem; achenium obovate, scabrous, slenderly margined, convex externally, and minutely bidentate at the summit.

Hab. On the dry grassy downs within the limits, and in the immediate vicinity of St. Barbara, Upper California. Annual, at first smooth; involucrum and upper leaves very hirsute, the former about five-leaved. Stigma filiform, distinctly bifid. Plant about two inches high, extending four or five inches; the persistent style or rather its sheath, extending out like a rigid spine.

GNAPHALIUM. (Linn.)

Gnaphalium Californicum; ⊙, Decand. Prod., Vol. VI., p. 224.

Hab. Common round St. Barbara, Upper California. Flowering in April and May. It appears to have a near affinity to *G. decurrens*, but with a different pubescence.

Gnaphalium Sprengelii? ⊙.

Hab. Near St. Barbara. Of this I have seen but a single specimen. It is nearly allied to the preceding, but has occasionally a thin tomentum spread over the leaves in addition to minute glandular hairs. The scales of the involucrum are also pale purple. As a variety, I would distinguish it as β. **erubescens.*

*Gnaphalium luteo-album; β. *occidentale,* a much larger plant than the European species. The lower leaves inclining to be decurrent; capituli also larger.

Hab. Wappatoo Island, and the banks of the Oregon, &c., also in Upper California and Chili, (according to a specimen from Dr. Styles.) It is probably the *G. Vira-vira* of Molini.

*Gnaphalium *palustre;* ⊙, softly, floccosely lanuginous and canescent; stem much branched; leaves oblong, or oblong-linear, acute, subamplexicaule; flowers in somewhat hemispherical, very woolly, bracteolate or foliaceous clusters; scales of the involucrum white or brownish, linear, and rather obtuse.

Hab. Rocky Mountains, Oregon, California and Chili. A very branching plant, allied to *G. uliginosum*, but with broader leaves, and a looser cotton-like tomentum; the involucrum also nearly white, with narrower scales, and nearly all of them tomentose to near their summits. In an advanced state it becomes exceedingly lanuginous and almost like loose flocks of cotton. The receptacle flat and naked; the size exceedingly variable, being from an inch to a span high.

*Gnaphalium *gossypinum;* ⊙, white and floccosely lanuginous; stem nearly simple? erect; radical leaves spathulate-lanceolate, acute, cauline crowded, linear, acuminate, sessile, narrower towards the base; capituli conglomerate, sessile, terminal; involucrum ovate, the scales yellowish, oval or oval-oblong, obtuse.

HAB. On the shores of the Pacific, at the estuary of the Oregon: rare. It has almost exactly the appearance of *Helichrysum graveolens*, is heavy-scented, and somewhat glandular beneath the copious pubescence. About twelve to eighteen inches high. Leaves one to two inches long, one to two lines wide, acute or acuminate; scales of the capitulum pale yellow. (I have seen but two specimens in a young state: it may, probably, branch at a later period.) It possesses several rows of feminine florets, and is therefore a true Gnaphalium.

Gnaphalium filaginoides, (HOOKER and ARNOT, Bot. Beechy.) A slender, often simple-stemmed species; radical leaves nearly smooth, or smoother, the rest whitely tomentose and apiculate. Stem simple. Flowers in sessile, subterminal clusters; capituli sharply ovate, yellowish, with the floral leaves broader, and more whitely and densely tomentose.

*Gnaphalium *microcephalum;* suffruticose? densely and whitely lanuginous; stem erect, simple; leaves lanceolate, apiculate, sessile, narrower towards the base, nearly all similar; capituli conglomerate, in a short spike, ovate; scales scariose, acute, white.

HAB. St. Diego, Upper California: rare. About a foot high, the stem rather woody beneath the dense white tomentum. Leaves one to one and a half inches long, two to three lines wide, white on both sides, with a blackish apiculate point. Flowering clusters confluent in a short spike or mass about two inches in length, involucrum very floccose at base, white and silvery, hermaphrodite florets about five. Somewhat allied, apparently, to *G. lanuginosum*, but it strongly resembles some of the species from the Cape of Good Hope. (I have seen but a single specimen.)

Gnaphalium spicatum.

HAB. St. Barbara, Upper California. The upper surface of the leaves green, but somewhat deciduously tomentose.

Gnaphalium sylvaticum.

HAB. In Labrador. (Herb. Schweinitz.) The low form, with dark scales to the involucrum.

*Gnaphalium *ustulatum;* ♃, herbaceous, erect; stem simple, terete; the whole plant whitely tomentose; stem somewhat floccosely pubescent; leaves oblong-spathulate, obtuse, mucronulate, the upper ones narrower, sessile, (not decurrent;) capituli oblong, aggregated in the axills of the upper leaves into a dense, continuous, short, oblong spike; scales of the involucrum lanceolate and linear, acute, brownish towards the points.

HAB. On the plains of the Platte, towards the Rocky Mountains, and near St. Barbara in Upper California. Nearly allied to *G. spicatum*, but without the decurrent leaves, which are whitely tomentose on both surfaces, and the lanuginous tomentum somewhat spreading, or flocculent. From *G. sylvaticum* it may be distinguished by the form of its leaves, and particularly by the scales of the involucrum, which in that species are lanceolate, and oblong obtuse, with the margin in place of the tips brown.—Perfect florets three or four.—It appears to be nearly allied to *G. falcatum* δ? of DECAND., Vol. V., p. 233, which, probably, does not appertain to that species.

*Gnaphalium *depressum;* canescently lanuginous, stemless, and cæspitose; leaves linear, obtuse, the primary ones smooth; capitulum solitary, sessile, campanulate; scales of the involucrum brown, oblong, acute; achenium villous.

HAB. The summit of the mountain, Pichincha, South America, (Dr. Jamieson.) I introduce this curious alpine plant, on account of its near relation to our section OMALOTHECA. It would readily be overlooked for a stemless individual, of *O. supina*, from which it is only distinguishable by the largeness of the capitulum, which, moreover, contains several rows of female florets, with only four or five hermaphrodite or sterile ones, and is therefore a true *Gnaphalium.*

§. OMALOTHECA. (Genus of *Decand.* and *Cassini.*)

* HETEROPHANIA.—*Dioicous; the sexes of different forms.*

*Gnaphalium *dimorphum;* white and lanuginous, stoloniferous; stem filiform, one-flowered; leaves linear, obtuse; in the female spathulate, in the male narrow-linear and attenuated below; scales of the involucrum in the male lanceolate acute, brownish; in the female very long acuminate!

HAB. On the Black Hills of the Platte. Flowering in the beginning of May. The male plant has a very stout, creeping, almost woody root, sending out thick, lanuginous, short stolons. Stem like a slender leafy peduncle, the leaves about an inch long or more, and about half a line to a line wide. Involucrum rather large, and somewhat campanulate, the scales pale brown; florets about fifteen, infertile, though apparently hermaphrodite, twice as large as in *O. supina;* but for the rest the plants could scarcely be told apart, in the depauperated individuals of the latter.—In the female, the leaves are spathulate, about an inch long, and two or three lines wide! the involucrum is also larger, with very long points to the scales! Notwithstanding all these curious discrepancies our plant is inseparable in genus from *Gnaphalium supinum.* It is not an *Antennaria,* as the threads of the pappus are all slender and equal in the male.

FILAGO. (Tournefort.)

*Filago * Californica;* ⊙, stem erect, branching from the base; leaves spathulate-linear, apiculate, below nearly smooth, the upper ones and the stem arachnoidly tomentose; capituli few, paniculate, in lateral and terminal clusters, sometimes almost in spikes; scales of the involucrum tomentose at base, above scariose and smooth, sublanceolate, acute.—β. **tomentosa;* leaves crowded and tomentose, flower clusters approximating in spikes.

HAB. Near St. Barbara, Upper California. Nearly allied to *F. montana*, but with larger capituli, &c., in β. the scales of the involucrum are brownish and purple. A much branched annual, about a span high. External florets, without pappus.

ANTENNARIA. (R. Brown.)

Antennaria plantaginea.

HAB. On the plains of the Platte to the "Black Hills." A one-flowered variety of this species sometimes occurs, as in the *A. monocephala*, of Decandolle, which is also, probably, a similar variety of *A. alpina*. Specimens have been sent to me from Louisiana by Professor Carpenter, and more recently they have been found on the Wishahickon, by Mr. C. Lea, Junior, of Philadelphia. In these specimens the solitary head of both sexes is unusually large, and the leaves very broad.

*Antennaria *parvifolia;* subcæspitose, with procumbent sarments; stem simple; lower leaves spathulate, or spathulate-linear, the upper linear, all whitely tomentose; flowers conglomerate; scales of the involucrum oblong-ovate, eroded, yellow.

HAB. On the Black Hills and plains of the upper part of the Platte. A dwarf species, spreading out in canescent tufts with very small leaves, which are about half or three quarters of an inch long, and about two or three lines wide; the flowers in an irregular, somewhat round mass, not a circular corymb, with the scales of the corymb sulphur yellow, and very conspicuous. Radical leaves somewhat rhomboidally spathulate. The pappus of the male flower is very conspicuously clavellate: the female flower has purple oblong-lanceolate scales to the involucrum, and a filiform pappus. A specimen of this sex from Altai has a near resemblance to our plant, but is larger in all its parts, and is the *A. hyperborea* of Don.

*Antennaria *Labradorica;* canescently tomentose; sarments procumbent, flowering; stem simple; radical leaves spathulate-linear, cauline linear, sessile, at length nearly smooth; capituli pedicellate in a cyme of three to five; scales of the involucrum ustulate and brownish, lanceolate and long acuminate, membranaceous.

HAB. Labrador. (Herb. Schweinitz.) Apparently a very distinct species. At first glance resembling *A. alpina*, but more nearly allied to *A. plantaginea;* it is, however, a much smaller plant, the leaves not three-nerved; the scales of the involucrum brown, and as it were soiled at the tips, which are very much acuminated; the achenium is also perfectly smooth; with the pappus thickened at the base, somewhat scabrous, and yellowish white.

ARNICA. (Linn.)

ARNICA *angustifolia*, VAHL. *A. fulgens*, PURSH, Flor. Bor. Am., Vol. II., p. 527.

HAB. On the plains of the Platte to the Rocky Mountains. Labrador, (Schweinitz!) from which locality it appears to be the *A. plantaginea* of Pursh.

Arnica * *lanceolata;* stem leaves about three pairs, semiamplexicaule, lanceolate or oblong-lanceolate, three-nerved, acute, irregularly dentate-serrate, nearly smooth, with the margin and stem pubescent; capituli about three, pedunculate; involucrum longer than the disk; sepals about twelve to fifteen, lanceolate, acuminate, hirsute and glandular, as well as the peduncle; achenium also hirsute; pappus nearly plumose.

HAB. On the White Mountains of New Hampshire, at the elevation of four thousand five hundred feet, (according to the observation of my friend Charles Pickering.) A very distinct species, allied, apparently, to *A. Chamissonis*. About a foot high, leaves two to three inches long, one to one and a half wide, of a thin consistence, and nearly as large at the summit as at the base of the stem; the lowest leaves somewhat cuneate, sessile. Stigmas much exserted, clavately thickened at the summit, and pubescent below the point; those of the ray long and filiform, much exserted: the ray without any rudiments of stamina, two and three-toothed at the extremity.

Arnica **foliosa;* pubescent and minutely glandular; stem leaves three to five pairs, lanceolate or oblong-lanceolate, subacute, the radical and lower mostly long petiolate or attenuate, often subserrate; capituli three to five, long pedunculate; involucrum about the length of the disk, the segments linear-lanceolate, subacute and pilose at the tips; rays scarcely longer than the involucrum, without abortive filaments; achenium pubescent.

HAB. On the alluvial flats of the Colorado of the West, particularly near Bear River, of the lake Timpanagos. A species of somewhat variable aspect, allied to *A. angustifolia*, but very distinct; the rays much shorter, narrower, and sulphur yellow. In the slender form the stem is about a foot high, with the radical leaves narrow lanceolate, mostly entire, and attenuated into a long petiole, the two or three upper pairs sessile and semiamplexicaule. In another variety, which I call β. * *andina*, the radical leaves are ovate-lanceolate, and usually subserrate, with a shorter stem, and more numerous flowers; sepals somewhat biserial, about fifteen or sixteen, more or less hirsute, not acuminate; point of the stigma thickened, with a somewhat conic point. This variety appears to be allied to *A. Chamissonis*, but the achenium is less hirsute than in *A. montana*, and the sepals rather obtuse than acuminate, &c.

Arnica Menziesii, HOOK. Flor. Bor. Am., t. 111.

HAB. In the Rocky Mountains, in the central chain, where it is sometimes diminished in size to four or five inches in height. There are no infertile filaments in the ray, and the pappus is almost perfectly plumose.

*Arnica *macrophylla;* slightly pubescent; stem about three-flowered, with three pairs of leaves; radical and lower petiolate stem leaves, cordate, acute, the radical often obtuse, irregularly and somewhat incisely dentate, uppermost pair small lanceolate, semiamplexicaule, acuminate; pedicel elongated, bracteate; sepals linear-lanceolate, acute, about twelve, hirsute at the base; rays without filaments.

Hab. In the valleys of the Blue Mountains of Oregon. Stem about twelve to eighteen inches high; the leaves distant from each other, the lowest two to three inches wide, and about the same in length; the petioles longer than the leaves, which with the lower part of the stem are more or less pilose. Rays pale yellow, about twice the length of the involucrum. Discal florets with the dentures hirsutely pilose at the tips. Achenium subcylindric, hirsute; the pappus nearly plumose. Veins of the leaves coarsely reticulated.

*Arnica *amplexicaulis;* nearly smooth; many stems from the same root; leaves five or six pairs, approximate, ovate, acute, amplexicaule, denticulate; capituli three to five, lateral and terminal; sepals about twelve, linear-lanceolate, acuminate; rays without filaments; achenium hirsute.

Hab. On the rocks of the Wahlamet, at the Falls. About a foot high, and very leafy; the leaves nearly all equal, except the uppermost floral pair: lateral branches leafy, one-flowered; rays longer than the involucrum, nearly linear, three-toothed, the teeth small; tips of the involucrum purple. Pappus nearly plumose.

SENECIO. (Lessing.)

† *Discoidal species.*

Senecio **debilis;* ♃, glabrous; lower leaves upon very long petioles, radical spathulate-oval, obtuse, entire, or incisely toothed at base, cauline few, amplexicaule, pinnatifid; segments oblong, remote, entire or sparingly toothed, the upper ones with a tuft of down at the base; corymb simple or compound; involucrum minutely bracteolate; sepals about twenty, not sphacelate; florets with the teeth glabrous; achenium smooth.

Hab. Plains of the Oregon, near the Wahlamet. Nearly allied to *S. elongatus*, of Pursh. Lower leaves with petioles three or four inches long, the primary ones quite entire and obtuse, at length toothed, and finally pinnatifid, with clasping auricles; umbell usually twice compounded, the umbells with three to five heads, the proper pedicels rather short; florets bright yellow. Lower leaves often greatly resembling those of *Barbarea vulgaris*, the pinnatifid ones remarkable for the remoteness and shortness of their lobes, which are mostly entire.

*Senecio *rapifolius;* smooth; stem nearly erect, angular and striated, leafy; leaves spathulate-obovate, acute, the radical ones petiolate, cauline amplexicaule, the uppermost lanceolate or ovate, all sharply and unequally dentate, the base sometimes runcinate; corymb paniculate; involucrum cylindric, small, about fifteen-flowered; sepals linear-lanceolate, about eight to ten; pedicels bracteolate to their summits; achenium smooth and angularly striated; pappus shorter than the florets.

HAB. Towards the Rocky Mountains, along the upper branches of the Platte. Allied in habit and affinity to *S. cacaliaster*, which is also sometimes without rays. OBS. The root tuberous, stout and perennial. Many stems from the same radical crown, somewhat decumbent, about a foot high, every where quite smooth and shining. The leaves very much like those of *Sonchus oleraceus*, sharply toothed, their outline pretty much that of *Brassica rapa*, inclining to be lobed or incise near the base, four or five inches long, by two or three wide; the lower leaves of the stem with broadly alated petioles; upper part of the stem branching, the branches all corymbiferous; umbellets with three to five or six capituli; the pedicels with several subulate bractes, a few of which also approach the base of the involucrum; sepals membranous on the margin, a little pubescent, but not sphaceolous at the tips.—(In my herbarium this species was first marked by the name of *S. *argutus*, which I have changed for the present, as more applicable.)

† † *Capituli radiate.*

*Senecio *Andinus;* smooth; stem erect, angular and grooved, very leafy; leaves elongated, linear-lanceolate, acute, sharply serrulate, corymb compound, paniculate; pedicels long, bracteolate, smooth; involucrum turbinate-cylindric, of twelve to fifteen sepals, sphacelate at the tips; bractes beneath the involucrum rather numerous, subulate; flosculi about twenty; rays six to eight, about the length of the involucrum; achenium smooth, pappus as long as the florets.

HAB. In the valleys of the highest of the Rocky Mountains or Northern Andes, at an elevation of about six thousand feet above the level of the sea. Flowering in July. Very nearly allied to *S. sarracenicus*, which extends to the Altaic Mountains. About a foot high, and full of leaves, three to five inches long, by half to three quarters of an inch wide; the corymb often very irregular, made up of many slender, fastigiate flowering branchlets; the flowers small.

Senecio integerrimus, (NUTT. Gen. Am. and DECAND., Vol. V., p. 432.)

HAB. On the plains of the Platte, towards the Rocky Mountains. My specimens differ somewhat from those of the Missouri, in not affecting wet places; the upper part of the stem in these is occasionally sprinkled with a few soft hairs. The stem twelve to eighteen inches high, nearly terete, and simple; the lower and radical leaves frequently oblong, or oblong-lanceolate, sometimes denticulate, the stem leaves narrow-lanceolate, amplexicaule, acute, or acuminate, diminishing so rapidly upwards as to give the stem much the appearance of a scape. Corymb small and contracted, five to eight or ten-flowered, the pedicels and involucrum bracteolate; sepals linear, acute, about twenty, often with dark purple sphaceolous points. Rays about eight. Pappus shorter than the florets; achenium smooth. Considerably allied to *S. pratensis*, but nearly smooth, also to the *S. papposum*. There is a specimen very similar to our plant from Altai, sent to Dr. Schweinitz, but without any certain name.

Senecio **megacephalus;* ♃, stem low, densely lanuginous at base; leaves deciduously lanuginous, oblong-lanceolate, entire, cauline amplexicaule, linear-lanceolate, acute; corymb of three to five bracteolate, large capituli; involucrum pubescent, of twenty to twenty-four linear, acute sepals, tipped with tufts of hairs; rays pale yellow, ten to twelve, scarcely as long as the involucrum; achenium smooth, with about ten striatures; dentures of the florets papillose.

Hab. On the plains of the Platte, towards the Rocky Mountains. Nearly allied to *S. alpestris.* About six to eight inches high; the leaves perfectly entire, more or less pubescent beneath, lower leaves with long petioles. Capituli very large, for the size of the plant, about as large as those of the common bur, (*Arctium lappa.*)

Senecio **fastigiatus;* ♃, nearly smooth, or somewhat arachnoidly tomentose; stem erect, simple, grooved, the summit compoundly corymbose and fastigiate; leaves lanceolate or linear-lanceolate, entire or distantly serrulate, acute, the radical long petiolate, cauline few, sessile, linear, attenuated below, the uppermost amplexicaule; branches of the corymb two or three-flowered, pedicels elongated, bracteolate; involucrum turbinate, nearly naked, sepals twelve to fifteen; rays oblong, nearly entire, about eight, longer than the involucrum; achenium smooth.

Hab. The plains of Oregon, near the Wahlamet. A tall, rather slender species, two to three or more feet high, with a running root. Lower leaves with their petioles more than a span long, not more than half to three quarters of an inch wide. Leaves of the stem very small and distant, giving the plant a remarkably naked appearance. Sepals yellowish, linear, and acuminate. Rays long, (often twice as long as the involucrum,) few, and bright yellow, linear-oblong, slightly toothed, attenuated below, and sometimes tubular. Tubular florets, about twenty, the teeth ovate, acute, nearly smooth, exserted beyond the pappus. A few irregular slender bractes beneath the involucrum.

Senecio **exaltatus;* ♃, more or less hirsute with white hairs; the radical leaves nearly smooth; stem tall, robust, nearly cylindric and grooved; lower leaves oblong-lanceolate, unequally and glandularly serrate, rather broad and long petiolate; upper leaves small and amplexicaule, incisely, and sometimes deeply serrate; corymb compound, many-flowered, fastigiate; involucrum campanulate, sparingly bracteolate; sepals about fifteen, linear, carinate, not sphacelous; rays oblong, short, six to eight, about the length of the short involucrum; achenium smooth; pappus much shorter than the florets.

Hab. The plains of Oregon, near the outlet of the Wahlamet. A remarkably tall and robust species, from three to five feet high, above nearly naked and without a branch, except the subdivisions of the corymb, which may contain from forty to fifty capituli, all in one fastigiate cluster. Involucrum brownish, short and rigid, the sepals with pubescent tips. Allied to *S. lugens*, but with smaller and more numerous capituli, and fewer rays, the upper stem leaves are also those which are most divided, instead of being entire. The stem and upper leaves are sometimes almost hoary with rough white hairs, never arachnoidly pubescent.

*Senecio *cordatus;* ♃, more or less hirsute, particularly the lower part of the stem; stem tall and robust, subcylindric, and angularly grooved; corymb many-flowered, nearly simple; lower leaves cordate-ovate, nearly entire, or repandly serrulate, obtuse, long petiolate; stem leaves lanceolate, amplexicaule, serrate; involucrum campanulate, rather small; sepals linear, carinate, about fifteen, with black, pubescent, sphacelous tips; rays five or six, oblong, about the length of the involucrum; achenium smooth, pappus a little shorter than the florets.

Hab. Alluvial situations in Oregon, near the outlet of the Wahlamet; rather rare. With the preceding: flowering in June. About two and a half to three feet high. The capituli comparatively small, twenty to thirty in a slightly divided corymb; pedicels and base of the involucrum sparingly bracteolate; involucrum smooth. The stem appearing naked from the sudden diminution of the leaves: the radical two to three inches broad, by three to four long, sometimes nearly entire, at other times very regularly crenate. Allied to the preceding, but with a smaller and nearly simple corymb, and the leaves at the base of the stem nearly as broad as long.

*Senecio *hydrophilus;* ♃, very smooth and robust, erect; stem cylindric, fistulous and grooved; leaves lanceolate, nearly entire, or repandly denticulate; cauline amplexicaule, acuminate; capituli bracteolate, paniculate; branchlets subfastigiate, the corymbuli contracted, thyrsoid; involucrum small, subcampanulate; sepals about twelve, linear-lanceolate; rays about six, narrow, shorter than the involucrum; achenium smooth; receptacle deeply alveolate, fimbrillate.

Hab. By the margins of ponds and springs in wet places, in the Rocky Mountains, by Ham's Fork of the Colorado of the West. Leaves very smooth and rather thick, very much like those of *Solidago limonifolia.* Stem about two feet high. The root presenting an abrupt crown with circles of thick fibres. Lower leaves narrowed below, with wide sheathing bases, an inch to one and a half inches wide, the petiole six to seven inches long; stem leaves gradually becoming smaller;

the inflorescence six to eight inches long, the lateral branches terminating in thyrsoid clusters; tubular florets twenty to thirty.

*Senecio *Purshianus;* ♃, softly and whitely tomentose, subcæspitose; leaves lanceolate-oblong, entire, cauline amplexicaule, lanceolate, incisely dentate at base; corymb irregular, simple, few-flowered, the pedicels elongated, bracteolate; rays about eight; sepals about twelve, linear-lanceolate; receptacle convex! achenium smooth, pentagonal, ten-striate; pappus as long as the florets. *Cineraria integrifolia,* PURSH, non WILLD. *Senecio integrifolius,* NUTT. Gen. Am., Vol. II., p. 165.

HAB. Rocky Mountains (banks of the Platte,) also the banks of the Missouri. Allied to *L. tomentosus*, but in that, besides other differences, the achenium is hirsutely ribbed. Nearly allied to *S. canus*, but with a different achenium, and stem leaves.

Senecio subnudus; (DECAND., Vol. VI., p. 428;) ♃, smooth; stem erect, simple, with one capitulum; lower leaves long petiolate, cuneate-spathulate, obtuse, denticulate, cauline sessile, the upper sublanceolate, incisely dentate at base; upper part of the stem scapoid and nearly naked; capitulum subhemispherical, slightly bracteolate; sepals about twenty, acuminate; rays twelve to fifteen, longer than the involucrum; achenium smooth, pappus as long as the florets.

HAB. The Cascade Mountains on the Oregon; (the late Dr. Gairdener, from whom I received the only specimen I possess.) It appears to be somewhat allied to *S. Cymbalaria* of Pursh. Petiole longer than the leaf; the leaf less than an inch long, scarcely a quarter of an inch wide, the uppermost reduced to slender subulate bractes. Stem eight or nine inches high, and in all the specimens I saw with a solitary capitulum.

*Senecio *Cymbalarioides;* ♃, very smooth, except the axills of the leaves, which are arachnoidly floccose; radical leaves cuneate-oval, very long petiolate, serrate; cauline oblong, incisely serrate or subpinnatifid, narrowed below, the base amplexicaule, uppermost leaves very small; corymb simple, four to eight flowered; peduncles elongated, nearly naked; involucrum naked, turbinate, short, of fifteen acuminate, smooth, linear-lanceolate sepals; rays about eight, oblong, longer than the involucrum; achenium smooth, angular, ten-striate; pappus as long as the florets.

HAB. In Oregon. Allied to *S. balsamitæ*, but with the radical leaves shorter, entire at the base, on very long petioles, and with the capituli larger and fewer. Lower leaves about an inch long by three quarters of an inch wide, appearing short, oval, and are mostly cuneate and entire at base; petiole two or three times as long as the leaf; at the very base within, is seen a tuft of loose floccose down; the leaves themselves are exceedingly smooth and lucid.

*Senecio *Schweinitzianus;* ♃, smooth, stem grooved; lower and radical leaves long petiolate, cordate, obtuse, or acutely cordate-ovate, coarsely or sharply toothed, incise at base; cauline pinnatifid, auriculate and amplexicaule, the auricle deeply cleft; umbell loose and subcompound; pedicels very long and mostly naked; a few minute bractes under the base of the involucrum; involucrum smooth, the sepals acuminate, about twenty; rays about twelve, longer than the disk; achenium smooth; pappus nearly as long as the florets.

Hab. In Arkansa, and, according to Schweinitz, in Carolina, marked *S. Caroliniana* in his herbarium, but not, apparently, the plant of Sprengel. About a foot and a half high, perfectly smooth, except a slight down, in the axills of the radical leaves. Radical leaves with the petioles four or five inches long, the lamina of the leaf two to three inches long, by one and a half to two broad; umbell compound, with as many as twenty capituli.

*Senecio *Plattensis;* ♃, somewhat pubescent; base of the stem arachnoidly tomentose; leaves all pinnatifid, the radical petiolate, cauline amplexicaule, lobes oblong, denticulate, the centre lobe sublanceolate; corymb nearly simple; involucrum subcampanulate, minutely bracteolate; sepals about twenty, acute; rays usually twelve, oblong, a little longer than the short involucrum; achenium puberulous; pappus about the length of the florets.

Hab. In the Rocky Mountain range, and in Arkansa. About ten to fourteen inches high; stem simple, striated. Corymb nearly simple, with ten to twelve heads of flowers, pedicels one to two inches long, slightly bracteolate. The Arkansa specimen is taller and more slender, with the primary small radical leaves entire and smooth, the leaves more elongated, and less denticulate. The whole habit of the plant, as well as the flowers, are very similar to *S. tomentosus*, at least the smoother variety, but the achenium is less pubescent.

*Senecio *coronopus;* ☉, smooth, dichotomously branched from the base; leaves all pinnatifid, auriculately amplexicaule; the rachis wide, with few acute segments, segments of the upper leaves denticulate; branches few-flowered, fastigiate, pedicels elongated, naked, the summit beneath the campanulate involucrum minutely bracteolate; sepals about twenty, smooth and carinated, with acute, reflected, sphacelous tips; rays about fifteen, oblong, longer than the involucrum; achenium cylindric, ten-ribbed, the ribs strigose; pappus about the length of the florets.

Hab. In Upper California, near St. Barbara. Flowering in May. A very distinct species, allied, though remotely, to *S. Californicus*. The capituli, though fastigiate, are not in a corymb, but terminate the forked branchlets. Flowers bright yellow. Stem much branched, six to eight inches high, somewhat angular. Nearly allied to *S. coronopifolius:* may it not be a variety of that plant introduced by accident? It is not, however, glaucous.

*Senecio *filifolius;* ♃, stem leafy, striated, and, as well as the leaves, arachnoidly tomentose; leaves pseudopinnate, sessile, segments linear, almost filiform, about two pair, the margin revolute; corymb few-flowered; involucrum smooth, minutely bracteolate, subcampanulate; the sepals obtusely carinate, acuminate, about twenty; rays few and revolute; achenium hirsute, pappus copious, as long, or longer than the florets.

Hab. The banks of the Missouri, towards the Rocky Mountains. With much the aspect of some of the species from the Cape of Good Hope. Leaves a good deal like those of *S. abrotanifolius*, but whitely tomentose, and divided into a very few simple segments, about an inch long, and a quarter of a line wide. (I have seen but a single small specimen.)

CROCIDIUM. (Hooker.)

Capitulum many-flowered, radiate; rays feminine, in a single series, (eight to twelve.) Involucrum in one series, subimbricate, eight to twelve-parted, the divisions ovate, somewhat spreading, at length reflected, the margins of the inner series membranaceous. Receptacle conic, elevated, naked, minutely papillose. Branches of the stigma very short, lanceolate, acuminate, slightly pubescent, not exserted, in the ray very short. Achenium subcylindric, pentagonal, the intervals of the ridges densely squamellose at the summit, appearing almost like an external pappus. Pappus deciduous, barbellate, almost plumose, very white, and little more than the length of the achenium; the radial achenia wholly similar, (not compressed,) but without pappus.—A remarkably distinct genus, approaching more to the Anthemideæ than the present section, but, in fact, a new type, and a stranger in each of the present orders.

Hab. On the shelving rocks of the Oregon, at the confluence of the Wahlamet; common. A very elegant but fugacious annual, six to eight inches high, sending up numerous simple branches from the base, each terminating in a single clear yellow flower. Radical leaves spathulate, incisely indented, the cauline small, linear, acuminate or subulate, sessile; pedicel very long, naked. Axills of the leaves floccosely lanuginous. Involucrum smooth and greenish. Rays oblong, nearly entire, twice as long as the involucrum. All parts of the capitulum, except the persisting involucrum, caducous. Border of the discal florets campanulate, deeply five-cleft, the divisions linear-lanceolate. Stamens and stigmas not exserted, very short.—This plant appears to have no relation to *Senecio*. The general appearance of the flower is much like that of *Chrysanthemum segetum*.

TETRADYMIA. (Decand.)

Capitulum homogamous, four-flowered. The involucrum of four biserial, foliaceous, oblong, obtusely carinated sepals, the inner membranaceous on the margins. Receptacle naked and narrow. Corolla tubular, deeply five-cleft, the lobes linear. Branches of the stigma nearly terete, the apex obtuse and hirsute. Achenium turbinate, densely villous with simple hairs. Pappus copious, in many series, the setæ all equal, rather rigid and barbellate.—Canescent, much branching, and sometimes spiny shrubs of the plains of the Rocky Mountains or Northern Andes. Leaves alternate, sessile, fasciculate in the axills, entire and linear. Capituli in terminal fascicles or racemes, pedicellate. Flowers deep yellow.

Tetradymia canescens, (DECAND.;) leaves mucronate; capituli racemose.

HAB. Oregon; (Douglas.) I have never seen this species, and think it more probable to be a native of California, or the Rocky Mountains. Certainly not along the plains of the north-west coast.

*Tetradymia *inermis;* shrubby, much branched, and canescently tomentose; leaves oblong-linear, slightly acute, somewhat clustered; capituli in terminal clusters of three to five, upon short peduncles, the central ones often sessile.

HAB. On the dry barren plains of the Rocky Mountains. Common, particularly near Lewis' River, of the Shoshonee, but not in the plains of Oregon. A much branched shrub, two or three feet high, whitely canescent with a close soft tomentum, which is also spread over the branches; the branches studded with the cicatrices of former buds. Leaves about three-quarters of an inch long, often obtuse, slightly apiculated. Sepals oblong, obtusely carinated, connected at base. Achenium thickly clad with long simple hairs, beneath which it is entirely hid; the pappus very copious and long, at length longer than the florets, becoming pale brown, the setæ rather slender, and all similar; at length growing out to the length of half an inch.

Tetradymia spinosa; canescently tomentose, shrubby and much branched; axills spinescent; leaves linear-oblong, obtuse or acute, clustered, at length nearly smooth; capituli in terminal clusters, pedunculate.

HAB. With the above, on the dry plains of Lewis' River, and on Ham's Fork of the Colorado of the West: common. Flowering in July. A very elegant and singular shrub, growing in tufts, two or three feet high, in the manner of the Furze bush of Europe, (*Ulex.*) Spines half an inch to three-quarters of an inch long, sharp and somewhat curved. From under the flowering clusters come out often tomentose branches, entirely clad with alternate spines, in two rows, in the axills of which are formed buds, which afterwards produce leaves. Capituli on long peduncles; the sepals distinctly carinate, oblong-lanceolate, receptacle entirely naked. The leaves thinly tomentose, almost green. The villous hairs of the achenium shorter than in the preceding; bristles of the pappus slender, and all similar.

*LAGOTHAMNUS.

TETRADYMIA, but with the capitulum five-flowered, the involucrum subcampanulate, of five (or rarely six) flat, oblong sepals in a single series. Receptacle naked, alveolate, dentate. Branches of the stigma subterete, obtuse, the upper part, as well as the summit, pubescent. Achenium oblong, thickly clad from the base with long, slender, fastigiate, minutely serrulate hairs of the same height with the true pappus, which consists of about twenty stout and rigid barbellated bristles.—A decumbent, canescent, much branched, spiny shrub. Leaves clustered in the axills of preceding slender spines, entire, linear, minute, thick, almost acerose and smooth. Flowers solitary, axillary, terminating small branchlets; the pedicels bracteolate, appearing, from their situation above each other on the branch, to form a raceme; branches and involucrum white and densely tomentose.—(The name alludes to the soft, tomentose clothing of the plant.)

*Lagothamnus *microphyllus.*

HAB. On the arid plains of the Rocky Mountains, and near Lewis' River, as well as Ham's Fork of the Colorado of the West: common. Flowering in July and August. A much branched, spreading shrub, three or four feet high, with the young shoots, as well as their spines, soft and whitely tomentose. Leaves clustered, oblong-linear, somewhat convex, perfectly smooth at all times, scarcely more than two lines long, by half a line wide. Capituli mostly nodding, numerous; the florets bright yellow and large, deeply cleft, with smooth, linear, acute segments. Cone of anthers exserted, the cusps linear and acute. Stigmas rather small, pubescent below as well as at the summit. Involucrum conic-campanulate, three of the divisions oval obtuse, two other smaller and acute. About twenty of the bristles which immediately surround the floret are about as stout and as much barbellated as in *Tetradymia.* The most singular part of the plant is the pubescence of the achenium, the hairs of which are very slender, and as much serrulated as in the true pappus of Senecio, which they wholly resemble; they appear also nearly all of a length, and come up nearly even with the few bristles of the true pappus.

Lagothamnus **ambiguus;* with the whole aspect and character of the preceding, but with the divisions of the involucrum all obtuse; the false pappus of the sides of the achenium more copious, and the inner true pappus so slender as to be scarcely distinguishable.

HAB. With the above.

Appendix to SENECIONIDEÆ. Subtribe MELAMPODINEÆ.

Division II. MILLERIEÆ?

*PICROTHAMNUS.

Capitulum monoicous, heterogamous, few-flowered; rays feminine, (three to five,) tubular, truncated, two or three-toothed; discal florets masculine, with abortive styles, (five to ten,) globose-ovate, five-toothed, teeth triangular, and, as well as the rays and achenium, copiously clothed with long flaccid hairs, the tube very slender. Receptacle naked, very small. Involucrum hemispherical, imbricate, about five-leaved, the leaves rounded. Style bifid, stigmas terete-cylindric, with a minutely pencillated summit, nearly smooth. Achenium obconic, turbinate, subcylindric, without pappus, sending off, upwards, numerous long, tortuous hairs. Discal florets without any rudiments of fruit.—A low, much-branched, inelegant, spiny shrub, somewhat softly lanuginous. Leaves alternate, twice trifid. With the habit of an *Artemisia;* capituli in short, leafy racemes, the rachis of which, at length, becomes a long spine. Florets pale yellow.—(The name from πικρος, *bitter*, and θαμνος, *a bush;* in allusion to its bitterness.)

Picrothamnus **desertorum.*

HAB. Rocky Mountain plains, in arid deserts, towards the north sources of the Platte. Root woody, much branched and very long, covered with numerous fibrous vestiges of bark. Stem from four inches to a foot or more, woody and branched from the base; the whole plant hirsute and grayish canescent. Leaves twice trifid, pseudopetiolate, the segments short, oblong, and entire. A plant of very doubtful affinity, allied in some respects to *Clibadium*, and therefore to the division MILLERIEÆ. It is also allied to the IVEÆ; but the tube of anthers are united.

Tribe V. *CYNAREÆ.*

Subtribe CARDUINEÆ. (Lessing.)

CARDUUS. (Gærtner.)

§. I. *LEPTOCHÆTA.—*Rays of the pappus slender and few; anthers bisetose at base, the setæ lacerate.*

*Carduus *occidentalis;* ♃, dwarf; leaves deeply pinnatifid, above nearly smooth, beneath canescently tomentose, segments subpalmate, ultimate divisions lanceolate, terminating in short spines, and spinosely serrulate; involucrum subglobose, arachnoidly tomentose; divisions lanceolate, erect, terminating in stright spines, the innermost scariose, spineless and acuminate.

HAB. Round St. Barbara. Stem tomentose, six inches to a foot high. Leaves four or five inches long, about three-quarters to one and a quarter inches wide, with a lanceolate outline, softly tomentose beneath, the lower petiolate, cauline amplexicaule at the base, divisions somewhat palmate, in three or four unequal segments, the spines short. Capituli two or three, terminal, subsessile, pale purple; florets very slender, subringent or unequally cleft. Anthers distinctly bisetose and lacerate at base; pappus scanty, more slender than in most European *Cardui;* somewhat scabrous, the whole habit of the plant similar to that of *Circium discolor.* The pubescence of the involucrum quite as remarkable as in the Cob-web Sempervivum, spreading from one scale to another in right lines.

CIRCIUM. (Tournefort.)

OBS. To the character of this genus I would add, that in all the species which I have examined, indigenous to America and the old world, the anthers are very distinctly caudate at base, with this appendage generally torn or cleft more or less deeply at the extremity. *Erythrolæna* and *Chamæpeuce* are, therefore, mere sections in the present genus, distinguished principally, and almost solely, by habit and the form of the involucrum.

§. II. ERIOLEPIS. (Cass., Decand.)

*Circium * Hookerianum;* arachnoidly tomentose; stem nearly simple; radical leaves deeply sinuately pinnatifid, beneath canescently tomentose, the segments sublanceolate, unequally bifid, spiny at the points, and ciliately spinulose; stem leaves narrow lanceolate, slightly decurrent, rigidly spiny, the summit merely toothed, with the segments bifid and very short; capituli few, axillary and terminal, subsessile; involucrum subglobose, densely and arachnoidly tomentose, the segments lanceolate, terminating in erect rigid spines, the inner series merely acuminate; pappus conspicuously clavellate.

HAB. In Arctic America. (Hooker.) According to the specimen which he transmitted to the herbarium of the late Mr. Schweinitz, now in the Academy of Natural Sciences in Philadelphia, marked as "*Carduus discolor*," it appears to be also the *C. discolor* of the Flor. Bor. Am., Vol. I., p. 302. The specimen seems to be about sixteen inches high, without a branch, with one terminal flower, and three axillary buds: the involucrum would almost be mistaken for that of *C. lanceolatum;* the flowers are apparently pale purple: the stem leaves four to four and a half inches long, and less than three-quarters of an inch wide, excluding the spines, with a slender arachnoid deciduous pubescence above, and a white tomentum beneath; the radical leaves are more than a foot long, the lateral segments two to two and a half inches long, linear-sublanceolate, slenderly ciliate with minute spines. Florets unequally cleft, the segments narrow and glandularly thickened at the extremity, cauda of the anthers deeply lacerate. Pappus plumose, rather short, and barbellated.

Circium Douglasii. (HOOK.) OBS. This species, which I collected near Fort Vancouver, on the Oregon, is scarcely, if at all distinct from the *C. undulatum.* The flowers are unequally cleft, as usual, the segments linear and acute; cusps of the anthers linear and acuminate; the caudate process deeply lacerate in several threads, the outer row of florets produce almost a simply barbellated, strong, rigid pappus, the inner florets a soft, plumose pappus, with slender clavellate tips. The capituli, when fully developed, are nearly naked and globular. Flower pale purple. The leaves on both sides are white, more so beneath, and very softly pubescent; they very much resemble those of the common Artichoke.

*Circium *stenolepidum;* stem branching, naked above, and, as well as the upper surface of the leaves, somewhat pilose and hirsute; flowers fastigiate, somewhat corymbose; leaves deeply pinnatifid, sublanceolate, beneath tomentose, segments deeply and almost equally bifid, spinosely ciliate and spinose at the points, somewhat decurrent and amplexicaule at base; capitulum nearly naked, slightly arachnoid, tomentose; divisions of the involucrum very long and linear, terminating in short, continuous, erect spines, the inner series much acuminated and unarmed.

HAB. In the plains of Oregon. A tall and stout species, with the leaves somewhat resembling those of *C. discolor.* Capituli large and globular, somewhat clustered or corymbose, the branches fastigiate, sometimes producing two capituli. Flowers purplish, very remarkable for the narrowness and great length of the sepals, which are nearly an inch long, and less than half a line wide, except the base, the form linear-lanceolate, with very long points, all nearly attaining the same common height. Pappus plumose, as usual, and clavellate; the florets unequally cleft, and the anthers caudate at base.—Nearly allied to *C. remotifolium.*

*Circium *canescens;* ♃, dwarf and slender, canescently tomentose; leaves lanceolate, decurrent, pinnatifid, undulated segments oblong, bifid, spinescent, and with spiny serratures; capituli few, (three to five,) conglomerate, sessile; involucrum slightly pubescent, the scales lanceolate, with rigid, erect spines.

Hab. In the arid deserts of the Platte. The root creeping as in *C. arvense.* Stem about eight to ten inches high, and, as well as the leaves, arachnoidly tomentose and canescent. Leaves three or four inches long, about an inch wide, nearly white on both sides, most so beneath, decurrent, with narrow spiny margins. Flowers few; the capitulum somewhat hemispherical, the spines stout and rather broad. Florets pale rose, unequally cleft. Anthers caudate at base, and lacerate. Pappus plumose and slenderly thickened above.

*Circium *edule;* annual or biennial, nearly smooth; stem pubescent, angular and grooved; leaves lanceolate, amplexicaule, moderately pinnatifid, segments obtuse, almost equally two-lobed, spinescent and spinulosely ciliate; capituli terminal, conglomerate, sessile, by three and five together; involucrum subglobose, arachnoidly tomentose, the scales linear-lanceolate, terminating in short, erect spines.

Hab. The plains of Oregon and the Blue Mountains: common. Three to four feet high, robust and somewhat succulent; flowers purple, nearly the size of those of *C. lanceolatum,* growing in lateral and terminal clusters, corolla unequally cleft, anthers caudate, appendage lacerate; cusps of the anthers lanceolate, filaments, as in all the preceding, pilose and hirsute. Pappus plumose. Allied to *C. foliosum.* The young stems, stripped of their bark, are commonly eaten raw by the aborigines, and have a somewhat pleasant and sweetish taste.

*Circium *scariosum;* ♃? dwarf and robust; stem and mid-rib of the leaves above and beneath softly and copiously pilose; leaves narrow lanceolate, beneath whitely tomentose, amplexicaule, pinnatifid, segments lanceolate, terminated and ciliated with long spines, uppermost leaves and bractes linear, very spiny; capituli conglomerate, sessile, roundish; involucrum somewhat arachnoidly tomentose, the scales lanceolate and acuminated with rather slender spines, inner scales terminating in scariose, lanceolate, fimbriate, reflected points.

Hab. The plains of the Rocky Mountains. Stem stout, about nine inches or a foot high, leafy: the leaves about half an inch to an inch wide, and four to six inches long, the segments of the stem leaves very short, ending in long spines; capituli three to five; two or three series of inner, scariosely appendaged scales. Corolla unequally cleft, ringent; anthers lacerately caudate; pappus plumose; achenium smooth and even. The inner divisions of the involucrum, and, in fact, the whole aspect of our plant is very similar to that of *Echenais carlinoides*, which is also a true Circium, without any vestige of generic character, or even habit, to separate it; for, on examining the fruit when mature, I find it smooth and even, without any striatures whatever.

*Circium *megacanthum;* glabrous, robust and gigantic; capituli round, aggregated in clusters towards the summit of the stem; leaves deeply pinnatifid and somewhat decurrent, segments lanceolate or linear-lanceolate, terminating in stout spines nearly their length, the margin ciliate-serrate; capituli bracteolate, involucrate, the bractes and upper leaves exceedingly spiny; scales of the involucrum lanceolate, acuminate, erect, acicularly terminated; pappus very long.

Hab. On the banks of the Mississippi, in the vicinity of New Orleans. Found by Mr. Little and myself. Its measurements, according to Mr. Little, are three to six feet high. Stem two inches in diameter, at base; the largest leaves one foot four inches long: (a specimen from the Bayou Road.) The leaves are sometimes slightly arachnoid along the mid-rib. The larger spines are nearly an inch long, and as stout as coarse sewing needles. The clusters of capituli may be from ten to twenty, about three inches wide, when largest; the sepals terminated with mere acicular points. Pappus plumose, near one and a quarter inches long, white; tube of the floret twice as long as the nearly equal border; anthers caudate, the appendage deeply cleft; cusps acuminate. Resembles at first glance *C. spinosissimum*, but it is much larger, and wholly distinct. The segments of the leaves are long and narrow. One of the most terribly armed plants in the genus.

§. vi. Onotrophe. (Cassini.)

*Circium *brevifolium;* stem slender, subterete, and, as well as the under surface of the leaves, whitely tomentose; leaves oblong-lanceolate, amplexicaule, sinuately pinnatifid, with shallow, simple, or bifid lobes, ending in spines and spinose serratures; involucrum ovate, naked; scales lanceolate, glutinous, smooth, terminating in small, erect spines.

Hab. In the Rocky Mountain plains. Allied to *C. Virginianum;* but the leaves more divided and far more tomentose, as well as the stem; the capitulum very similar. Stem terminating in two or three capituli. Florets ochroleucous, unequally cleft. Anthers lacerately caudate. Pappus plumose, with slender tips. Leaves about half an inch wide, two to three inches long, nearly smooth, and green above.

Suborder II. LABIATIFLORÆ. (Decand.)

Tribe VI. *MUTISIACEÆ.* (Less.)

Subtribe II. Lerieæ. (Less.)

*CURSONIA.

Capitulum heterogamous, radiate; liguli flat, with rudiments of stamina, trifid at the apex, externally tomentose, inner lip obsolete, or none. Discal florets hermaphrodite, tubular, five-toothed, ringent, two of the dentures larger. Anthers in the discal florets caudate, the apex appendiculate. Stigma clavate, undivided, the branches adnate, that of the ray exserted and clavate. Involucrum hemispherical, loosely imbricated, the segments linear-lanceolate, setosely acuminate, and rather rigid. Achenium subcylindric-conic, somewhat sericeous. Pappus bristly and scabrous, in several series, and very unequal, five central bristles much larger and longer.—A small herbaceous plant of Peru, with alternate, lanceolate, denticulate leaves, tomentose beneath. Pedicels elongated, terminal. Capitulum somewhat loosely tomentose. Florets apparently dark red or purple.

*Cursonia * Peruviana.*

With the aspect of a *Chaptalia*, to which genus it is allied. Leaves approximating towards the summit of the branch, about an inch long, and less than half an inch wide, lanceolate, acute, attenuated below into a winged petiole, or properly sessile, repandly denticulate and acute, beneath somewhat whitely tomentose, above slenderly arachnoid; pedicels nearly naked, two to two and a half inches long, with one or two subulate bractes. Sepals about two series, linear-lanceolate, arachnoidly tomentose, nearly all of equal height, acuminated with long, bristly, rather rigid points. Rays few, about a single series, as long as the involucrum, flat, linear and trifid at the apex, of a very dark purple, almost black. Pappus a little shorter than the florets. Discal florets also dark purple; caudal processes of the anthers long and very slender, simple. Receptacle apparently naked.—(Collected in the mountains of Peru by Mr. Curson, with many other interesting plants, after whom this genus is deservedly named.)

POLYACHYRUS. (Lagasca.)

*Polyachyrus *glandulosus;* summit of the stem and involucrum glandularly pubescent, outer scales acute and much larger than the rest, which are scariose and smooth; pappus of the outer flower shorter on one side; leaves . . . . amplexicaule, the uppermost subulate, glandular and entire; capituli two-flowered.

HAB. In Peru. (Mr. Curson.) The specimen I possess is only a flowering fragment. The lower part of the stem is smooth; the leaves have been deciduous, and being wanting the form is unknown. The flowering cluster is three times as large as that of *P. niveus* (which Mr. Curson also collected in Peru,) the two outer scales lanceolate and acute, glandularly scabrous, the inner smaller scales are tipped with red; a large chaffy scale intervenes between the two flowers of the involucrum. Pappus long and yellowish white, in the outer flower shorter on one side. Achenium pubescent, more so in the floret, with long pappus. Flowers apparently white. Stigmas bearded and truncate at the summit, which is reflected. Corolla and caudate anthers much as in *P. niveus*.

Suborder III. LIGULIFLORÆ.

Tribe VIII. *CICHORACEÆ.* (Vaill. Jussieu.)

Subtribe iii. Hyoserideæ. (Lessing, Decand.)

APOGON. (Elliott.) Serinia? (Rafin.)

Obs. Involucrum generally eight-leaved, connivent in the fruit. Liguli about the length of the involucrum.

Apogon lyratum, (Nutt.;) smooth and glaucous; cauline leaves dilated at the base, the lower and radical ones runcinate lyrate; pedicels two or three; pappus none; achenium smooth.—*Serinia cespitosa?* Rafinesque, Flor. Lud., p. 149. Probably a dwarf state, as it is not cespitose.

Hab. The plains of Arkansa. Very nearly allied to *A. humilis,* from which it principally differs in its lower lyrate leaves; segments about two pairs, upper leaves elongated linear-lanceolate, the floral pair opposite. Involucrum eight-leaved. In *A. humilis,* the summit of the pedicel, and base of the involucrum is often pubescent.

*UROPAPPUS.

(Section Calocalaïs of Calaïs, Decand. in part.)

Capitulum many-flowered. Involucrum ovate, loosely imbricate; sepals sublanceolate in two or three series, the outer shorter. Receptacle naked, flat. Florets about equal with the involucrum. Achenium subcylindric, minutely scabrous or muricate, striate, attenuated into a thick rostrum. Pappus of five linear-lanceolate, one-nerved paleæ, cleft at the summit, with a slender, somewhat scabrous awn issuing from the cleft.—Smooth and rather slender annuals of Upper California, with long, linear, attenuated leaves, entire or pinnatifidly laciniate. Pedicels very long, scapiform, one-flowered. Flowers yellow.—(The name alludes to the singular setaceously caudate pappus.)

§. I. CALOCALAÏS, (Decand.)—*Involucrum with the external series shorter and unequal. Fruit in all the florets similar, and with a long rostrum.*

Uropappus Lindleyi. Calaïs Lindleyi, DECAND. Prod., Vol. VII., p. 85.

HAB. On the north-west coast of America.

Uropappus linearifolius. Calaïs linearifolius, DECAND., Vol. VII., p. 85. Exclude the synonym of *Hymenonema? glaucum* of Hooker, which appertains to the following genus.

HAB. This plant I have met with, both at St. Barbara, and St. Diego, Upper California. OBS. Leaves very long and narrow, linear, the lower often irregularly laciniate, or more or less pinnatifid, with slender segments. Flowers yellow and small. Pedicels six inches to a foot long; the stem frequently branched from the base. Pappus of a silvery whiteness, and very shining, the awn much shorter than the paleæ. Achenium black, ribbed, and transversely striate, but smooth, and with a longish rostrum; the fruit all similar. Sepals from eight to twelve, with four or five other shorter external ones.

*Uropappus *grandiflorus;* leaves (as in the preceding) long and linear, the lower often laciniately pinnatifid, with filiform segments, the upper entire; at first often tomentosely ciliate at base; stem branching, pedicels very long; involucrum of ten to fifteen leaves, the outer shorter; achenium slightly striate or lined, scabrous with minute hairs, and with a very long rostrum.

HAB. With the above, which it wholly resembles, except in the larger capitulum, brown and very slender, scabrous achenium, and the shorter proportion of the bristles of the pappus. Sepals, as in all the other species, lanceolate and acuminate.

§. II. *BRACHYCARPA.—*Achenium somewhat attenuated, scarcely rostrate, transversely rugose; the fruit of the outer series (five or six) hirsute, all deeply striate; the bristles of the pappus as long as the scale.*

*Uropappus *heterocarpus;* stem short and few-flowered, often scapoid; leaves long and linear, at first a little hirsute; longer sepals about eight, three or four shorter.

HAB. St. Diego, Upper California. About half a foot high, with the leaves entire, scarcely a line wide, attenuated at both ends; pedicel long, resembling a scape. Flowers pale yellow and small. Achenium long and cylindric, but not properly rostrate. Paleæ straw colour, the bristles distinctly scabrous, and about the same length.

*SCORZONELLA.

Capitulum many-flowered. Involucrum ovate, imbricate, the sepals acuminate, the outer, or those of all the series ovate, the margins membranaceous. Receptacle naked, alveolate. Achenium not rostrate, quadrangular, strongly and obtusely ten-ribbed. Pappus paleaceous, five to ten parted, united at base into a rigid cup, the segments short ovate, terminating in very long, slender awns. Style exserted, slender, filiform, the branches of the stigma rather short.—Perennial herbs of Oregon, with fusiform, tuberous roots, and sheathing, slenderly pinnatifid, smooth leaves; pedicels very long, naked and scapoid. Flowers yellow, the liguli longer than the involucrum, the apex five-toothed. (The name alludes to the general aspect of Scorzonera.) Allied, though somewhat remotely, to *Calaïs*, from which they differ wholly in habit and duration, having large, conspicuous flowers, like those of *Scorzonera;* the achenium is also truncate and strongly angular.

Scorzonella laciniata; leaves deeply pinnatifid, with entire, narrow segments; sepals all broad ovate, acuminate, in about three series; segments of the pappus ovate, the awn scarcely scabrous. *Hymenonema? laciniatum*, Hook. Flor. Bor. Am., Vol. I., p. 301.

Hab. On the plains of the Oregon, near the outlet of the Wahlamet. Twelve to sixteen inches high; the pedicel often eight inches to a foot long, a little enlarged beneath the involucrum. Stem bearing one to three or more flowers. Segments of the leaves often as slender as threads, and very long. Florets very numerous, nearly as much so as in the common Dandelion, of a bright sulphur yellow; sepals very much acuminated. Achenium light brown, a little scabrous towards the summit. Root tap-shaped, nearly like that of Salsafy.

*Scorzonella *leptosepala;* leaves, as in the preceding, slenderly divided; involucrum with the sepals in two series, the outer about five-leaved, ovate; the inner eight-leaved, lanceolate, acuminate; segments of the pappus oblong-lanceolate, with scabrous awns; achenium wholly smooth.

Hab. With the above, and scarcely distinguishable from it, except by the involucrum.

Scorzonella glauca. Hymenonema? glaucum, Hook. Flor. Bor. Am., Vol. I., p. 300. With this plant I am unacquainted.

KRIGIA. (Schreber.)

Krigia occidentalis, (Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 104;) leaves mostly lyrate, with slender segments; scapes glandularly pubescent; sepals five to eight, lanceolate, carinate, somewhat obtuse; setæ of the pappus scarcely the length of the scales.

Hab. Arkansa. Annual, as usual, and so similar to *K. virginica*, that I at first considered it the same; but the specific characters given are constant, and prove it very distinct. In *K. virginica*, the sepals are flat, linear-lanceolate, and acuminate, and the awns of the achenium are several times longer than the scales.

Krigia dichotoma, (Nutt.) is nothing more than an advanced state of growth of *K. virginica*.

Subtribe VI. Scorzonereæ. (Lessing.)

*STEPHANOMERIA.

Capitulum subcylindric, three or five-flowered. Involucrum three to five-leaved; sepals linear-oblong, imbricate, one-nerved, with a caliculum of a few shortish, unequal scales. Receptacle naked, scrobiculate. Achenium oblong, obtusely five-ribbed or pentangular, transversely rugose, the summit truncated. Pappus of ten to twenty-four thick, closely plumose rays, separate, or connected together at the base by pairs.—Perennial, tuberous-rooted, or annual, herbaceous plants, very much branched, above nearly leafless, the lower leaves linear, or runcinate-pinnatifid. Capituli terminal; the flowers pale rose-red. Nearly allied, both in habit and character, to *Lygodesmia*, but differing in the pappus and achenium.

Stephanomeria *minor;* ♃, smooth, and much branched from the base, branches obscurely striate; leaves entire, linear-subulate; achenium subrugulose, with five obtuse, carinated ribs; pappus of twenty to twenty-four rays. *Lygodesmia minor*, Hook. Flor. Bor. Am., Vol. I., p. 295, tab. 103, fig. A.

Hab. On the plains and hills of the Oregon. About a foot high, flowering only at the summit; flowers small, pale rose-red; caliculum of about five, small, ovate scales. Pappus white.

*Stephanomeria *heterophylla;* ♃, radical leaves oblong, runcinately toothed or pinnatifid, subhirsute, as well as the lower part of the stem; upper leaves linear-subulate, minute; stem much branched, erect or flexuous; flowers solitary, terminal; scales of the caliculum lanceolate, acute.

HAB. On the borders of Big Sandy creek, a rivulet of the Colorado of the West. A low species, about a span high, with a large tortuous root; the upper leaves reduced to mere scales. Sepals lanceolate. Stem scarcely striated.

*Stephanomeria *runcinata;* ♃, radical, and often the stem leaves runcinate-pinnatifid, more or less pubescent, the lower part of the stem scabrous; upper leaves linear; branches short and somewhat spreading, one-flowered; involucrum six-leaved, six-flowered; sepals linear-oblong; pappus white, of about twenty rays; achenium nearly even.

HAB. With the above, which it nearly resembles, but has larger capituli, shorter branches, and generally more of the runcinate leaves. Flowers, as in the preceding, rose-red. Height about seven or eight inches. Pappus white and rather long. Infertile branches clad to the summit with leaves, which are more deeply runcinate-pinnatifid as they approach the extremity.

† *Annual species, divaricately branched; achenium pentangular, transversely rugose, obscurely ribbed.*

*Stephanomeria *paniculata;* ⊙? smooth and glaucous; stem tall, stout and erect, cylindric and striated, virgately branched; flowering branches short and axillary, somewhat paniculate or virgate; leaves linear, dentate or sagittate at the base; segments of the caliculum or bractes oblong and small; pappus gray, of about fifteen to twenty rays.

HAB. On the Rocky Mountain plains, towards the Colorado. Stem rigid and stout, two or more feet high, virgately branched. Pedicels very short and leafy, axillar. Flowers very small, pink red, and pale. The leaves and involucrum are frequently incrusted with clear drops, of a very bitter resin. Achenium straw-coloured, linear, transversely rugose, and pentangular; the ribs depressed.

*Stephanomeria *exigua;* ⊙, glaucous and smooth; branches divaricate, very slender and numerous; radical leaves runcinate-pinnatifid; the cauline resembling mere scales; flowers lateral and terminal, on long bracteolate branchlets; involucrum three to four-leaved, three to four-flowered; pappus white, of fifteen to eighteen rays.

HAB. With the preceding. With divaricate, and almost capillary branchlets; scales of the caliculum about three, lanceolate, minute. Flowers pale red, and small. Achenium pentangular, with acute angles, and transversely rugose sutures. Minute leaves, often denticulate at the base. Pappus with small intercallary simple hairs.

*RAFINESQUIA.

Capitulum many-flowered. Involucrum subcylindric-conic, caliculate; sepals equal in length, imbricated in about two series, linear and acuminate. Receptacle naked, puncticulate. Achenia subterete, subulate, scarcely striate, somewhat rugose, terminating in a long, filiform rostrum; the external series pubescent. Pappus plumose, in several series.—An annual, much-branched, tall, smooth herb of Upper California, with the aspect of a *Sonchus*. Leaves amplexicaule, runcinate-lyrate, flowers in loose corymbs; the branches microphyllus; caliculum rather short and spreading, the segments linear-subulate. Flowers small, white, externally dark purple in the centre of the liguli. Allied apparently to *Tragopogon*, but very distinct in habit.—(Dedicated to the memory of an almost insane enthusiast in natural history; sometimes an accurate observer, but whose unfortunate monomania was that of giving innumerable names to all objects of nature, and particularly to plants.)

Rafinesquia Californica.

Hab. Near the sea-coast, in the vicinity of St. Diego, Upper California. An annual growing to the height of two or three feet, and nearly erect. Stem terete, and purplish, somewhat divaricately branched, branches fastigiate, tending to a corymb at the summit. Leaves more or less deeply and runcinately pinnatifid, amplexicaule, lanceolate, and acute. Floral branches with minute reflected leaves. Involucrum rather long, at first almost cylindric, but quickly enlarging at the base, so as to become conic in the manner of the Sow Thistle. Sepals twelve to fifteen, all of the same height, but in two series, with membranous margins; the caliculum squarrose and short. Florets very fugacious and small, only opening for a few hours, and but little exserted, toothed at the apex. The outer row of achenia pubescent, with short appressed hairs, all somewhat rugulose, attenuated into a rostrum about one and a half times its length, and slenderly filiform; the crown of pappus copious, and softly plumose, the rays fragile. I have had this plant in cultivation in Philadelphia, but it is now lost.

Subtribe VII. Lactuceæ. (Lessing., Decand.)

PYRRHOPAPPUS. (Decand.)

Obs. Achenium linear-oblong, muriculate, with five broad, appressed ribs, and internally grooved.

Pyrrhopappus grandiflorus. *Borkhausia grandiflora,* NUTT. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 69. *Pyrrhopappus scaposus,* Decand. Prod., Vol. VII., p. 144. The achenium, seen in a young state, exhibits a short rostrum.

HAB. In the plains of Arkansa, (Dr. Pitcher;) also in Mexico, (Berlandier.)

Pyrrhopappus Carolinianus. *β. *maximus;* smooth, leaves for the most part laciniately pinnatifid, acuminate; capitulum very many-flowered.

HAB. In Arkansa. Two to three feet high; the root apparently perennial; the lower leaves a foot long, with divaricate, linear segments. Stipe of the achenium about twice its length. The pappus decidedly simple, not in the least scabrous, seen through an ordinary microscope. Sepals with a lateral, obtuse tooth at the summit, as in the original species. Branches of the stigma short, rather obtuse, and pubescent.

TARAXACUM. (Haller.)

*Taraxacum *montanum;* very smooth; leaves spathulate-oblong, nearly entire or runcinately toothed; scape smooth, much longer than the leaves; caliculum biserial, short and appressed, the scales ovate, or lanceolate, with broad membranaceous margins; sepals not corniculate, about twelve; achenium spinosely muriculate at the summit, scarcely half the length of the rostrum.

HAB. On the banks of the Platte, in subsaline situations towards the Rocky Mountains, and in the highest valleys of the Colorado of the West. Allied very nearly to *T. obovatum* and *T. collinum.* Perennial. Leaves three or four inches long, half to three-quarters of an inch wide, erect; never pinnatifid, mostly obtuse, the teeth shallow and simple. Base of the stem, in a young state, somewhat pubescent, in the axills only. Scape six to ten inches high, perfectly smooth. Flowers rather small.

MACRORHYNCHUS. (Lessing.)

OBS. The genus ought probably to be confined to the species with an alated, winged achenium.

Subgenus *KYMAPLEURA.† *Achenia compressed, deeply alated, ten-ribbed, the wings undulated; the exterior series hirsutely pubescent, the interior smooth, with narrow ribs.*

*Macrorhynchus *heterophyllus;* ⊙, more or less hirsute; primary leaves spathulate, the rest pinnatifid, with remote linear segments, the central lobe elon-

† From κυμα, *a wave,* and πλευρα, *a rib,* the achenium having undulated ribs.

gated; stem very short, pedicels naked, scapoid, one-flowered; outer sepals rather shorter than the inner, somewhat smooth.

HAB. The plains of Oregon. An annual, from four or five inches to a foot high. Stem scapoid, hid among the leaves; outer series of sepals slightly pubescent, the inner smooth, both linear-lanceolate. Corolla pale yellow, externally purplish, very fugacious. Outer pubescent achenia larger, purple, the inner straw-yellow, with smooth and shallower ribs. The whole plant nearly resembles *M. pterocarpus*, for which it might readily be mistaken.

*CRYPTOPLEURA.

Capitulum many-flowered. Involucrum subcampanulate, imbricate in a few series, the external shorter, pubescent and caliculiform. Receptacle naked. Liguli elongated. Achenium smooth, linear-oblong, compressed, obtuse, terminated by a very long filiform rostrum, the inner series bearing ten narrow, alated ribs; the outer series inflated, truncated at the apex, marked with obsolete lines; basilar areola minute. Pappus very slender, white and scabrous.—Annuals, with the whole habit of the preceding genus. Stem scapoid, scarcely any; florets yellow, conspicuous, as in *Troximon.*—(The name from κρυπτως, *hidden*, and πλευρα, *a rib*, the ribs of the radial achenia being obsolete or hidden.)

Cryptopleura Californica.

HAB. Near St. Barbara, in Upper California. A dwarf annual, about three to four inches high; hirsute and nearly scapoid. Leaves linear-lanceolate, incisely serrate. Involucrum in about three series, the outer resembling a caliculum, with the divisions ovate and acute, hirsute; the two inner series nearly equal in length, lanceolate, almost smooth. Rays five-toothed, exserted. Pappus softly pilose, white, very slender and scarcely hirsute; the stipe twice as long as the achenium; all the achenia abrupt at the summit, straw white; those of the exterior series truncated at the summit and inflated, so that the seed is seen free in the testa: these are without striatures, and almost without lines. The inner achenia are compressed, and have ten narrow sharply winged ribs.

*STYLOPAPPUS.

Capitulum many-flowered. Involucrum hemispherical or subcampanulate, of several series of nearly equal leaflets, calyculate; caliculum foliaceous, spreading, of several series, mostly resembling the true leaves. Liguli elongated. Branches of the stigma short, nearly smooth, and slenderly filiform. Receptacle naked. Achenia smooth, linear-lanceolate, somewhat compressed, sharply ten-ribbed; the outer series abortive, tabescent; the apex attenuated into a filiform rostrum about twice its length, the base with a callous cicatrice. Pappus short and white, of slender subscabrous hairs.—Perennials with long tap-roots and laciniated, incise or pinnatifid leaves. Stems scapoid, naked or bracteolate; the involucrum large, subtended at base by numerous large, and usually dissimilar bractes. Flowers yellow. Nearly allied to *Macrorhynchus,* but of a different habit, with conspicuous flowers; an abortive, external series, an involucrum of many leaves, and an achenium merely ribbed.—(The name alludes to the long stipe of the pappus.)

§. I. *Caliculum of many series, wholly leafy, dissimilar to the involucrum, which is hemispherical.*

Stylopappus * *grandiflorus;* nearly smooth, except the base of the stem, which is lanuginous; leaves lyrately pinnatifid, the terminal segment large and oblong-lanceolate; scape robust and grooved, bracteolate; involucrum hemispherical; caliculum squarrose, of many series of ovate, pubescent, toothed leaves; sepals linear-sublanceolate and smooth.

HAB. High plains of the Wahlamet. A very stout species, the capitulum larger than that of the Dandelion, containing very many flowers. Scape twelve to fourteen inches high, nearly as thick as a goose-quill, grooved. Leaves eight or nine inches long, very irregularly divided, attenuated into long petioles. The flower not seen. An external row of abortive achenia, nearly without striatures, and smooth; fertile achenium linear-lanceolate, narrow and acutely ten-ribbed, pale brown, the filiform stipe more than twice its length. Leaves often pubescent beneath, the inner surface of the broad leaves of the caliculum tomentose.

§. II. *Involucrum campanulate; divisions of the involucrum similar, the outer leafy and somewhat squarrose.*—TROXIMERIA.

Stylopappus * *laciniatus;* smooth or pubescent; leaves very irregularly and often deeply pinnatifid, the segments long and linear; scape naked, smooth; involucrum campanulate; leaves of the caliculum lanceolate, somewhat squarrose; stipe more than twice the length of the achenium, slenderly filiform. *β.* * *longifolius;* more pubescent, leaves very long and deeply divided; the caliculum leaf-like, longer than the involucrum, spreading, sometimes proliferous into true leaves.

Hab. Plains of the Wahlamet, near its estuary. With the habit of a Troximon. Flowers pale yellow. Scape six inches to a foot high. Sepals linear-lanceolate, smooth, the outer two series, for the most part, slightly pubescent. In β. the leaves are twelve to fourteen inches long, the scape two feet, with the involucel or caliculum squarrose, and sometimes several inches long.

Stylopappus **elatus;* smooth, the base of the scape pilose; leaves very irregularly and deeply pinnatifid, the segments long and linear; involucrum widely campanulate; leaves of the caliculum lanceolate, the lower series hirsute; stipe rather thick, a little more than the length of the elongated achenium.

Hab. With the above, which it closely resembles, but appears to be a larger plant, the scape from twelve to fourteen inches high; but the principal distinction is in the achenium, which is twice as large, with a much thicker stipe. The outer series of tabescent achenia are also pubescent, and there appears, likewise, to be another inner, abortive, smooth series. Flowers almost exactly like those of *Troximon glaucum.*

TROXIMON. (Nutt. Gen. Am., non Gærtner.)

Capitulum many-flowered. Involucrum imbricate, subcampanulate, divisions lanceolate, distinct, or united at base. Receptacle naked, punctate. Achenium subterete, with ten obtuse ribs, attenuated above into a somewhat similarly striated, and rather short, thick rostrum. Pappus copious, setaceous, persistent, widest at base, longer than the achenium, and scarcely scabrous. —Stemless perennials, with fusiform roots, and mostly entire, linear, smooth, sublanceolate leaves. Scapes terete, exserted, one-flowered; flowers yellow or rose-coloured. Obs. The only species of this genus known to Gærtner, *T. lanatum,* is now referred to *Scorzonera,* the name thus unoccupied may, therefore, still be retained for the American species.

† *Achenium terete, shortly rostrate, with obtuse ribs.*

Troximon glaucum. The involucrum is usually smooth, the divisions in about three series, the outer shorter, all of them lanceolate and acute.

Hab. On the plains of the Platte, and Missouri, about the Great Bend.

Troximon marginatum. The scape taller than in the preceding. Divisions of the involucrum in about two series, with the outer broader and as long as the inner, all of them linear-lanceolate. Achenium subcylindric, somewhat narrower at the summit, pale straw-colour, with ten obtuse ribs, the basal cicatrice minute, not a calosity. Pappus white and shining, coarse and rather bristly, scarcely in the least scabrous, thicker at the base, longer than the achenium.

HAB. With the above, to the Rocky Mountains.

*Troximon *pumilum;* leaves lanceolate or oblong-lanceolate, scarcely acute; scape but little longer than the leaves; involucrum campanulate; sepals numerous, in three or four nearly equal series, ovate-lanceolate, acute, pubescent, the inner linear, all divided to the base.

HAB. Plains of the Rocky Mountains, in Oregon. The only specimen I have seen is about four and a half inches high, the scape about an inch longer than the almost obtuse, smooth, and glaucous leaves. The sepals are unusually numerous, and nearly all of a length, the outer a little shorter. Allied to *T. glaucum*, but with the habit and leaves of *T. aurantiacum;* the involucrum wholly different from either.

*Troximon *taraxacifolium;* subhirsute; leaves lanceolate or oval-lanceolate, scarcely acute, incisely and runcinately dentate at base; involucrum of about two series of leaflets, the inner linear; achenium rostrately attenuated, the ribs shallow and slender.

HAB. Plains of the Wahlamet. But I have only seen it after flowering. A very distinct species, from the broadness of the leaves, which are one and a quarter inches wide, by about six inches long, attenuated at base, and most pubescent on the mid-rib. Scape rather short. Pappus very long and coarse, minutely scabrous.

† † *Achenium compressed, with ten shallow, acute ribs, and attenuated into a distinct rostrum, shorter than the long and bristly pappus. Involucrum ovate, in about three series of unequal, lanceolate sepals.*

*Troximon *parviflorum;* leaves linear-lanceolate, acuminate, smooth or pubescent, often runcinately denticulate towards the base; scape pubescent at the summit, lanuginous; sepals nearly smooth, in three unequal series, lanceolate, acuminate; flowers yellow.

HAB. On the plains of the Platte to the Rocky Mountains. About four or five inches high. The leaves about two lines wide, acuminated at each end. Pappus minutely scabrous; the outermost divisions of the involucrum only about half the length of the inner.

*Troximon *roseum;* leaves narrow lanceolate, runcinately pinnatifid, acuminate, the segments or teeth linear and acuminate; scape elongated, smooth, except the summit, which is lanuginous; sepals in about three unequal series, lanceolate, acuminate; flowers rose-colour.

HAB. With the above, which it wholly resembles, except the leaves, and red flowers; four to six inches high. Leaves three or four inches long, half to three-quarters of an inch wide, with narrow, curving, and mostly runcinate teeth or segments. Achenium distinctly rostrate, rather flat, with shallow, acute ribs, nearly as long as the coarse, white and bristly, scarcely scabrous pappus.

*MALACOMERIS.

Capitulum many-flowered. Involucrum widely campanulate, loosely imbricate in about two nearly equal series, irregularly bracteolate or caliculate at the base; the segments smooth, linear, nerveless, and membranaceous on the margin. Receptacle naked. Anthers bisetose at base. Achenium oblong, erostrate, truncate, somewhat pentagonal, with about fifteen very slender striæ. Pappus white, in several series, slenderly pilose, deciduous, long, and somewhat barbellated towards the base.—A suffruticose, softly tomentose, and canescent plant of Upper California. Leaves pinnatifid with few linear segments; stem short, above scapoid, one to three-flowered; flowers rather large and yellow. (The name is given in allusion to the soft pubescence.)

*Malacomeris *incanus.*

HAB. St. Diego, on an island in the bay. Suffruticose and decumbent, base of the branches woody. Radical leaves in tufts, whitely and softly tomentose; primary leaves smoother, all more or less pinnatifid and linear, with very few segments, the summit trifid; scape or stem rising two or three inches above the leaves, one to three-flowered, towards the summit becoming smoother, with numerous, smooth, ovate bractes, six or eight of which form a sort of caliculum. Involucrum smooth, the segments numerous, linear and partly acute, all of them of equal height. Florets very numerous and exserted, pubescent on the tube. Stigmas nearly smooth, slender, and but little exserted. Pappus three or four times longer than the short, smooth achenium. The fruit somewhat like that of *Hieracium,* but not ribbed, and the involucrum and habit of the plant that of *Troximon.*

BARKHAUSIA. (Mœnch.)

Barkhausia elegans. Crepis elegans, HOOKER, Flor. Bor. Am., Vol. I., p. 297. Scarcely distinct from *B. nana,* which appears like a dwarf growth of this species.

*CREPIDIUM.

Capitulum many-flowered. Involucrum double, the inner of a single series of leaflets, (about twelve,) the outer short and caliculiform. Receptacle naked. Achenia linear-oblong, subpentangular, erostrate, truncate at the summit, marked with ten somewhat elevated ribs. Pappus pilose, white and slender, in two or three series, slightly barbellate, about the length of the achenium. —Perennials, with the habit of *Hieracium*, as well as that of *Crepis*. Leaves runcinately toothed, scapoid stems corymbose, branching. Flowers yellow. —(The name alludes to the affinity with *Crepis*.)

Crepidium **runcinatum*; smooth; leaves oblong-lanceolate, runcinately and incisely toothed, acute; scape branching, corymbose, few-flowered; involucrum pubescent, the segments acuminate. *Crepis biennis*, Hooker, (according to a specimen from the author,) not of Linnæus. It differs from the present, how ever, in having somewhat hirsute leaves, and less deeply toothed.

Hab. On the grassy plains of the Platte, in subsaline soils. Scape about a foot high, with seven to nine capituli, and a linear bracte at the base of each pedicel, as well as at the base of the bifurcation of the stem. Leaves much like those of the Dandelion, but less divided, green, and somewhat fleshy. Involucel about eight-leaved.

*Crepidium *glaucum*; smooth and glaucous; leaves spathulate-lanceolate or obovate, runcinately and incisely toothed, acute, attenuated below, but rather broad to the base; scape smooth, divaricately branched, with minute bractes; capituli small; involucrum smooth, the segments linear and somewhat obtuse.

Hab. With the above, but less common; every where very smooth, the leaves much larger than in the preceding, half a foot long, and one to one and a half inches wide, sometimes nearly entire, rather thick and succulent. The scape twice forked, or more; about three flowers together at the summits of the branches, not half the size of those of the preceding. Scape eighteen inches to two feet high, terete and almost entirely naked, all the bractes being minute and subulate. Involucrum of about twelve linear leaves; involucel minute, of about eight lanceolate leaflets. Style and stigmas very long and filiform, slightly pubescent.

*Crepidium *caulescens*; very smooth, but not glaucous; leaves spathulate-lanceolate or oval-lanceolate, runcinately incise toothed and acute; stem scapoid, naked, dichotomously branched, with a conspicuous toothed leaf at the base of the first division; involucrum smooth, the segments lanceolate-oblong.

Hab. With the above, of which I, at first, took it for a mere variety; but the presence of a true stem, though short, and the form of the sepals, distinguish it.

CREPIS. (Mœnch, Decand.)

§. *Leptotheca.—Involucrum cylindric, leaflets linear in a single series, (five to eight;) involucel of three to five minute bractes; florets five to eight. Achenium attenuated into a short, indistinct rostrum, similar with itself.—Perennial. Stems scapoid, dichotomous, corymbose. Leaves runcinately pinnatifid; stem leaves linear, entire.—In habit allied to *Prenanthes*.

*Crepis * acuminata;* ♃, stem smooth, above angular and paniculate; branches corymbose, naked, many-flowered; leaves runcinately pinnatifid, acuminate, pubescent; segments sublanceolate, sparingly laciniate, below attenuated into a petiole; upper stem leaves linear, entire; involucrum smooth; involucel appressed, pubescent.

Hab. Plains of the Platte. About a foot high. Root long, black, and fusiform. Radical leaves about six inches long, with a lanceolate outline, one and a half to two inches wide in the middle, more or less pubescent on both surfaces. Flowers numerous and showy, bright yellow, with exserted five-toothed liguli. Style and stigma exserted and hirsute. Receptacle scrobiculate. Pappus copious, white and soft, a little barbellated. Central achenia longest, all ten striate, the rostrum short and thick. *C. elegans* approaches this species in the involucrum, which is quite similar; but the achenium is furnished with a long slender rostrum, which places it, artificially enough, in the genus Barkhausia. It has also all the habit, as well as great affinity with *Barkhausia tenuifolia* of Siberia.

* PSILOCHENIA.

Crepis, but with the achenium cylindric, curved, narrower above, and without any visible striæ, the testa indurated, and, when mature, black; an abortive outer series of florets, with the achenium empty. Pappus copious, slenderly pilose, scabrous, and yellowish white, about the length of the achenium. Receptacle naked, alveolate, the alveoles minutely fringed.—A low perennial herb; stem dichotomous and corymbose. Leaves lanceolate, runcinately pinnatifid, and, as well as the somewhat hirsute involucrum, cinereously and closely lanuginous; flowers yellow, rather large.

*Psilochenia * occidentalis. Crepis occidentalis,* Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII., p. 29.

Hab. On the plains of the Platte, towards the Rocky Mountains. The whole plant more or less canescently pubescent. Stem about six or seven inches high, forked and corymbose at the summit. Leaves about an inch wide, four or five inches long, deeply and runcinately pinnatifid, the segments linear-lanceolate and denticulate, uppermost leaves linear. Involucrum campanulate; sepals about twelve to fifteen in a single series, linear and somewhat acute; involucel or bractes four or five, small and subulate: there are blackish hairs mixed with the hoary pubescence of the sepals. Florets about twelve, yellow, exserted.

SONCHUS. (Cassini, Decand.)

Sonchus fallax? *β. *Californicus.*

HAB. In Upper California, around St. Diego. Dentures of the leaves, which are pinnatifid, deep and pungently spinulose; achenium smooth and even, elliptic, *alated*, puberulous on the margin. Probably a distinct species, though so similar to the present as not to be distinguishable, except by the pungency and length of the marginal spines, and the alated achenia.

*Sonchus *tenuifolius;* ⊙, smooth; leaves bipinnatifid and pinnatifid, auriculate at the base; segments few, linear-lanceolate, spinulosely serrulate, the upper simply pinnatifid, with linear, subulate segments; involucrum caliculate, smooth; achenium substriate, transversely rugose.

HAB. In Upper California, round St. Diego, in shady ravines, among rocks. A very distinct species. Primary divisions of the leaves, when bipinnatifid, with a single pair of segments, central or terminal segments usually elongated and acuminate; divisions of the lower leaves obtuse. Involucrum scarcely tumid. Stem slender, about two feet high. Leaves three or four inches long, of a very thin consistence, as in *S. tenerrimus.*

Subtribe *ANDRYALEÆ.

Receptacle naked or fimbriliferous, sometimes with the margin paleaceous. Pappus white, usually double, the inner deciduous, filiform, barbellate towards the base, where it adheres in a circle, the outer a minute paleaceous crown. Achenium erostrate, striate, angular or cylindric.

ANDRYALA *Ragusina, A. varia, A. sinuata, A. integrifolia,* and probably other species. In these, except the first, the outer pappus is obscure, and the salient summits of the ribs of the achenium resemble the outer pappus: these, with a very deciduous and much less barbellated pappus, &c., ought to be restored to the genus VOIGHTIA, of Roth.

*LEPTOSERIS.

Capitulum many-flowered, (forty, or more.) Involucrum campanulate, caliculate; sepals distinct to the base, linear-lanceolate, in a single equal series, the margin membranaceous; caliculum small, of about eight unequal bractes. Receptacle naked. Achenium finely striate, somewhat attenuated above, and partly quadrangular. Pappus double, the outer a very minute paleaceous crown; the inner in a single series, white, pilose and soft, slenderly bearded towards the base, and connected together in a circle, which is quickly deciduous in the mass.—An elegant, smooth, dwarf annual, from the plains of the Platte, with several scapoid, somewhat corymbiferous stems. Leaves nearly all radical, pinnatifid, or runcinate, with the segments short and spinulosely denticulate, in the manner of the Sow Thistle. Flowers yellow and conspicuous.

Leptoseris * *Sonchoides.* ⊙.

Hab. The plains of the Platte. Flowering in June. Four or five inches high, with a slender, simple, whitish tap-root. Leaves about two inches long and half an inch wide, resembling those of a diminutive Sow-thistle, the lateral segments short, oblong and acute; stems three or four, rather naked, branching from below, or only from above, producing an imperfect corymb of three to four capituli. Sepals about twelve to fifteen, one-nerved, pale green, with broad whitish margins; caliculum similar, but very short; the scales ovate. The florets minutely toothed, bright yellow, exserted, about the length of the involucrum. Stem leaves small and few. Stigmas filiform, exserted and nearly smooth. Achenium pale straw-yellow, linear, much resembling the fruit of a *Crepis*, but angular, though less so in the centre of the capitulum. Pappus deciduous, like that of the Thistle, in a sort of ring, or rather circle of adherence, there being no true annular receptacle. Flowers at first nodding. This curious plant appears almost intermediate with *Sonchus* and *Crepis*, but with the former it only agrees in habit.

* LEUCOSERIS.

Capitulum many-flowered. Involucrum broadly campanulate, involucellate; sepals distinct to the base, imbricated in one or two series, subequal, linear, acute, membranaceous on the margin; involucel in two or three series, subsquarrose, shorter than the involucrum. Receptacle convex, naked. Florets deeply five-cleft at the summit, the tube hirsute. Anthers bisetose at base. Achenium short, unequally pentangular, truncate, five-ribbed, the sides with one or two intermediate striæ in each; the basal cicatrice four-lobed. Pappus double, the outer a very minute paleaceous crown; the inner in a single series, white, pilose and soft, slenderly bearded towards the base, and connected together in a circle, which is quickly deciduous in the mass. —Perennial plants of Upper California, with erect, or low, decumbent, spreading stems. Leaves entire, laciniated, or pinnatifid. Branches leafy, one or two-flowered; flowers large and white. Allied to *Leptoseris*, but with a widely different aspect, and much more compound capitulum, &c. Also to *Andryala varia* in the pappus, and in the presence of an outer, paleaceous, minute crown; but wholly distinct in habit, pubescence, colour of the flower and achenium, which last, in *Andryala*, is cylindric and ten-ribbed; the whole, however, form a very natural group, with its usual gradations of form.—(The name is given in allusion to the remarkable colour of the flowers.)

Leucoseris * *saxatilis;* stem leafy and decumbent; leaves oblong or linear-oblong, amplexicaule and auriculate; the radical lanceolate, subserrate, beneath hirsute; lower leaves now and then irregularly cleft, or somewhat pinnatifid towards the base; flowers large and white.

Hab. St. Barbara, on shelving rocks near the sea. Flowering in April. A large spreading perennial, with terete, hollow stems, spreading out in a circle of one and a half to two feet. The leaves are rather thick and somewhat succulent, two to three inches long, by about half an inch wide; the young shoots pubescent. Flowers fastigiate, pure white, as large as those of the Dandelion. Florets one hundred, or more, in a capitulum, ligulate, flat, deeply cleft at the summit, the segments obtuse and glandular, the tube very hairy. Style and stigmas slenderly filiform, exserted, nearly smooth: pedicel enlarging towards the base of the capitulum. Involucrum smooth, of many equal, linear segments, in about two series; caliculum somewhat squarrose, imbricated in two or three series, the segments lanceolate, acuminate. Receptacle wide and convex, merely punctate. Achenium dark brown, very short, obtuse at each end; the pappus pure white and silky, about three times the length of the fruit, softly barbellated towards, and at the base, collected into a single series of about thirty rays.

Leucoseris * *tenuifolia;* suffruticose and smooth, erect and branching; leaves sessile, laciniately pinnatifid, segments narrow, long and linear, upper ones entire, filiform; capituli few, corymbose.

Hab. St. Barbara, on the mountains near the town. The expanded flower and fruit I have not seen, and I only place this plant here by its approximating habit. Two or three feet high, having a considerable woody base. Involucrum and involucellum as in the preceding, but the segments narrower and more acuminate.

Leucoseris? Californicus. Hieracium? Californicum, Decand., Vol. VII., p. 235. From the remark that "the pappus is *white*, fragile, and in a *single* series," I conjecture this may be a species of the present genus. The author also imagines that it may belong to a new genus. The flowers have probably been white, as he says they are purplish beneath.—Collected in Upper California by Mr. Douglas. It is described as smooth, with the stem erect, striated, the summit paniculate, the branches bracteolate and monocephalous; the leaves sessile, sublanceolate-linear, acuminate, entire; the scales of the involucrum linear and imbricated. The mature fruit was not seen.

Obs. This genus, nearly allied to *Andryala*, is distinguished by the free leaves of the involucrum, which are not at all ingrafted; by the presence of a copious, imbricated involucellum; a convex receptacle, wholly naked; a pentangular achenium, white flowers, and a pubescence which is not stellated or glandular. On the other hand, the mode of growth is similar, the form of the involucrum, as well as the singular character of the pappus, and general form and striatures of the fruit. Under *A. Cheiranthifolia*, L'Heritier has well described the pappus of that species as pilose and *pubescent* at the base: the rays are about eighteen.

Subtribe viii. Hieracieæ. (Lessing.)

MULGEDIUM. (Cassini.)

† *Flowers blue, the substance of the achenium attenuated into a long point.*

Mulgedium pulchellum. Sonchus pulchellus, Pursh. *Lactuca integrifolia*, Nutt. Gen. Am., Vol. II., p. 124. *Lactuca pulchella*, Decand., Vol. VII., p. 134.

*Mulgedium *heterophyllum;* leaves linear-lanceolate or oblong-lanceolate, the lower ones often runcinately pinnatifid or toothed towards the base; panicle divaricate, squamose; involucrum conic-ovate, the segments lanceolate in three or four series, and very unequal; flowers blue; achenium with a distinct rostrum, of the same substance with the striated achenium. *Sonchus Sibiricus*, Hooker, Flor. Bor. Am., Vol. I., p. 293, not of Linn.

Hab. Lake Huron, and Canada, to latitude 66°. (Hooker.) On the Rocky Mountain plains, and the banks of the Oregon, in the interior. Entirely unlike *M. Sibiricum*, which is annual;

ours a stout perennial, with large deeply penetrating roots; very smooth and sometimes glaucous; the panicle spreading, not racemose. Flowers as large and showy as those of *Cichorium Intybus*. Nearly allied to the preceding, which, however, appears to have different leaves, but with the fruit very similar.

† † *Flowers blue or white; achenium shortly acuminate.*

Mulgedium acuminatum. *Sonchus acuminatus*, Willd. Achenium pale and spotted, with a tumid margin and two or three striæ on either side.

*Mulgedium *divaricatum;* branch leaves sessile, somewhat runcinately pinnatifid with wide and shallow denticulated segments; panicle divaricate, naked; involucrum subcampanulate, caliculate; achenium with a short, conformable rostrum, transversely rugulose, with about three elevated central striæ on either side; pappus white.

Hab. Louisiana. (Mr. Trudeau.) The flower appears to have been blue or white; segments of the caliculum lanceolate. Bractes of the very divaricate panicle minute, distant, and subulate. Apparently a very distinct and genuine species of the present genus.

§. Leucomela.—*With the pappus gray; florets nearly half way tubular; anthers bisetose at the base. Achenium transversely rugose, merely attenuated at the summit, with three ribs on one side and four or five on the other; flowers white, with a tinge of purple.*

Mulgedium leucophæum, Decand., Vol. VII., p. 250.

*GALATHENIUM.

(*Lactuca* and *Mulgedium* species of authors.)

Mulgedium, but with the achenium elliptic and flatly compressed, transversely rugulose, with a broad and thin opaque margin, the centre on either side marked with one to three slender striæ; the rostrum distinct, abrupt, shorter than the achenium, ending in a circular disk with a pubescent margin. Pappus white, slender and slightly scabrous, in several series.—North American plants, usually perennial, with the habit of Lactuca or Sonchus; the flowers yellow or blue; the achenium black.—(The name from γαλαθηνος, *milky*, in allusion to the milky properties of the plants, and also their alliance with *Lactuca*.)

† *Flowers blue, or bluish-white.*

Galathenium macrophyllum. *Sonchus macrophyllus,* WILLD. *Mulgedium macrophyllum,* DECAND., Vol. VII., p. 248.

Galathenium multiflorum. *Mulgedium multiflorum,* DECAND.. Vol. VII., p. 249. Perhaps too nearly allied to the following.

Galathenium Floridanum. *Sonchus Floridanus,* LINN. *Mulgedium Floridanum,* DECAND., ib., p. 249. Achenium scarcely striated.

*Galathenium *salicifolium;* ♃, very smooth; stem simple and terete; leaves entire, lanceolate or linear-lanceolate, much acuminate, sessile, lower ones repandly dentate; panicle contracted, racemose, bracteate; achenium elliptic, acute, with a single nerve on either side, the stipe nearly the length of the fruit.

HAB. In West Florida. (Mr. Ware.) Bethlehem, Pennsylvania and Salem, North Carolina. (Herb. Schweinitz.) The flower appears to have been pale blue or white. Leaves three to four inches long, by half an inch wide, entire, or now and then with a slight denticulation, but nothing down to the root like dentation or division of any kind, (in the three perfect specimens before me.) Uppermost leaves diminishing to bractes with long filiform acuminations. Flowers crowded, on short bracteolate pedicels in the Florida specimen, the flowers racemose, and rather distant.

Galathenium graminifolium. *Lactuca graminifolia,* MICH., Flor. Bor. Am., Vol. II., p. 85. Stem leaves entire, sagittate at base. Achenium elliptic-lanceolate, dark brown, with one striature on a side only, the stipe nearly as long as the fruit. Panicle divaricate, naked and dichotomous. Radical and lower stem leaves more or less runcinate.

† † *Flowers yellow.*

Galathenium elongatum. *Lactuca elongata,* MUHL. in WILLD., Vol. III., p. 1525. Achenium brown, one-nerved in the centre, the rostrum shorter than the fruit.

Galathenium integrifolium. *Lactuca integrifolia,* BIGEL. Flor. Bost. *Lactuca sagittifolia,* ELLIOTT, Sketch, Vol. II., p. 253. Leaves sometimes denticulate; achenium black, with a distinct, pale coloured rostrum two-thirds of its length, with only a single striature on a side.

Galathenium sanguineum. *Lactuca sanguinea,* Bigel. Flor. Bost., (ed. 2,) p. 287. Leaves very often nearly all entire, or only runcinately toothed; achenium one-nerved, black.

Galathenium ludovicianum. *Sonchus ludovicianus,* Nutt. Gen. Am., Vol. II., p. 125.

Obs. The plants of this genus (peculiarly North American) appear to be intermediate between Lactuca and Mulgedium. From Lactuca they differ wholly in the achenium, which, in *L. sativa* and others, is of a pale colour, and covered with longitudinal striatures. In *Lactuca perennis,* however, the striatures are few, and the achenia has a tumid margin, as in Mulgedium, but it is also furnished with a very long rostrum. From *Mulgedium* our plants differ in the form, compression, colour, and margin of the achenium, as well as in the presence of an abrupt and distinct rostrum, seldom, if ever, the length of the elliptic fruit, and of a different colour and consistence with the achenium.

LYGODESMIA. (Don.)

Subgenus *Pleiacanthus.—Capitulum four to five-flowered. Involucrum cylindric-ovate, imbricate, of a few unequal, flat, lanceolate sepals, the external so short as to appear like a caliculum. Receptacle minute, naked. Achenium subcylindric, obtusely five-ribbed, truncated. Pappus bristly and barbellate, yellowish-white, long, and in several series.—A nearly leafless, divaricately branched, rigidly spiny perennial, with rose-red flowers in short racemes. Probably a distinct genus.

*Lygodesmia *spinosa;* stem divaricate; branchlets spinescent, microphyllous; capituli subracemose, with an irregular involucellum.

Hab. In the Rocky Mountain plains towards California. About eight to fourteen inches high. Lower leaves linear, entire, sessile, rather thick; upper leaves and those on the spiny branchlets minute, like very small bractes. Stem divaricate and spreading, the base somewhat pubescent and producing remarkably large tufts of brownish matted down; the bud scales broad ovate. Flowers pedicellate, in racemes. Every branch and twig ends in a spiny point. Larger leaves of the involucrum three or four, ovate, or ovate-lanceolate, three or four smaller ones at the base of the involucrum. Florets rose-red, deeply five-cleft at the summit. Stigmas filiform, exserted, pubescent. Pappus rigid and barbellate.

*ERYTHREMIA.

Capitulum about ten-flowered. Involucrum subcylindric, caliculate; sepals about eight, in a single series. Receptacle naked. Achenium short, subcylindric, erostrate, ten?-striate or ten-ribbed. Pappus exceedingly copious and long, barbellate towards the base, nearly simple, and more slender above. Style and branches of the stigma exserted beyond the anthers, very hirsute, the stigmas acuminate, sublanceolate or clavellate.—Perennials, with low, few-flowered stems, naked or foliaceous towards the base, with long, linear, fleshy, entire leaves, almost all radical. Capituli with rose-red flowers. Allied to *Lygodesmia*, but with a different achenium and pappus, and a more compound capitulum; also to *Nabalus*, but with a widely different habit and different achenium.—(The name is derived from ερυθρημα, *redness;* in allusion to the colour of the flowers.)

Erythremia **grandiflora;* leaves long and linear, acuminate; stem scarcely exserted beyond the leaves, forked, with two or three capituli.

HAB. In the Rocky Mountain range, on the borders of the Platte. Root large, tuberous or tap-shaped and descending; very milky and bitter. Leaves chiefly radical, or at the base of the stem, linear, entire and acuminate, glaucous or pale green, two to four inches long, half a line to a line wide, usually curved or spreading, of a thick and fleshy consistence. Stem three or four from the root crown, forked, having two or three capituli. Stem three to seven inches high: a large leaf at the first division, on the upper part of the stem shorter, or mere bractes as they approach the flower. Caliculum of about five, very short, ovate, lacerately ciliate leaflets. Involucrum of eight equal, linear-oblong, flat leaves, pubescent at the summits, somewhat obtuse, membranous on the margin, with a single faint nerve in the centre. Florets about ten, fine rose-red, and exserted beyond the involucrum, about its length, flat and five-toothed at the extremity. Style and stigmas very much exserted, and very hirsute; no awns or obscure ones at the base of the anthers. Pappus yellowish-white, in a crowded and numerous series, twice or three times the length of the achenium, the rays thicker and more serrated or barbellated towards the base. Receptacle punctate. The ripe fruit is unknown, but it appears to have about double the number of ribs there are in Lygodesmia. In *Lygodesmia juncea*, the stigmas only are exserted and slenderly filiform, and the pappus appears almost perfectly simple, or without any serratures. In both these genera, as well as in *Nabalus*, the anthers are bisetose at base.

Erythremia aphylla; radical leaves linear? stem dichotomous, striate, nearly leafless, with three to five capituli; stigmas clavate; anthers distinctly bisetose. *Prenanthes aphylla*, Nutt. Gen. Am., Vol. II., p. 123. *Lygodesmia? aphylla*, Decand, Vol. VII., p. 198.

Hab. Discovered on the Island of St. Marys, in Georgia, by Dr. Baldwyn. Stem twelve to eighteen inches high. Involucrum, caliculum, and florets, as well as their colour, exactly as in the preceding; the pappus, however, is scarcely more than scabrous. Lower part of the stem with one or two leaves.

HIERACIUM. (Linn.)

Hieracium *marianum*. Obs. This species is very nearly allied to *H. scabrum*, but is well distinguished by the achenium, which is attenuated above, and so far rostrate as to be precisely that of Crepis!

Hieracium barbatum, (Nutt. in Journ. Acad. Nat. Sci. Philad., Vol. VII.) This species also inhabits the western plains as far as the Rocky Mountains. The achenium, as in the preceding, is attenuated above, but not so much as in the preceding.

*Hieracium *macranthum;* nearly smooth and green; stem erect and simple, corymbosely branched at the summit; leaves numerous, sessile, linear-lanceolate or lanceolate, incisely and irregularly serrate, acute, scabrous on the margin; peduncles pubescent; involucrum blackish, but nearly smooth; sepals lanceolate, imbricate in about three series, appressed; achenium nearly black and truncated. *H. umbellatum*, Hooker, Flor. Bor. Am., Vol. I., p. 300.

Hab. In the forests of Oregon, near the Wahlamet. Nearly allied to *H. Canadense*, and still more nearly to *H. umbellatum*. Pubescence very sparing, stellate. The involucrum never squarrose. From two to three feet high, and sometimes robust, with the leaves narrower; when slender, with the leaves broader. Perhaps not sufficiently distinct from *H. umbellatum;* the leaves, however, are more gen ally serrate, and never so narrow.

Hieracium Scouleri.

Hab. Common near the Wahlamet. Considerably allied to some varieties of *H. Gronovii.*

Hieracium albiflorum.

Hab. Common round Fort Vancouver, on the Oregon, in shady woods, where it attains the height of two to three feet. The stem is rigidly erect, and smooth to a few inches from the root, where it presents long hairs like *H. Gronovii*, to which it is undoubtedly allied, and yet as certainly *white*-flowered. Upper part of the stem almost naked, paniculate, the branchlets corymbose and few-flowered. The involucrum of about two series, and slightly bracteolate. The flowers about the size of those of *H. Gronovii*. Achenium dark brown, slender, but truncated, striate and angular, as usual. Pappus scabrous, brittle, yellowish-white. The radical and lower leaves are for the most part repandly dentate, the teeth shallow and rather distant.

*Hieracium * argutum;* leaves and base of the stem clothed with long deflected hairs; stem smooth, paniculate, the branches divaricate, with long, naked and smooth pedicels; leaves oblong, or oblong-lanceolate, all incisely and sharply dentate, acute, the cauline sessile and few; involucrum small, slightly bracteolate, smooth and blackish-green, of very few sepals in about two series; pappus *gray* and scabrous; achenium brown, and truncate as usual; flowers white?

HAB. In St. Barbara, Upper California. The only specimen I have collected is about twelve to fifteen inches high. The lower leaves three to five inches long, three-quarters to an inch wide, marked beneath with a strong mid-rib. The smoothness of all the upper part of the stem is remarkable: the achenium rather slender, and striated, as usual. The gray colour of the pappus is very peculiar.

APPENDIX.

Subtribe Hyoserideæ. (After *Hyoseris.*)

*CALODONTA.

Capitulum many-flowered. Involucrum imbricate in nearly a simple series, the sepals linear, subcaliculate, or bracteolate. Receptacle naked, convex. Achenium turbinate, cylindric, smooth, slightly striate. Pappus of about ten to twelve entire, slender bristles, dilated at base, with short setæ interposed between them.—A perennial, evergreen plant of the Azores, with oval, amplexicaule, pinnately nerved, elegant, incisely dentate, smooth leaves. Flowers subcorymbose, pedicellate, rather large and yellow.—(The name alludes to the elegant toothing of the leaves.)

Calodonta **Azorica.*

Hab. In the Island of Fayal; in the Caldera and ravines adjoining. Root perennial, sending up several subdecumbent stems, about a foot long. Leaves broadish-oval and acute, amplexicaule, smooth and somewhat lucid, deeply and very elegantly serrated, almost like the leaves of a Holly, but with the serratures more numerous. Stem pubescent, somewhat tomentose. Branches spreading, one or two-flowered, the flowers terminal and fastigiate, in three or five, forming a sort of loose corymb. Involucrum nearly smooth, sepals about fifteen, linear-lanceolate, nearly all equal; bractes subulate, at the summit of the pedicels, and also forming a caliculum. Rays longer than the involucrum, five-toothed, the tube hirsute. Style and stigma exserted, nearly smooth and very slender. Achenium small, pale, testaceous, smooth, with about five broad, and almost even striatures. Pappus more than twice the length of the achenium; the hairs almost perfectly simple, dilated at the base, the dilated portion very short and somewhat lacerate: between each hair are two or three minute ones, appearing like an outer crown of pappus, but the hairs of which it consists are alternately intercalated and not external.

Tribe Eupatoriaceæ.

*HELOGYNE.

Capitulum homogamous, many-flowered. Involucrum subcampanulate, imbricate; sepals foliaceous, unequal, about eight, the inner scariose. Receptacle naked. Corolla tubular, equal, glandular, the apex shortly five-toothed and closed. Branches of the stigma connivent, clavate, very large, obtusely rounded, exserted, smooth and glutinous. Achenium slenderly obconic, pentangular, smooth, with a basilar cicatrice. Pappus plumose, short, about the length of the achenium; the rays about twenty.—An annual? plant of Peru, hirsutely pubescent and glandular. Leaves alternate, cuneate-oblong, sessile, entire, or toothed at the apex. Capituli terminal, sessile. Flowers whitish, or ochroleucous. It appears to have some affinity with *Agrianthus*, but the aspect of the involucrum is that of *Apalus*. It is bitter to the taste.—(The name from ηλος, *a nail*, or *stud*, and γυνη, *a female;* in allusion to the remarkable form of the stigma.)

Helogyne **Apaloidea.*

Hab. In Peru, towards Arequipa; (Mr. Curson.) My specimen is only a branch, covered, as well as the leaves, with short scaly hairs, more or less glutinous: many of the leaves are entire, a few of the larger have a blunt tooth on either side, towards the summit. Capituli fastigiate, terminal, and sessile, rather large, about twelve-flowered. Involucrum of about eight leaves, four or five larger, external, oblong, or oblong-ovate, very similar to the leaves, and equally pubescent, the inner narrower and scariose or membranous, all rather obtuse. Receptacle small. Corolla slenderly and equally tubular, glandular, about twice the length of the pappus; the teeth of the border very shallow and obtuse. Anthers small and closely included, not bisetose. Stigmas very large and conspicuous, brownish and glutinous, the extremities rounded in a clavate form, each summit wider than the whole corolla.

Tribe ASTEROIDEÆ.

Subtribe Baccharideæ.—Division Conyzeæ.

*PARASTREPHIA.

Capitulum many-flowered, heterogamous; the radial five-toothed tubular florets masculine! discal florets filiform, oblique, two-toothed, feminine. Stigmas equally filiform, exserted. Involucrum imbricated in about two series; sepals linear, membranaceous on the margin. Receptacle naked. Anthers not bisetose. Achenium compressed, linear, acute at base, villous. Pappus of the radial masculine florets double, the outer paleaceous, entire, acute and elongated, the inner of a single series of scabrous hairs; pappus of the discal florets simple, pilose and scabrous, in several series.—Apparently a small acerose leaved, evergreen shrub of Peru, resembling a Heath. Leaves linear, obtuse, narrow and short, adnately revolute to the centre. Flowers yellow? aggregated at the summit of the branches, sessile, and surrounded by the imbricated leaves.—(The name is derived from παραστρεφω, *to invert;* in allusion to the singular inversion of the florets, the masculine being external! in place of the usual order of internal.)

Parastrephia * *ericoides.*

Hab. In Peru, near Arequipa; (Mr. Curson.) In sandy soil. Leaves and stem quite similar to those of *Ceratiola ericoides*; the branches terete and tomentose; the leaves approximate, acerose, short and spreading, in about four rows, smooth and glutinous, bitter to the taste, about two lines long, and half a line wide, on the young shoots inbricated as in *Abies*. Involucrum sessile, the scales scariose on the margins, linear-oblong, nearly smooth. Pappus copious, as long as the florets, unequal and scabrous, rather rigid: the outer paleaceous pappus of the male flowers nearly half the length of the inner pilose hairs, subulate, white and shining, much longer than in any *Chrysopsis*. Achenium somewhat villous and compressed, linear-fusiform, almost exactly like that of *Aster*. In fact, our plant, notwithstanding its present arrangement, is nearly allied to *Chrysocoma* or *Lynosyris*, of which it has entirely the habit. The female florets are very slender and without any vestige of stamens; the style is also abortive in the male flowers of the ray. The florets of each kind are nearly equal in number; the female probably somewhat more numerous. (My specimens are mere sprigs, and I am, therefore unacquainted with the habit of this curious plant.)

Tribe *SENECIONIDEÆ.*—Division Heliopsideæ.

*MICROCHÆTA. (Lipochæta and Wollastonia, *Decand.* in part.)

Capitulum many-flowered, radiate; rays in one series, feminine. Discal florets hermaphrodite, five-toothed. Involucrum hemispherical or subcampanulate, the sepals foliaceous in two nearly equal series. Receptacle convex, paleaceous, the paleæ membranaceous and folded. Branches of the discal styles acutely acuminate, as well as those of the ray. Fertile achenia triquetrous, or obtusely quadrangular, indurated, subalated and scabrous; infertile or tabescent, compressed and linear. Pappus a short, persistent, or somewhat deciduous crown of two or three to five unequal, or nearly equal, short, acute paleæ, longer and fewer in the infertile fruit.—Suffruticose or herbaceous plants, chiefly of the Sandwich Islands and Australasia, with opposite, ovate, dentate or incisely lobed leaves; flowers terminal, or subumbellate, pedunculate, yellow. In habit allied to *Wedelia* and *Wollastonia*. With a different involucrum, achenium, receptacle and pappus from *Lipochæta umbellata*, with which I have compared our plants.

Microchæta lobata; β. hastulata. Lipochæta hastulata, DECAND., Vol. V., p. 611. *Verbesina hastulata*, HOOK. and ARNOTT, Bot. Beechy, p. 87.

HAB. In the island of Ouau and Atooi. A low suffruticose plant, with the leaves more or less lobed, sometimes nearly entire. Pappus of the tabescent florets (in an early stage,) with two awns, much shorter than the fruit, connected with a membranous, lacerate, minute cup. Involucrum subcampanulate, in almost a single series of broad ovate, leafy sepals. Rays about ten. Capituli sometimes solitary. Leaves ovate, or ovate-lanceolate, somewhat acuminate, the base often incisely one or two-lobed on either side; the short petioles connate at base.

*Microchæta *lanceolata;* herbaceous; stem angular, decumbent, dichotomous; leaves shortly petiolate, lanceolate or ovate-lanceolate, scabrous and strigose, entire and very acute, distantly serrate, the serratures shallow, appressed and mucronate; uppermost leaves alternate; peduncles solitary, dichotomal or terminal, in twos and threes; involucrum rather flat and hemispherical; rays short and numerous.

HAB. In Ouau, near the sea. Branches long and trailing, prostrate and ascending: the leaves three-nerved, attenuated into a short petiole. Pedicels elongated, naked; sepals ovate, strigosely hirsute, ten, in about two equal series. Rays as short as the involucrum, about twenty. Paleæ of the receptacle ovate above, hirsute, often three-toothed. Fertile achenium oval, turgid, triquetrious and scabrous, with salient angles. Pappus a small persistent crown of three to five minute paleæ united in the centre of the contracted summit into a sort of cup: in the tabescent achenia (which are very numerous,) the fruit is narrow-linear, with the paleæ arising, as it were, from the angles.

Microchæta? lavarum. Lipochæta lavarum, DECAND., Vol. V., p. 611.

Microchæta succulenta. Lipochæta succulenta, DECAND., ibid.

*Microchæta *integrifolia;* herbaceous and prostrate; canescently strigose with appressed hairs; leaves approximate, spathulate-oblong, small and entire, thick and somewhat succulent, three-nerved below; sepals oval, obtuse; peduncles solitary, one-flowered; rays short, about eight.

HAB. Near the sea, at Ouau and Atooi. Stems diffuse, procumbent, many from the same perennial tortuous root, each spreading out a foot or more, in all directions. Leaves about half an inch long, two or three lines wide, strongly nerved beneath, thick and somewhat succulent, pedicels two or three inches long. Capituli small, with the sepals obtuse. Scales of the receptacle obtuse, and hirsute at the tips as well as the florets. Fertile achenia short, roundish and angularly triquetrous, pubescent at the summit. Pappus rather deciduous, of three or four short linear, or linear-lanceolate scales of different sizes, all scarcely visible to the naked eye; tabescent achenia, which are numerous, compressed: some of the fertile ones are also often obtusely tetragonal.

Microchæta procumbens. *Wollastonia procumbens*, DECAND., Vol. V., p. 548. Very nearly allied to *M. lanceolata*, differing principally in the coarsely toothed, sessile leaves, and smooth achenium.

Microchæta strigulosa. *Wollastonia strigulosa*, DECAND., Vol. V., p. 548. Achenium obtuse, with three or four angles, with a coronal pappus of one to three deciduous awns.

† *Leaves connate, perfoliate; flowers paniculate, trichotomal; pappus minute.*

Microchæta connata. *Lipochæta connata*, DECAND., Vol. V., p. 611. *Verbesina connata*, GAUDICHAUD, in Freycenet's Voyage, p. 464.

HAB. Ouau, near the sea. Herbaceous. Leaves three to four inches long, two to two and a half wide, broadly connate, the centre of the connate portion salient, denticulate. Flowers trichotomal; pedicels one to three-flowered. Involucrum campanulate, few-flowered, in nearly a single series of six to eight oblong-ovate leaves. Paleæ of the receptacle often three-toothed. Achenium narrow, acutely triquetrous, hispid on the angles; the pappus of three or five very minute scales, which are somewhat deciduous; infertile achenia compressed.

*SCHIZOPHYLLUM.

Capitulum few-flowered, heterogamous. Rays feminine, two or three, bidentate; discal florets subcampanulate, five-toothed. Involucrum small, oblong, imbricate, about five-leaved. Receptacle paleaceous, the scales resembling the involucrum, embracing. Discal stigmas hirsute, with a slender conic apex. Achenia of the ray turgid, indurated, three or four-sided, obtuse and turbinate; those of the disk abortive, subquadrangular. Pappus none, or a slight vestige of an aristate crown.—An herbaceous plant of the Sandwich

Islands, with diffusely trailing, oppositely branching, quadrangular stems, and opposite, pseudobipinnate leaves. Flowers yellow, usually terminal in threes, nearly sessile.—(The name from σχιζω, *to dissect*, and φυλλον, *a leaf;* the leaves being remarkably dissected.)

Schizophyllum * *micranthum.*

HAB. The island of Atooi, in shady woods, near Kolao. A perennial plant with prostrate or trailing branches, extending over two or three feet of surface. The whole plant sparingly strigose, green. Leaves petiolate, deeply bipinnately dissected, the segments simple, cuneate-oblong, or two or three-lobed, the rachis set with small simple segments. Flowers small and very inconspicuous, terminal, on very short pedicels. Involucrum strigose, the leaves foliaceous, lanceolate, acute, very few, but imbricated, scarcely distinguishable from the paleæ of the receptacle. Rays two or three, pale yellow, oval, scarcely as long as the involucrum, with a smooth exserted style and stigma, and, as well as the florets of the disk, possessing a distinct tube. Anthers dark brown; teeth of the florets reflected. Achenium truncated and pubescent at the summit, the angles tubercular, the base also obtuse; tabescent achenia linear-obovate, also somewhat tubercular and quadrangular. Considerably allied to the preceding genus, but very distinct in habit, and almost wholly divested of pappus.

ARTICLE XXI.

Description of Nineteen new Species of Colimacea. By Isaac Lea. Read February 21, 1840.

Bulimus subglobosus. Plate XI., Fig. I.

Testâ globoso-turbinatâ, subtenui, rufo-fuscâ, fasciatâ, imperforatâ; anfractibus quinis, ventricosis; aperturâ rotundatâ; labro subreflexo, margine tenebroso; columellâ lævi.

Shell globosely turbinate, rather thin, reddish-brown, banded, imperforate; whorls five, ventricose; aperture round; lip slightly reflected, margin dark; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. 1.3, Length 1.7 inches.

Remarks.—A very globose species, with the superior whorls pale, while the base is dark brown. A single band of a deeper brown surrounds the middle of the last whorl. This character may vary in other specimens. A single one only was received from Mr. Wood. The base of the columella is white, surrounded by dark brown.

Bulimus viridostriatus. Plate XI., Fig. 2.

Testâ turbinato-conicâ, subcrassâ, viridi, albo-fasciatâ, nitidâ, imperforatâ; anfractibus quinis, ventricosis; aperturâ subrotundâ; labro reflexo, margine albo; columellâ lævi.

Shell turbinately conical, rather thick, green, white-banded, shining, imperforate; whorls five, ventricose; aperture subrotund; lip reflected, margin white; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.
Cabinet of P. H. Nicklin.

Diam. 1.3, Length 1.8 inches.

Remarks.—There were several specimens of this green and beautiful *Bulimus.* The white band under the suture, and the green striæ which cover the rest of the whorls, distinguish this shell at once. Some specimens have also brown bands, and when this is the case, the base of the columella will be found to be brown. In the interior the whorl is yellow. The apex is obtuse and white. In its general aspect this shell has some resemblance to *Helix viridis,* Lam., but it is much larger than that species.

Bulimus virginieus. Plate XI., Fig. 3.

Testâ ovato-conicâ, albidâ, tenui, tenuissimè striatâ, imperforatâ; anfractibus quinis, convexis; aperturâ ovatâ; labro simplici; columellâ lævi.

Shell ovately conical, white, thin, minutely striate, imperforate; whorls five, convex; aperture ovate; lip simple; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. 1, Length 1.5 inches.

Remarks.—Although this species might, at first view, be mistaken for the white variety of *B. gracilis,* herein described, it is distinguishable in being less elevated in its spire, in having one whorl less, in being without any colour at the base of the columella, and being devoid of any thickening there. The lip is curved at the base, which is not the case with the *gracilis.*

Bulimus Liberianus. Plate XI., Fig. 4.

Testâ exertâ, lacteâ, pellucidâ, nitidâ, minutè striatâ, perforatâ; anfractibus senis; aperturâ longulâ; labro incrassato, reflexo; columellâ lævi.

Shell produced, milky white, pellucid, shining, minutely striate, perforate; whorls six; aperture rather long; lip thickened and reflected; columella smooth.

Hab. Liberia, Africa. Dr. Blanding.
My Cabinet.
Cabinet of Dr. Blanding.

Diam. .4, Length .8 of an inch.

Remarks.—This shell was among those obtained by Dr. Blanding from Liberia. It has some resemblance to *B. radiatus,* Lam., a European species, but is rather larger, and is uniform in colour.

Bulimus Woodianus. Plate XI., Fig. 5.

Testâ ovato-conicâ, crassâ, rufo-fuscâ, imperforatâ; anfractibus quinis; subconvexis; aperturâ magnâ, ovatâ; labro incrassato, reflexo, margine purpuratâ; columellâ incrassatâ, lævi.

Shell ovately conical, thick, reddish-brown, imperforate; whorls five, rather convex, aperture large, ovate; lip thickened, reflected, margin purple; columella thickened and smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. .2, Length 3.6 inches.

Remarks.—This is one of the largest and finest species of *Bulimus* received from Mr. Wood, and I dedicate it to him. It somewhat resembles the *B. hæmastomas,* Lam., but has a more exserted spire, a smaller mouth, and is of a different colour. The interior is of a fine blue white, and the purple of the large, thick, and reflected lip fades into it. At the base the lip has a curve. Three specimens which are under my view all differ somewhat in character. The large one has the apex of the spire white; the second one perfectly blue; the smaller one has the spire considerably more exserted.

Bulimus gracilis. Plate XI., Fig. 6.

Testâ ovato-conicâ, tenui, imperforatâ; anfractibus senis, subconvexis; aperturâ parvâ, subrotundatâ; labro subreflexo, acuto; columellâ lævi.

Shell ovately conical, thin, imperforate; whorls six, rather convex; aperture small, rounded; lip slightly reflected, sharp; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. .9, Length 1.7 inches.

Remarks.—Looking upon a number of this species, one would, without hesitation, divide them into four, their colours being so very different. On close examination, however, no specific difference can be made out in their form. Some are of a uniform rich brown; others white, with a deep brown band in the centre of the whorl; others, again, entirely white, except at the base round the columella, where they are all more or less coloured; the fourth group is beautifully pink. The base of the columella is slightly thickened and curved.

Bulimus carinatus. Plate XI., Fig. 7.

Testâ acuminato-conicâ, subtenui, rufo-fuscâ, imperforatâ, carinatâ; anfractibus septenis, subplanulatis; aperturâ ovatâ; labro reflexo, margine tenebroso; columellâ lævi.

Shell acuminately conical, rather thin, reddish-brown, imperforate, carinate; whorls seven, rather flattened; aperture elliptical; lip reflected, margin dark; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. 1.2, Length 3 inches.

Remarks.—This graceful species differs from all those sent by Mr. Wood in having a carina visible on the last whorl, from the termination of the suture. The mouth is rather more than one-third the length of the shell. The whole surface is of a rich brown, light towards the spire, and quite dark at the base. The mouth is very white, as well as the base of the columella, where the lip is somewhat retuse.

Bulimus bicoloratus. Plate XI., Fig. 8.

Testâ turritâ, suprà rufo-fuscâ, subtus viridî imperforatâ, carinatâ; anfractibus septenis, subconvexis; aperturâ subrotundatâ; labro reflexo, margine subnigro; columellâ lævi.

Shell turreted, above reddish-brown, below green, imperforate, carinate; whorls seven, somewhat convex; aperture nearly round; lip reflected, margin nearly black; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. 1.3, Length 2.3 inches.

Remarks.—I am under obligations to W. Wood for this beautiful *Bulimus*, and many fine shells herein described, from the Philippine Islands. They were sent to me from Manilla, his present residence. This species is very remarkable in the contrast of the brown above and green below the carina in the middle of the whorl. Within, it is very white, which contrasts strongly with the dark margin. When the green epidermis is removed from the inferior part of the whorl, the substance of the shell is white. The base of the spire is dark brown.

Helix Blandingiana. Plate XII., Fig. 9.

Testâ subglobosâ, corneâ, longitudinaliter striatâ, imperforatâ, obliquè depressâ; anfractibus senis; aperturâ obliquè rotundatâ; labro incrassato, reflexo; columellâ lævi.

Shell subglobose, horn colour, longitudinally striate, imperforate, obliquely depressed; whorls six; aperture obliquely rounded; lip thickened and reflected.

Hab. Banks of the River St. Paul, Liberia, Africa. Dr. Blanding.
My Cabinet.
Cabinet of Dr. Blanding.
Cabinet of P. H. Nicklin.

Diam. .7, Length .8 of an inch.

Remarks.—Two specimens of this interesting species were presented to me by Dr. Blanding, to whom I dedicate it. It is remarkable for its gibbous form, and its general resemblance to the *H. contusa* of Fer., (Desh., No. 156,) being obliquely depressed like it in the last whorl. In the mature specimens the umbilicus is closed, and has a reflected fold. The junior specimen has the epiphragm perfect. It is very remarkable, being deeply striate, depressed in the middle, and inverted at the outer edge.

Found on the roots of the Mangrove.

It belongs to the group which Mr. Gray proposes to separate under the generic name of *Streptaxis.*

Helix Balestieriana. Plate XII., Fig. 10.

Testâ orbiculato-conoideâ, sinistrorsâ, subcarinatâ, subtenui, castaneâ, infernè, inflatâ, prope periphæriam tenebrosiori, minutè rugoso-striatâ, perforatâ; anfractibus senis, convexis; aperturâ parvâ; labro incrassato, subreflexo; columellâ lævi.

Shell orbicular conoidal, sinistral, somewhat carinate, rather thin, chestnut-coloured, inflated below, darker near the periphery, with minute rough striæ, perforate; whorls six, convex; aperture rather small, lip thickened, slightly reflected; columella smooth.

Hab. Philippine Islands. J. Balestier.
My Cabinet.

Diam. 1.4, Length .8 of an inch.

Remarks.—Any species of the *Gasteropoda* with the sinistral character, however inobtrusive it may be in other respects, must always prove highly interesting. I owe this, with many other fine shells, to the kindness of Mr. Balestier, of Singapore. It is, perhaps, more nearly allied to *H. Himalana,* (nobis,) than to any other species, but may at once be distinguished by its thickened and reflected lip; also by its darker colour, and having two more whorls, which are less flat. It is also a larger shell, but not so large as *H. Senegalensis,* Lam., (which comes here from *Canton* in abundance,) the latter being a more globose species, with transverse lines.

Helix Lamarckiana. Plate XII., Fig. 11.

Testâ orbiculato-convexâ, subcarinatâ, rufo-fuscâ, subtenui, irregulariter striatâ, minutè perforata; anfractibus quaternis, supernè planulatis; aperturâ magnâ, transversâ; labro acuto; columellâ lævi.

Shell orbicular convex, somewhat carinate, reddish-brown, rather thin, irregularly striate, perforation small; whorls four, flattened above; mouth large, transverse; lip acute; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. 2.4, Length 1.2 inches.

Remarks.—This fine large Helix seems to be most nearly allied to *H. monozonalis*, Lam. It may be distinguished by the absence of the band, by the whorls being more flat above, and by the striæ, which, on the inferior part of our shell, might be said to be wrinkled. Immediately below the periphery, the brown colour is deep, and shades off to nearly the colour of the superior part. If we were strictly to adhere to Lamarck's division of *Carocolla*, this species might be placed in that genus.

Helix Cuvieriana. Plate XII., Fig. 12.

Testâ orbiculato-convexâ, carinatâ, tenui, longitudinaliter minutè striatâ, infrà periphæriam tenebrosâ, supernè pallidâ; minutè perforatâ; anfractibus quinis, subplanulatis, suprà suturas impressis; aperturâ parvâ, transversâ; labro acuto; columellâ lævi.

Shell orbicular-convex, carinate, thin, longitudinally and minutely striate, darkened below the periphery, above pale; slightly perforate; whorls five, rather flattened, impressed above the sutures; aperture small, transverse; lip sharp; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. 1.2, Length .6 of an inch.

Remarks.—The carination of some of the specimens before me would warrant this species being placed with Lamark's *Carocolla.* This species, in its general aspect, is very like *Carocolla bicolor*, Lam. It is, however, not so solid a shell, nor has it so sharp a carina. It also resembles *Helix Himalana*, (nobis.)

Helix luteo-fasciata. Plate XII., Fig. 13.

Testâ orbiculato-conoideâ, supernè minutè cancellatâ, infernè lævi, tenebroso-castaneâ, luteo-univittatâ, minutè perforatâ; anfractibus senis, convexis; aperturâ parvâ, transversâ; labro acuto; columellâ lævi.

Shell orbicular-conical, above minutely cancellate, below smooth, dark chestnut-coloured, with a single yellow band, minutely perforate; whorls six, convex; aperture small, transverse, lip sharp; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. 1.4, Length .8 of an inch.

Remarks.—The several specimens which are before me differ but little in character. The region of the umbilicus is, like the band on the periphery, of a fine deep yellow, which is more or less expanded on the several specimens. In some of the individuals the concellate appearance does not extend to the periphery; it never goes below it, the inferior portion of the whorls being perfectly smooth, or slightly striated longitudinally. It has some resemblance to the dark varieties of *H. citrina*, Lam., but is more closely allied to *H. Nuttalliana*, (nobis.) It cannot, however, be easily confounded with any species known to me.

Helix cepoides. Plate XII., Fig. 14.

Testâ globosâ, conico-turbinatâ, subtenui, longitudinaliter striatâ, suprà rufo-fuscâ, subtus luteo-fuscâ, infrà periphæriam fasciatâ, ad basim uniplicatâ, imperforatâ; anfractibus septenis, inflatis; aperturâ lunatâ; labro irregulariter reflexo, acuto, margine rufo; columellâ lævi.

Shell globose, conically turbinate, longitudinally striate, rather thin, above reddish-brown, below the periphery banded, with one fold, at the base imperforate; whorls seven, inflated; aperture lunate; lip irregularly reflected, acute, with a red margin; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. .2, Length 1.6 inches.

Remarks.—This is among the most remarkable of all the *Helices* which have come under my notice. It most resembles the *H. unidentata*, Chem. and Lam., having a fold at the base of the columella somewhat like it. It is, however, a more globose shell, not so solid, has one more whorl, and the lip is not so thick, nor is it so regular; the band, too, is placed lower down. Within it is white.

Helix Blainvilliana. Plate XII., Fig. 15.

Testâ obtuso-convexâ, supernè granulatâ, infernè lævi, infra periphæriam unifasciatâ, minutè perforatâ; anfractibus senis, convexis; aperturâ parvâ, transversâ; labro acuto; columellâ lævi.

Shell obtusely convex, above granulate, below smooth, below the periphery single banded, perforation small; whorls six, convex; aperture small, transverse; lip acute; columella smooth.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.

Diam. 1.5, Length .8 of an inch.

Remarks.—In colour this species resembles the *H. Lamarckiana* herein described, but is a much smaller shell, more convex, and has more whorls. In colour it is also somewhat like *H. Himalana*, (nobis,) which, however, is a sinistral species. On the superior part of the whorls the transverse striæ cause it to be completely granulate. The inferior part of the whorl is smooth and shining, and of a paler colour. I dedicate this species to the distinguished malacologist.

Helix Humphreysiana. Plate XII., Fig. 16.

Testâ orbiculato-conoideâ, subtus convexâ, minutè rugosâ, albido-fulvâ, ad periphæriam fasciatâ, latè umbilicatâ, profundè perforatâ; anfractibus senis, convexis; aperturâ submagnâ, obliquâ; labro acuto; columellâ lævi.

Shell orbicular-conical, convex beneath, minutely wrinkled, tawny, banded on the periphery, widely umbilicate, deeply perforate; whorls six, convex; aperture rather large, oblique; lip acute; columella smooth.

Hab. Pondicherry. S. Humphreys.
Hab. Singapore. J. Balestier.

My Cabinet.

Diam. 1.9, Length 1.2 inches.

Remarks.—About a year since, Mr. Humphreys kindly presented me with several specimens of this shell, and subsequently I have received two or three from Mr. Balestier, of Singapore. In general outline it resembles *H. unidentata*, Lam. Its spire is elevated. Some individuals have an indistinct band over the dark one of the periphery.

Helix ferruginea. Plate XII., Fig. 17.

Testâ globoso-conoideâ, transversim striatâ, solidâ, ventricosâ, interdum vittatâ, imperforatâ; anfractibus quaternis, convexis; aperturâ magnâ, obliquâ; labro incrassato, reflexo; columellâ lævi.

Shell globosely conical, transversely striate, solid, ventricose, sometimes banded, imperforate; whorls four, convex; aperture large, oblique; lip thick, reflected; columella smooth.

Hab. Philippine Islands. W. W. Wood.

My Cabinet.

Diam. 2.3, Length 1.5 inches.

Remarks.—Two specimens of this fine large *Helix* were in the collection from Mr. Wood. One has a band immediately below the periphery, and one above it. The other specimen is without a band: under the epidermis it is of a pale reddish-brown. In form it is somewhat like *H. hæmastoma*, Lam., but it is more globose, and has a white lip, which is more rotund. The lip is largely reflected.

Carocolla bifasciata. Plate XII., Fig. 18.

Testâ orbiculari, suprà convexâ, subtùs subplanulatâ, luteo-albâ, nitidâ, minutissimè longitudinaliter striatâ, viridi bifasciatâ; anfractibus quaternis; labro acuto, reflexo.

Shell orbicular, above convex, beneath rather flattened, yellowish-white, shining, very minutely and longitudinally striate, with two green bands; whorls four; lip acute and reflected.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.
Cabinet of P. H. Nicklin.
Cabinet of Dr. Jay.

Diam. .9, Length .5 of an inch.

Remarks.—For several years I have had a single specimen of this beautiful *Carocolla* in my cabinet. In the "envoi" of Mr. Wood were several of this species. It resembles, in size and form, the *H. carioscula,* Drap., but is a smoother shell, and of a more regular form. It may also be distinguished at once by the two green bands, one above and the other immediately below the carina.

Cyclostoma Woodiana. Plate XII., Fig. 19.

Testâ orbiculatâ, subdepressâ, rufâ; albo-maculatâ et cincta; striatâ, latè et profundè umbilicatâ; anfractibus quinis; apice accuminato; labro incrassato, reflexo, albo.

Shell orbicular, rather depressed, reddish, white spotted and banded, striate, widely and deeply umbilicate; whorls five; apex acuminate; lip thickened, reflected, white.

Hab. Philippine Islands. W. W. Wood.
My Cabinet.
Cabinet of P. H. Nicklin.

Diam. 1.1, Length .6 of an inch.

Remarks.—There appears to be little or no variation in the several specimens sent by Mr. Wood. The series of white spots along the suture, and the white band of the periphery seem to be constant. The region of the umbilicus is also white. The striæ consist of several large ones, with intermediate small ones.

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Fig. 2.

Observations of the Thermometer Decr. 19–21. 1836.

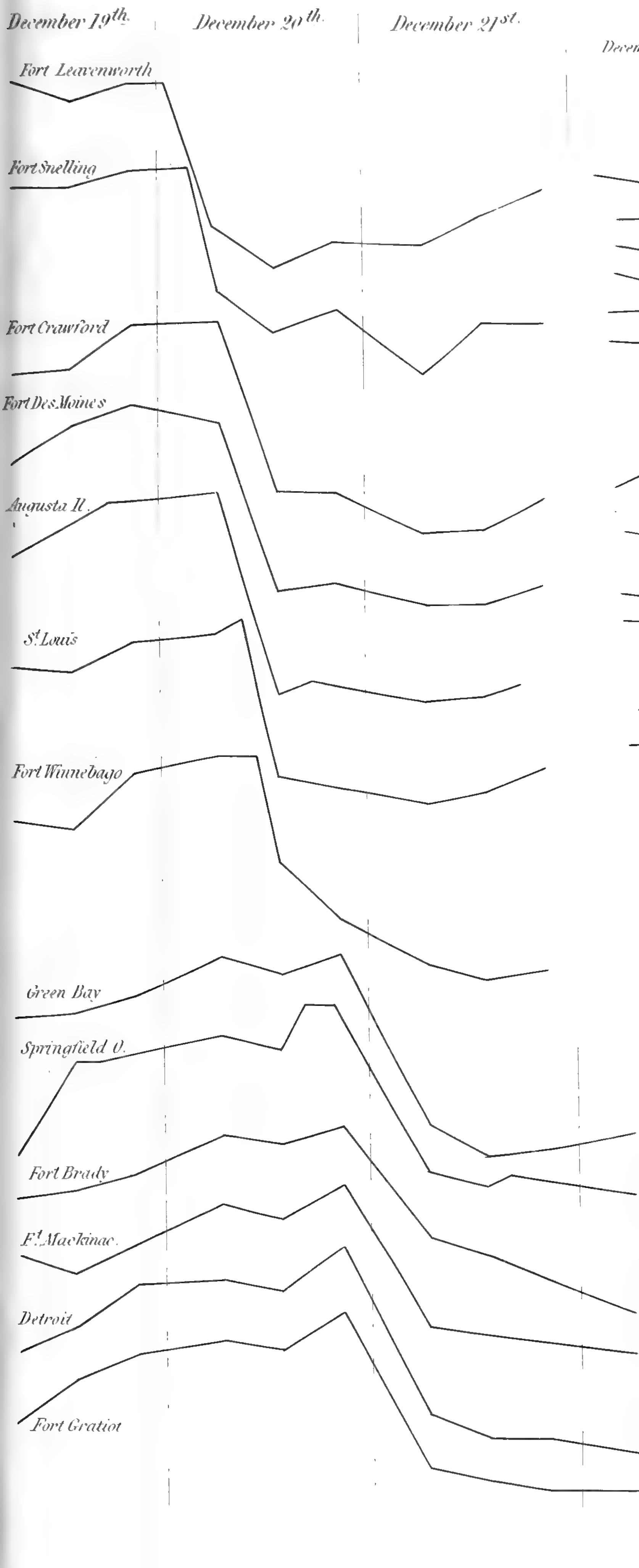
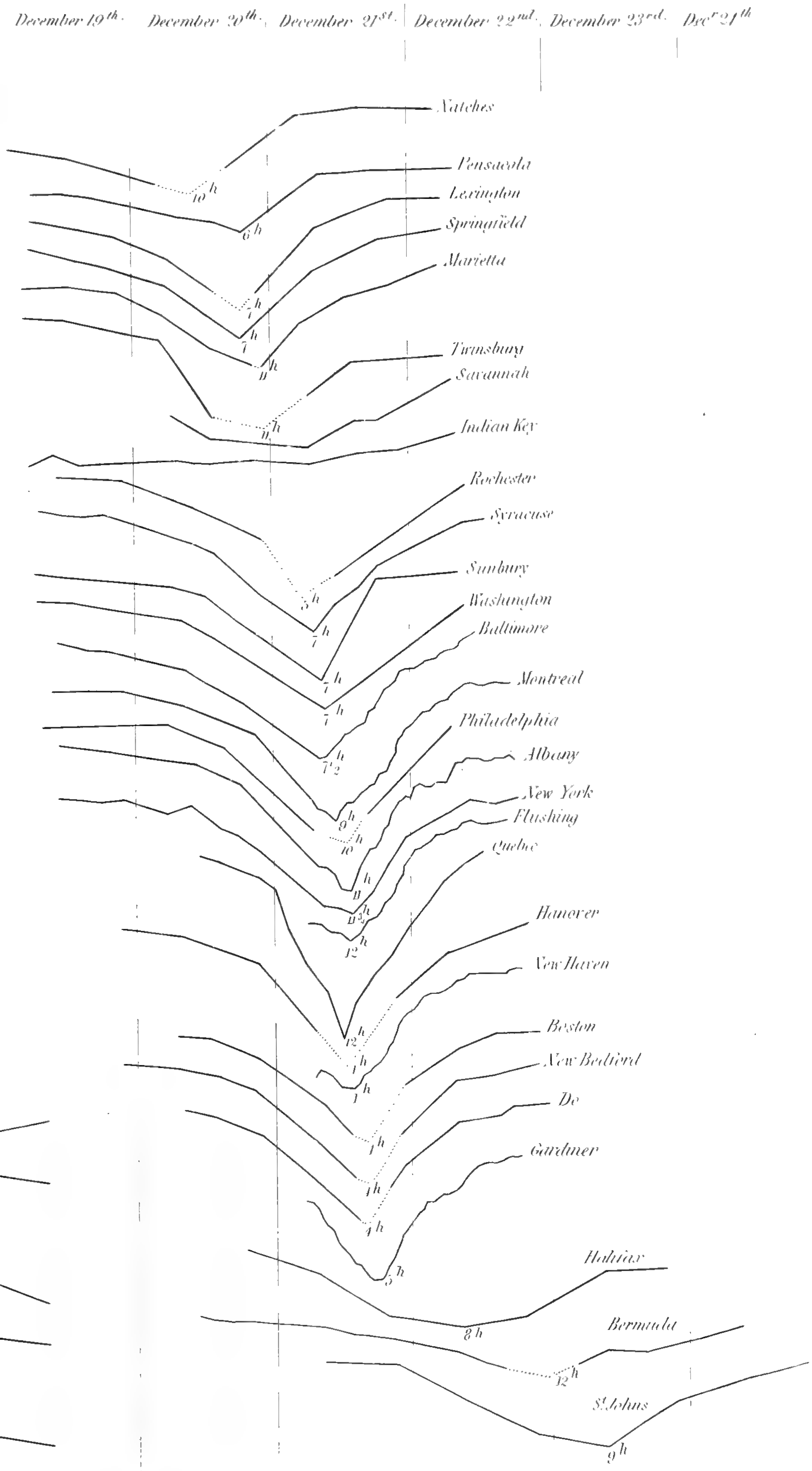


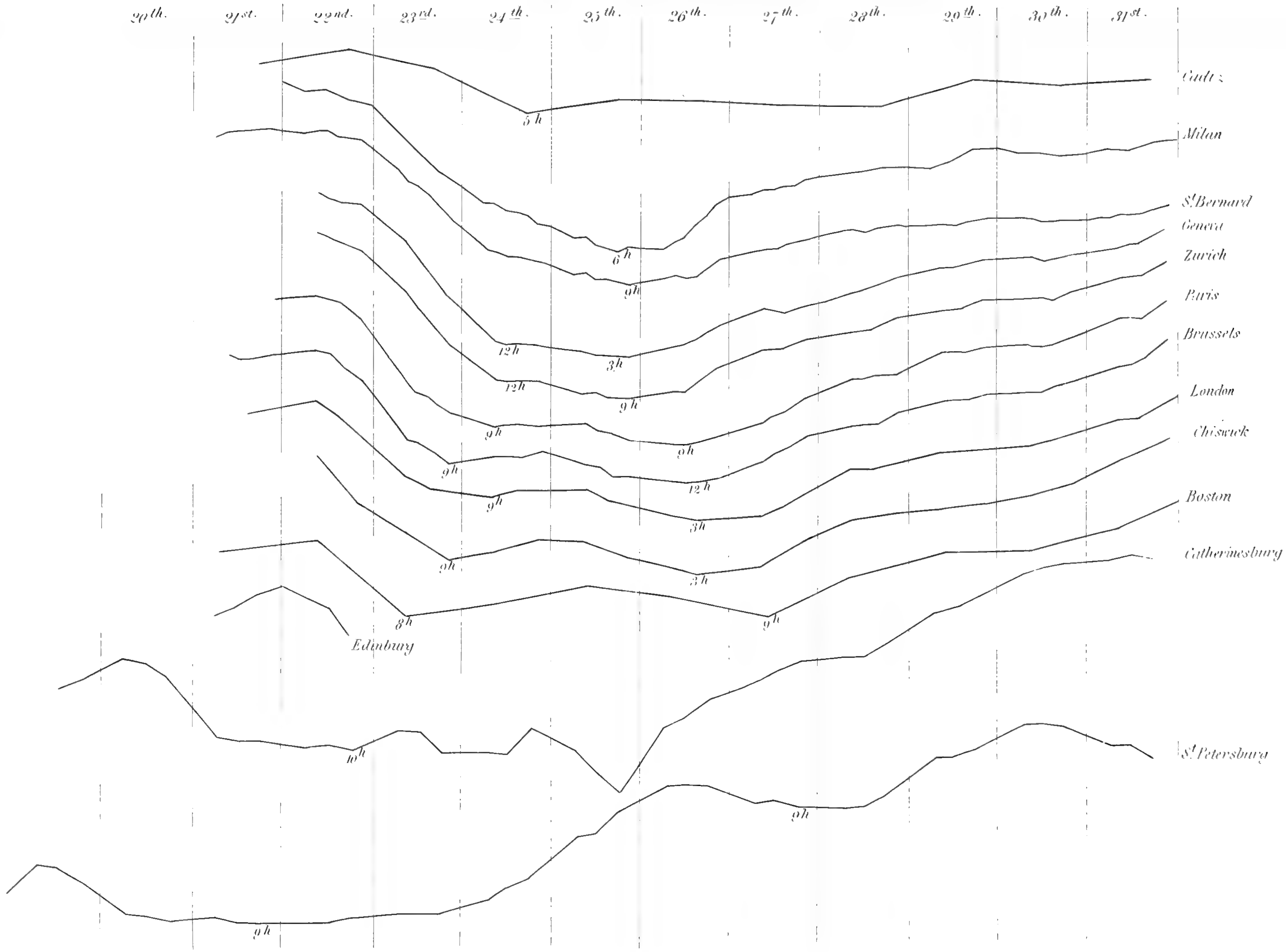
Fig. I

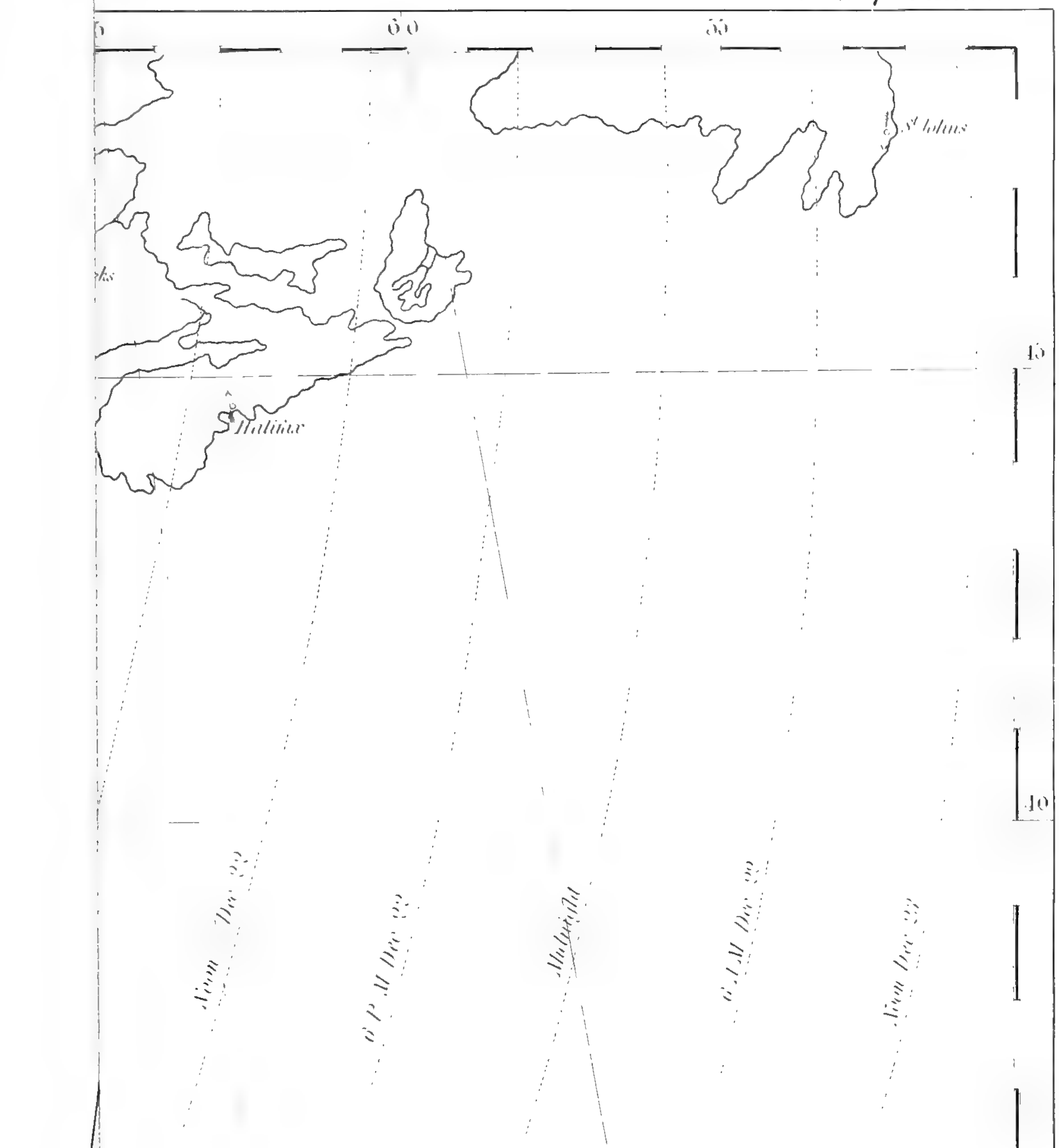
Oscillation of the Barometer in the U. States Decr. 19–24. 1836.
on a scale in which the actual rise and fall of the Barometer is reduced 1/3.



Oscillation of the Barometer in Europe Decr. 1836.

on a scale exhibiting the actual rise and fall of the Barometer.




60
55
45
40
35
30
65
60
St Johns
Halifax
Midnight
Bermuda
CHART,
Illustrating the Storm of Decr 20th 1836.
The arrows indicate the direction of the wind on the morning of the 21st

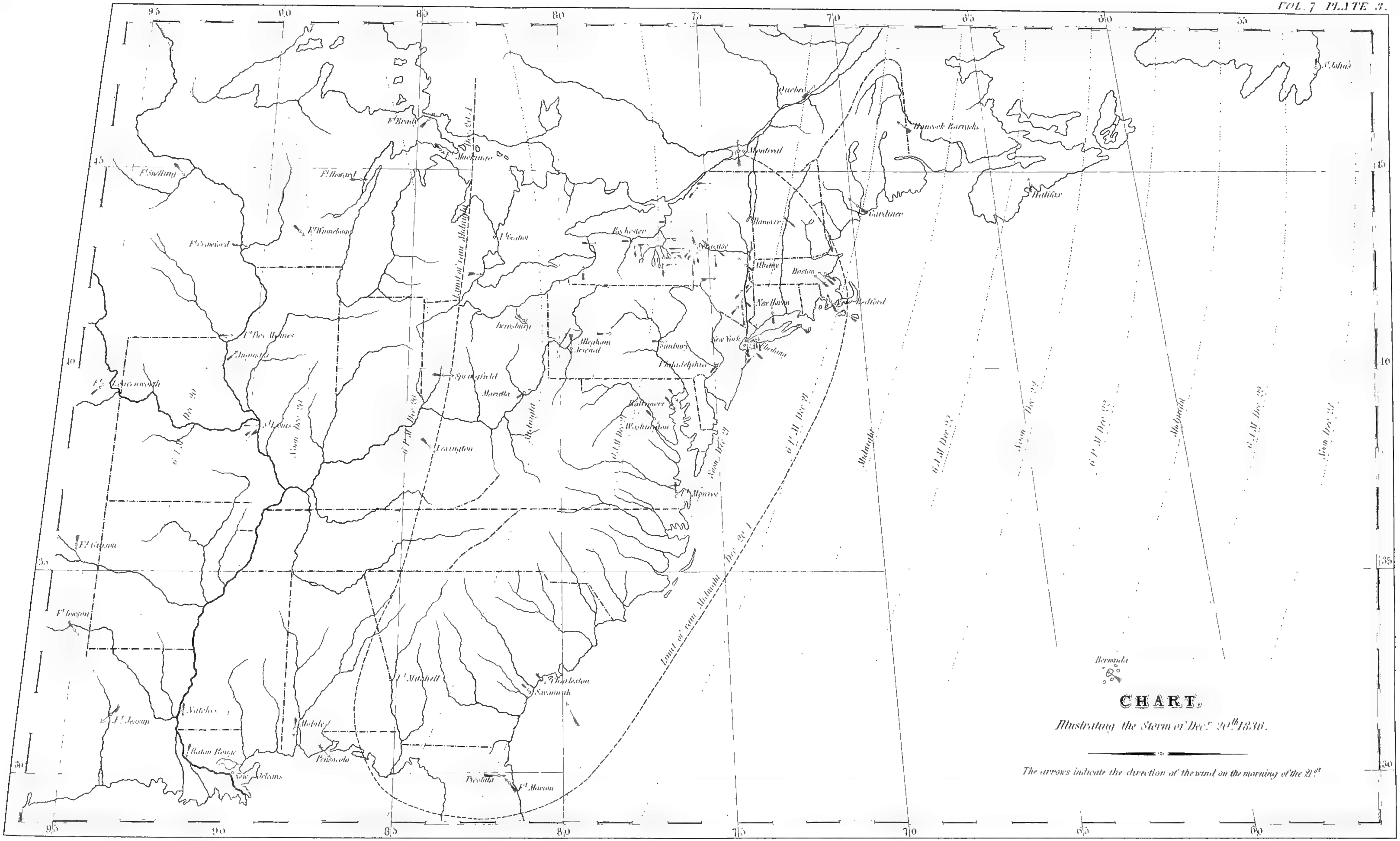
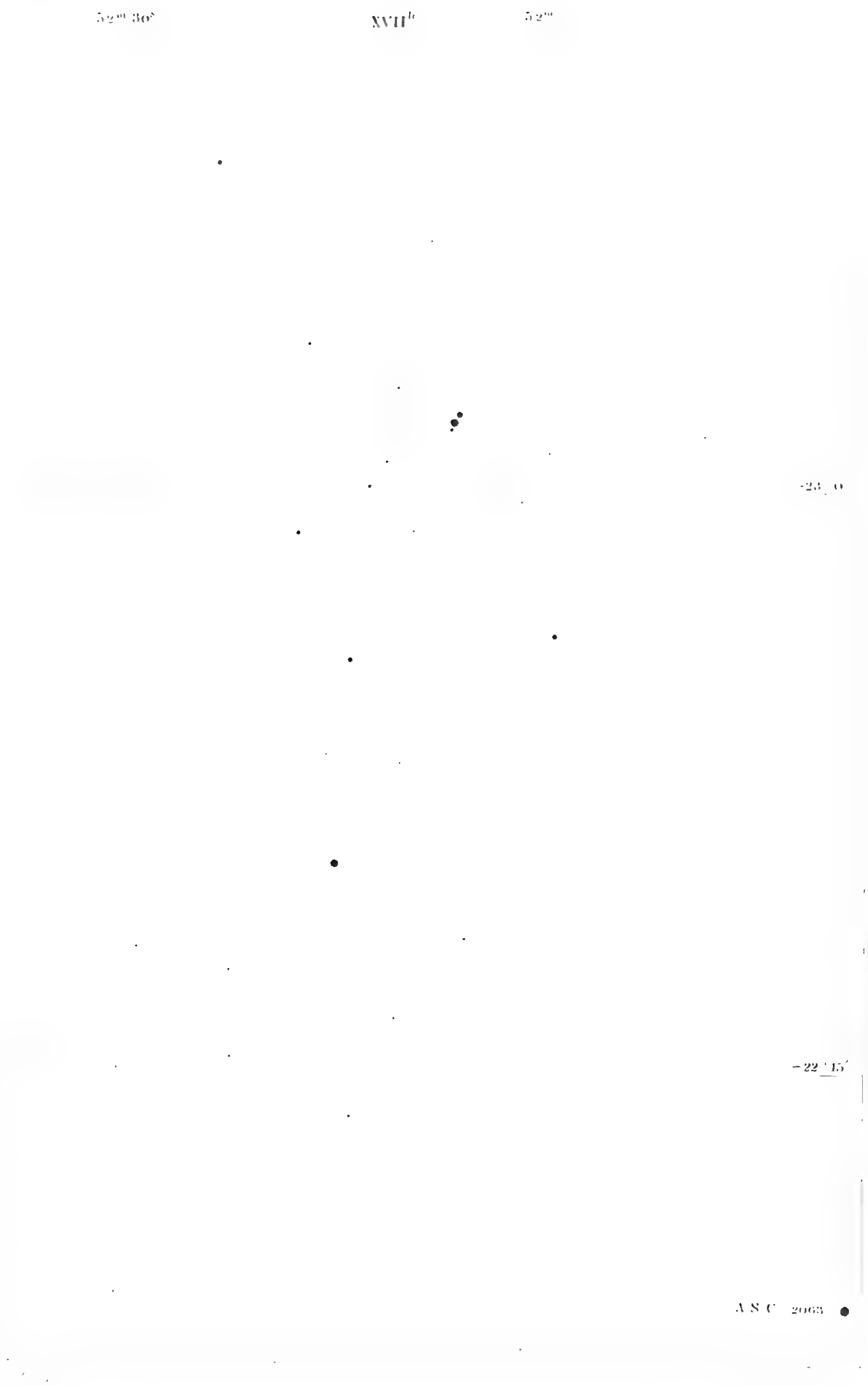
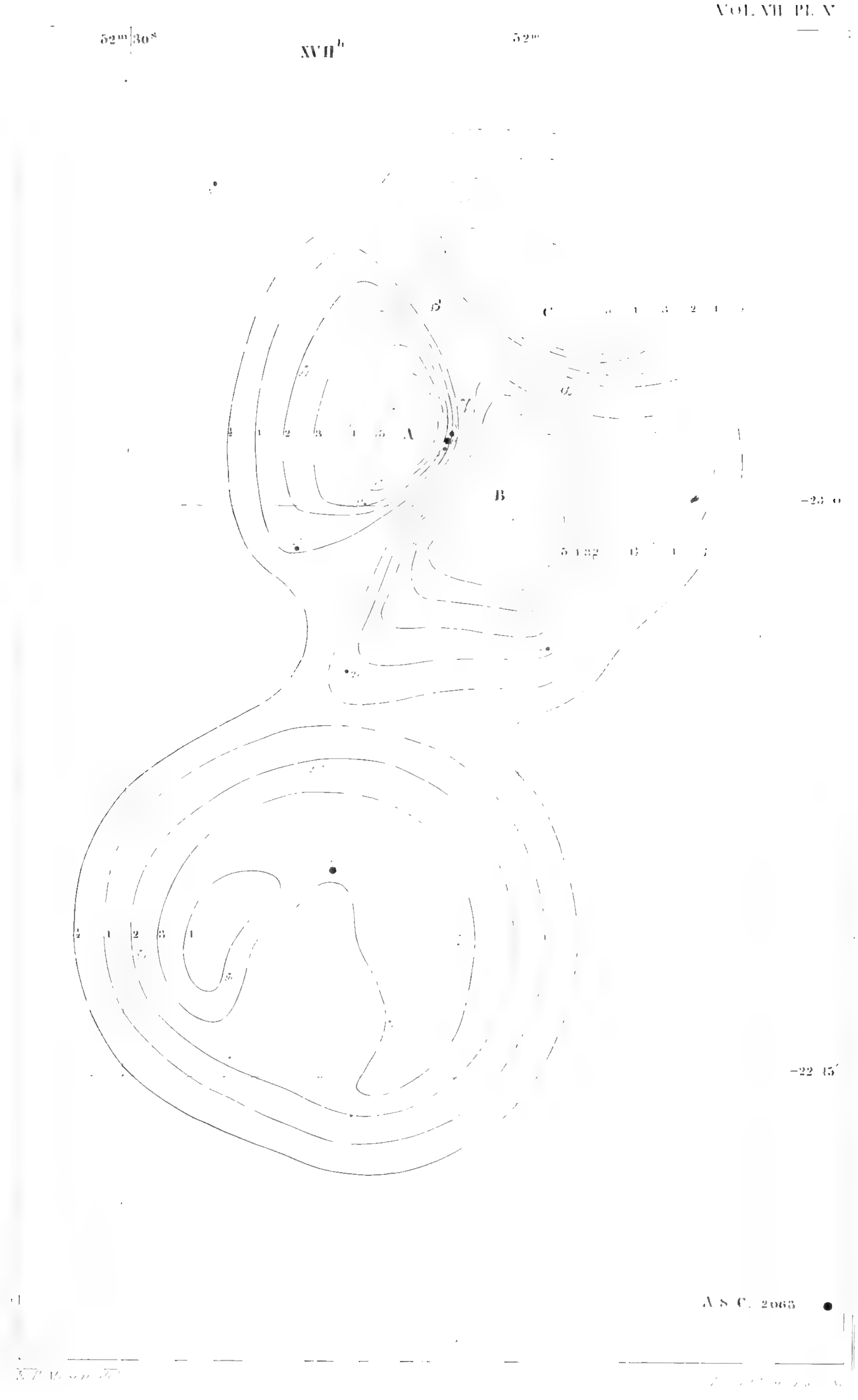


CHART.
Illustrating the Storm of Decr. 20th 1836.
The arrows indicate the direction of the wind on the morning of the 21st


52m 30s
XVIIh
52m
-23° 0'
-22° 45'
A.S.C. 2063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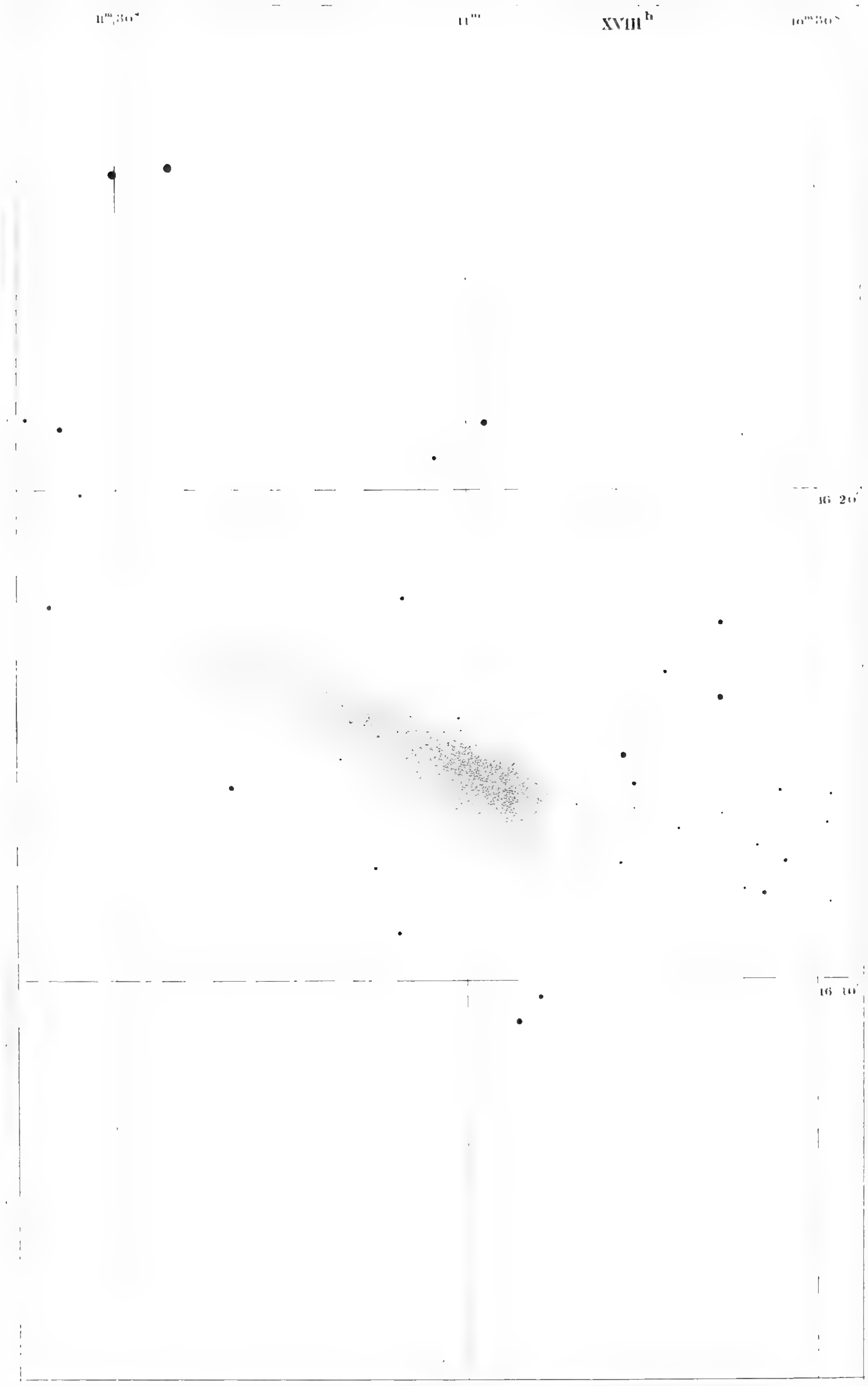
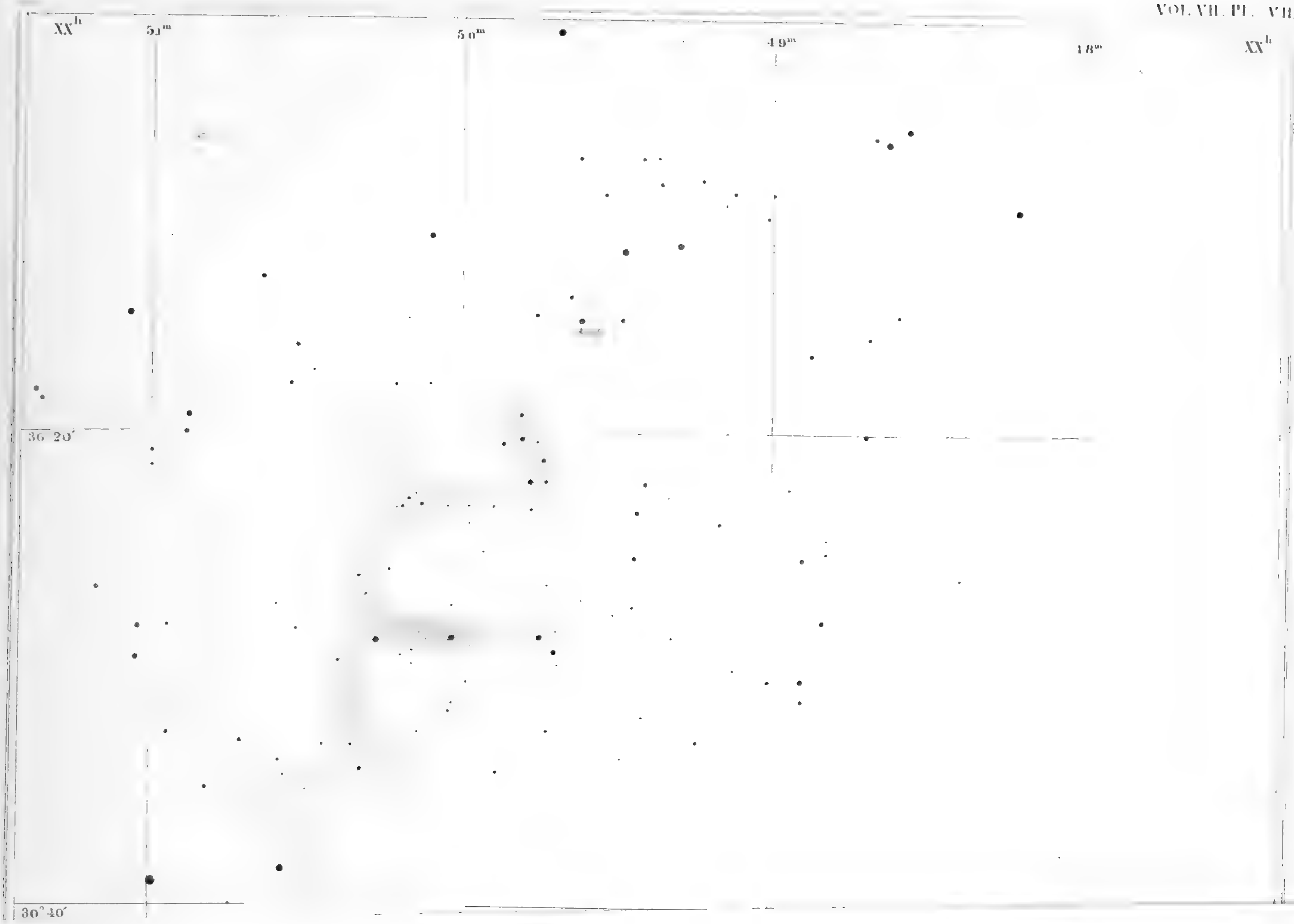
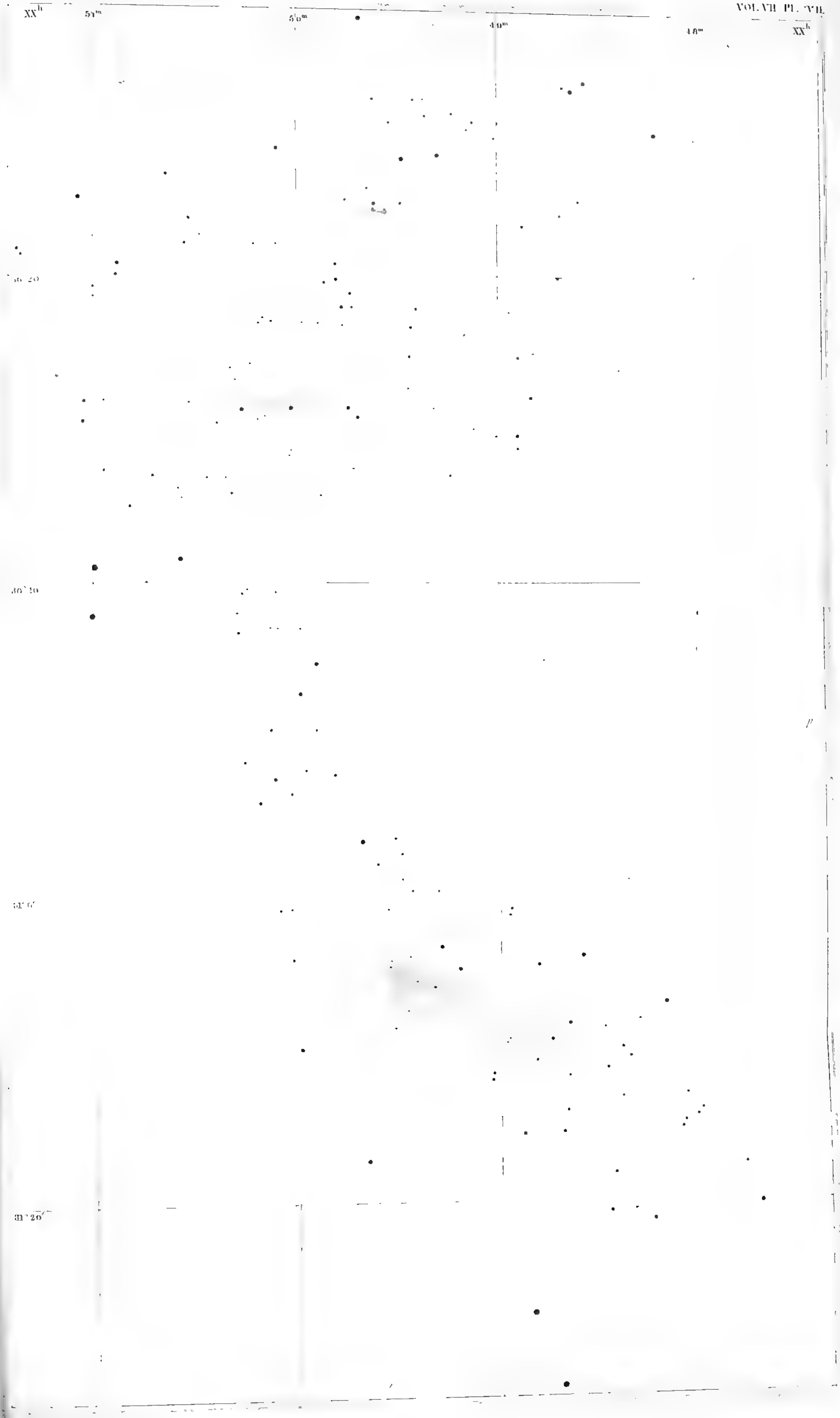
A S C. 2065


11m 30s
11m
XVIII h
10m 30s
16° 20'
16° 40'


XX^h
51^m
50^m
49^m
48^m
XX^h
36°20′
36°40′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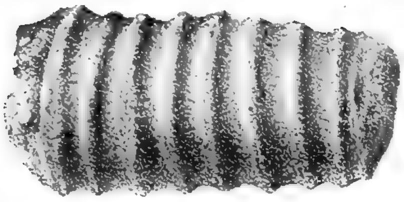
48m
XXh

1.



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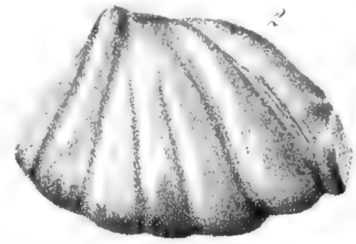

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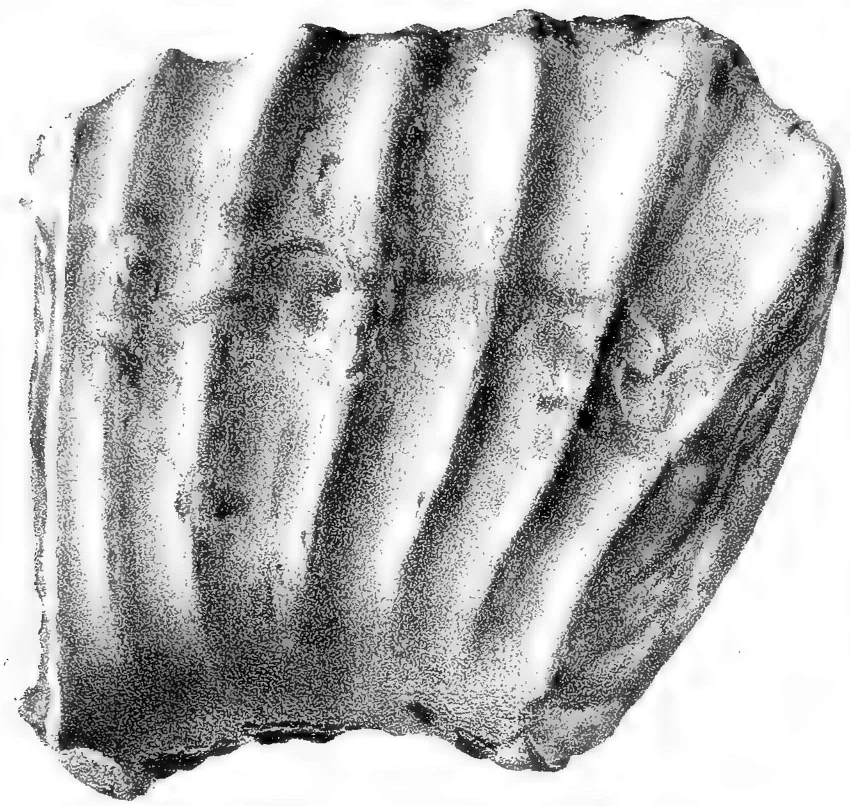

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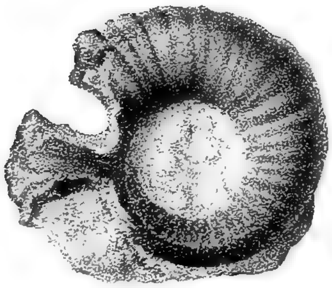

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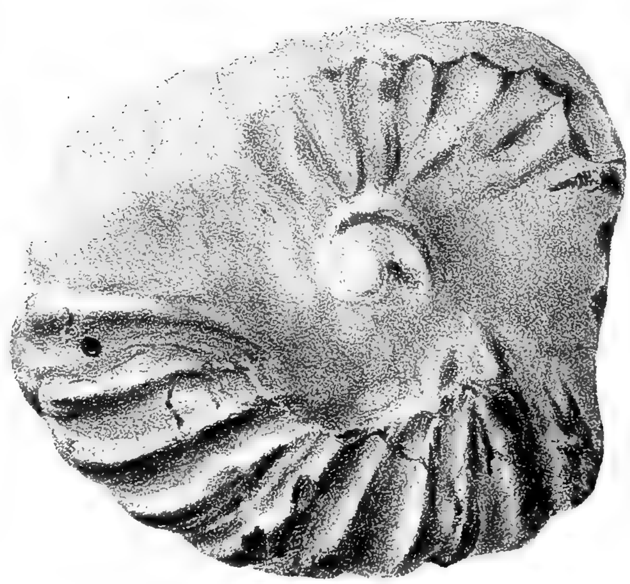

1. *Orthocera Humboldtiana*
2. *Ammonites Tocaimaensis*
3. .... *Gibbonianus*
4. *Ammonites Occidentalis*
5. ... *Vanuxemensis*
6. ... *Americanus*

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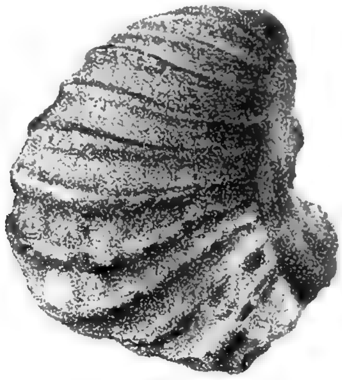
7.

8



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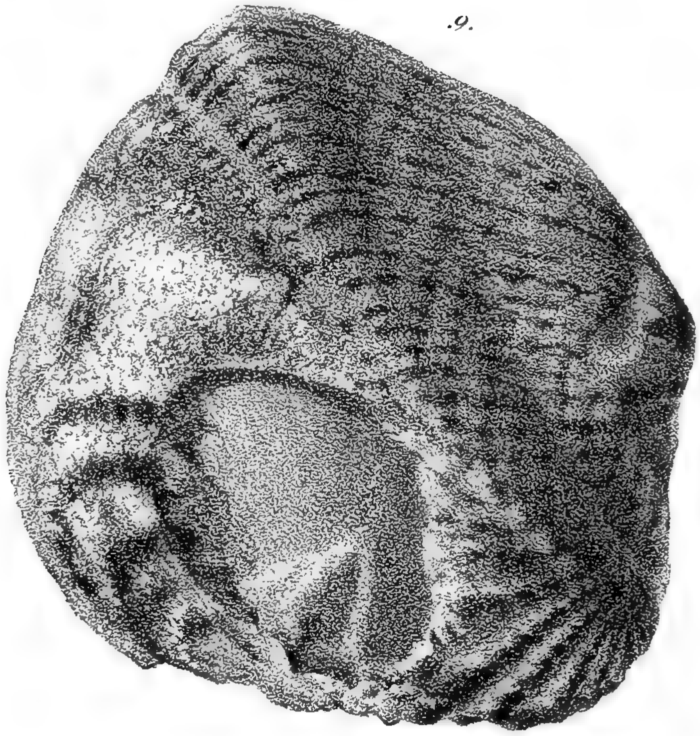
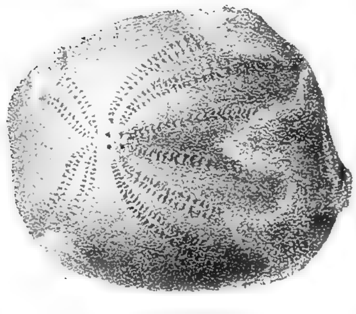


10.

11.



7. *Trigonia Gibboniana*
8. " " *Tocaimaana*
9. " *Hondaana*
10. *Natica Gibboniana*
11. *Spatangus Columbianus.*

12. *Terebratula Tayloriana*
13. ....,........ *Poeyana*
14. *Tellinites Humboldtiana*
15. *Nautilus Cubaensis*
16. *Arca Sillimaniana*
17. *Cucullea dubia*
18. *Chama tortuosa*
19. *Conus latus*
20. *Cardium globosum*
21. .... *depressum.*

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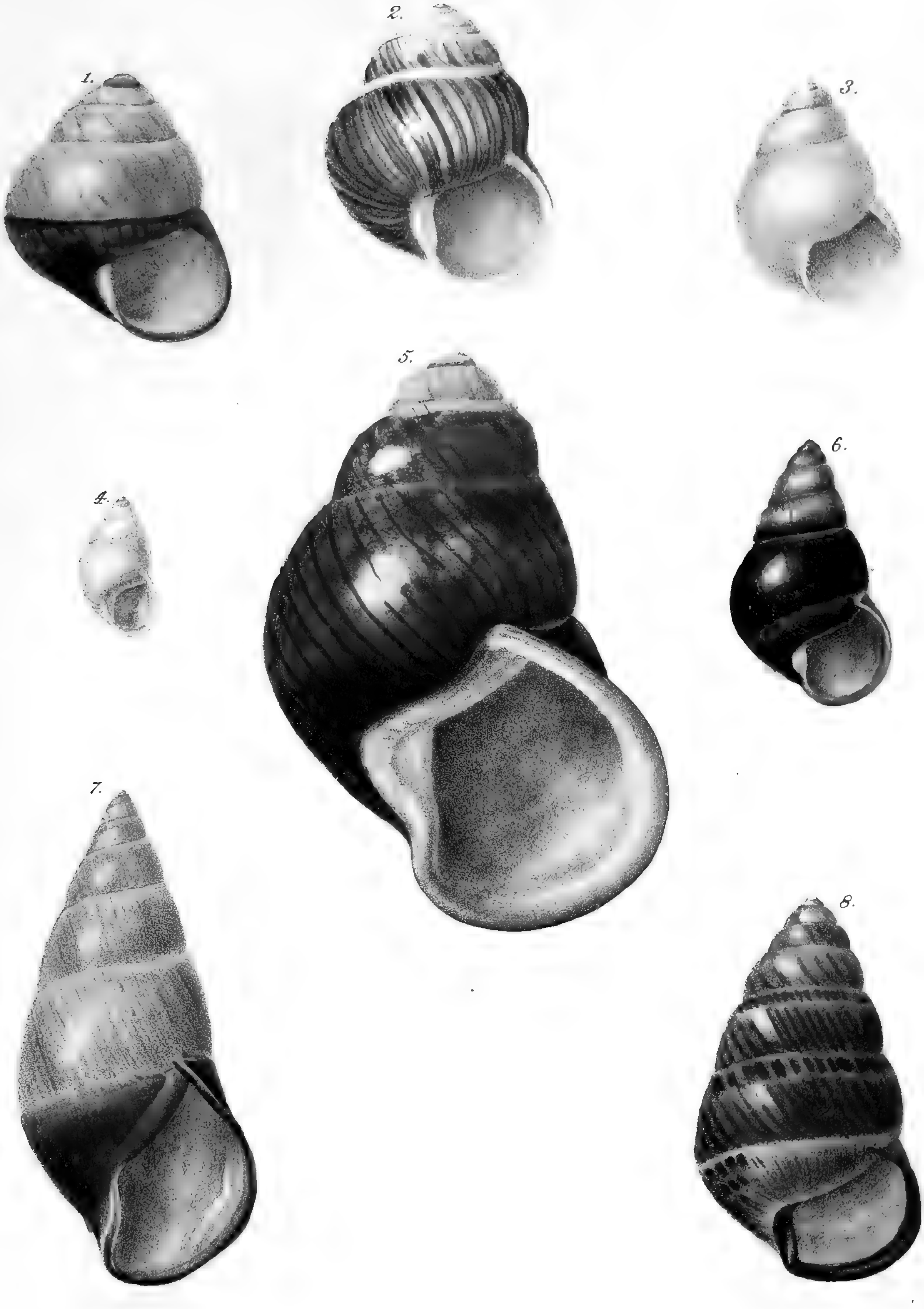
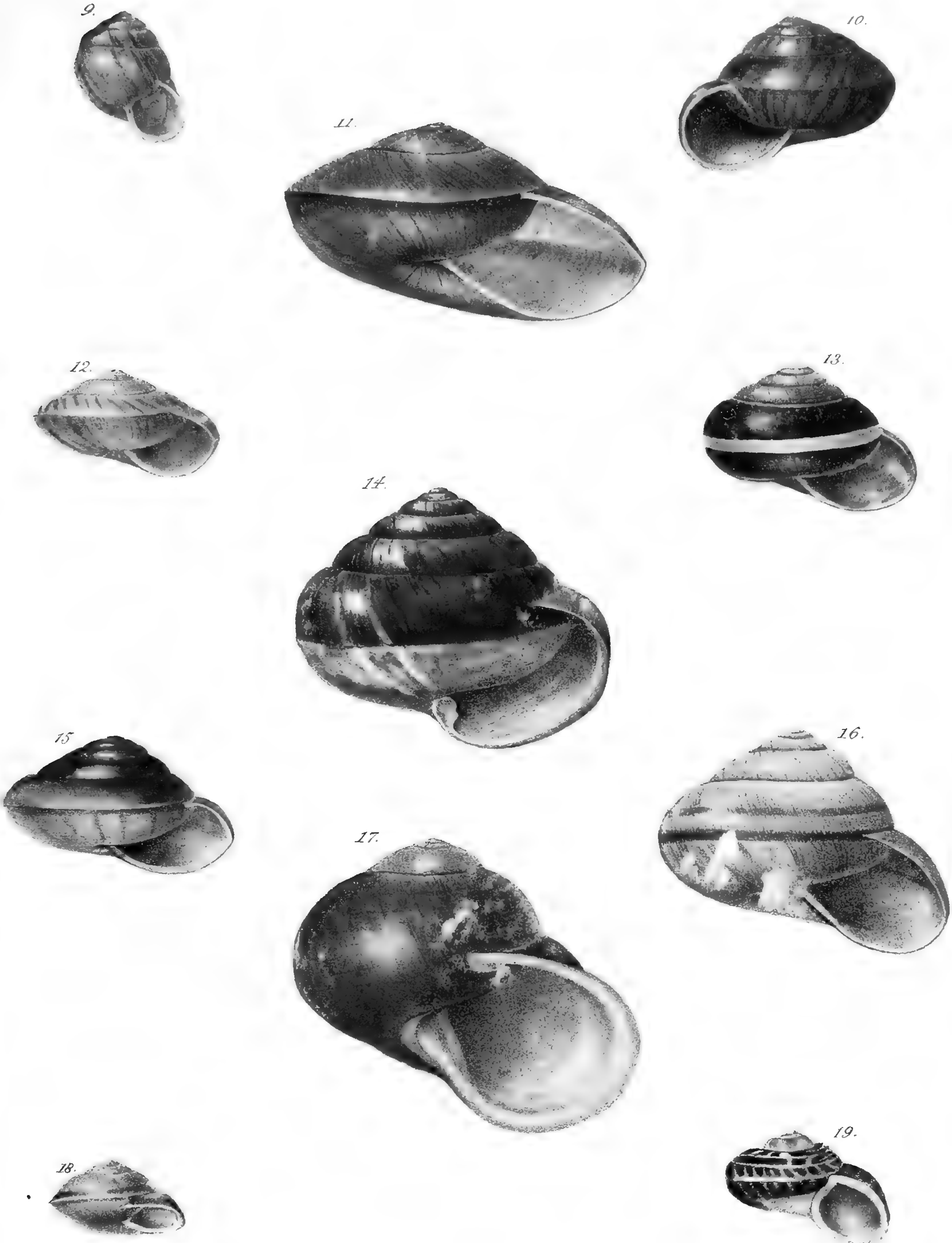


1. Bulimus Subglobosus.	5. Bulimus Woodianus.
2. „ Virido-striatus.	6. „ gracilis.
3. „ Virgineus.	7. „ carinatus.
4. „ Liberianus.	8. „ bi-coloratus.

... pinx. P. S. Duval. Lith Phila. On Stone by Jas Queen.



9. *Helix Blandingiana.*
10. „ *Balesteriana.*
11. „ *Lamarckiana.*
12. „ *Cuvieriana.*
13. „ *luteo fasciata.*
14. *Helix cepoides.*
15. „ *Blainvilliana.*
16. „ *Humphreysiana.*
17. „ *ferruginea.*
18. *Carocolla bi-fasciata.*
19. *Cyclostoma Woodiana.*

M. Lawson, pinx.t P. S. Duval, Lith. Phila. On Stone by Jas. Queen