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Article/Chapter Title: Account of a tornado near New Harmony, Indiana, April 30, 1852, with a map of the tract, &c.
Author(s): Chappelsmith, John
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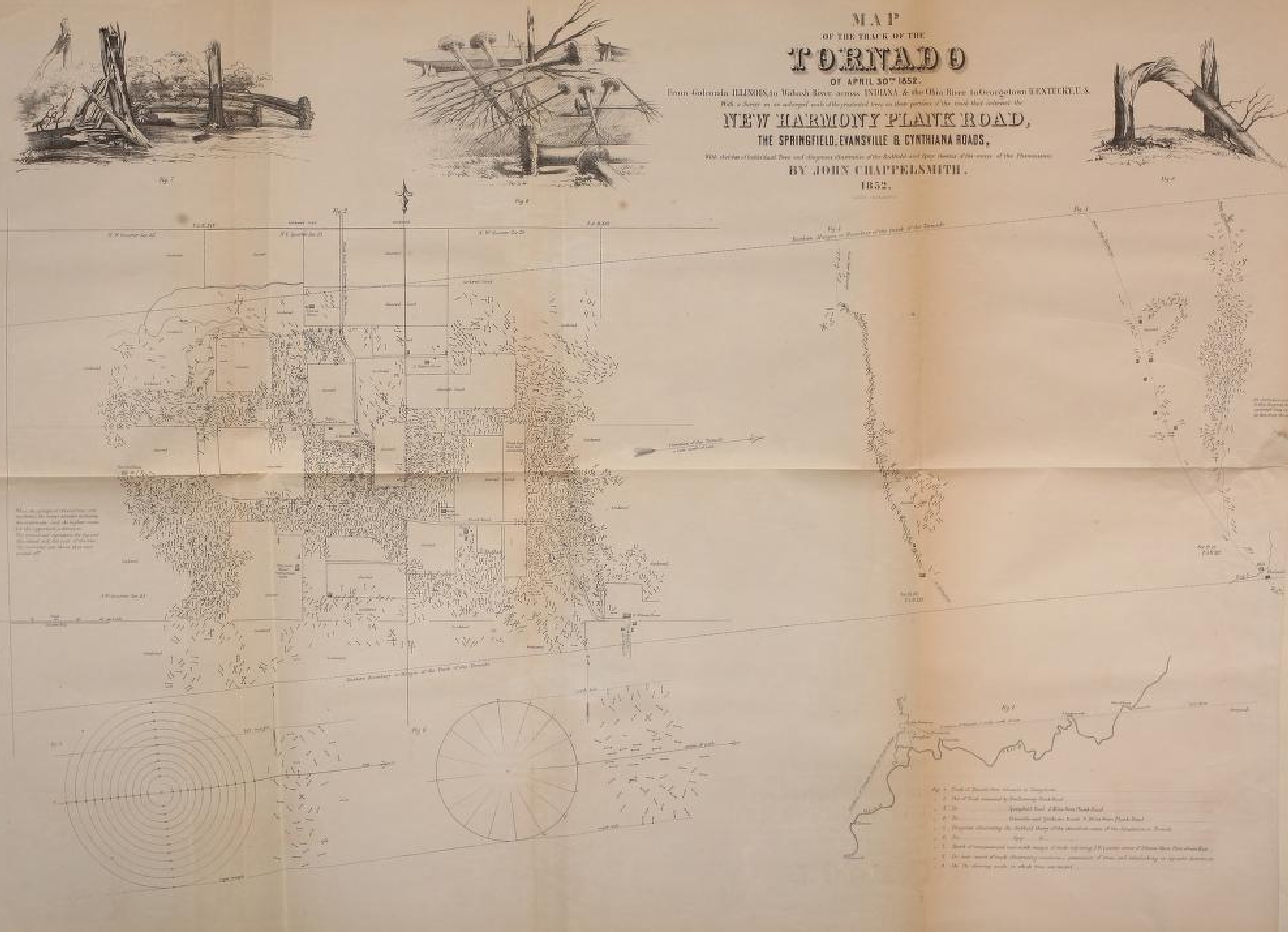
MAP
OF THE TRACK OF THE
TORNADO
OF APRIL 30TH 1852:
From Golconda ILLINOIS, to Wabash River across INDIANA & the Ohio River to Georgetown KENTUCKY, U.S.
NEW HARMONY PLANK ROAD,
THE SPRINGFIELD, EVANSVILLE & CYNTHIANA ROADS,
BY JOHN CHAPPELSMITH.
1852.

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SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

ACCOUNT

OF A

TORNADO NEAR NEW HARMONY, IND.,

APRIL 30, 1852,

WITH A MAP OF THE TRACK, &c.

BY

JOHN CHAPPELSMITH.

[ACCEPTED FOR PUBLICATION, DECEMBER, 1853.]

COMMISSION

TO WHICH THIS PAPER HAS BEEN REFERRED.

Prof. J. H. Coffin.
Prof. A. Caswell.

Joseph Henry,
Secretary S. I.

ACCOUNT OF A TORNADO,

THAT PASSED NEAR NEW HARMONY, INDIANA, APRIL 30, 1852.

WITH A MAP OF THE TRACK, DIAGRAMS, AND ILLUSTRATIVE SKETCHES.

As every accurately observed meteorological fact must be of importance in the necessary accumulation of data, from which the phenomena of storms are to be understood, and the laws which govern them deduced, I am led to believe that a map and memoir illustrating the tornado which recently passed near New Harmony, Indiana, will be of some service to the cause in which so many are at present engaged.

On April 30, 1852, a tornado crossed the New Harmony Plank road, five miles south of the town, about five o'clock in the afternoon; its velocity, and the length and breadth of its destructive violence, exceed that of any, to my knowledge, on record. From within three miles of Golconda, Illinois, its course appears to have been north 30° east to the Wabash river, a distance of fifty miles; crossing the river near Grand Chain rapids, it altered its course to east, or rather to a little north of east, and continued apparently in this to about four miles north of Georgetown, Kentucky, a distance of 200 miles. At different localities, from Golconda to Georgetown, the tornado is described as manifesting similar evidences of its destructive power; buildings being blown down; houses and cabins unroofed; trees torn up by the roots, or their tops twisted off; fences scattered in every direction; and beds, bedding, and articles of every description being carried to various and considerable distances. See Figures 1, 2, 3, 4, of the map.

Fig. 1 is a map of the track of the tornado from Golconda, Illinois, to Georgetown, Kentucky, a distance of about 250 miles.

Fig. 2 is a survey of a square mile of the track east and west of the New Harmony Plank road, showing the compass-bearings of the prostrated trees; the crossed end represents the top of the tree; the dotted end, the root; where the dot is absent, the tree has been broken, or twisted from the stem.

Fig. 3 is a plot of the trees thrown across the road from New Harmony to Springfield, two miles east of the Plank Road; this road passes through a forest; a small portion is cleared, which is marked on the plot.

Fig. 4 is a plot of the road from New Harmony to Evansville, and of the Cynthiana road, eight miles east of the Plank road; the Evansville road is through cleared ground, but the Cynthiana road passes through a forest all the way to the mill at Big creek. The observations extend to about one hundred and fifty yards on each side of the road, except near the middle of the track, where they cover a wider space.

The tornado passed over Leavenworth on the Ohio, and a correspondent thus writes to the Louisville Courier of May 11: "The storm came from the southwest, across the bluff from the opposite side of the river, tearing up trees by the roots, or twisting off their tops; it then crossed the river, swelling the waves to an incredible height, lifting skiffs from the river bank, and dashing them to pieces against the houses. It struck the town about 6¼ P. M., and raged from three to five minutes, unroofing and prostrating sixty buildings, some of them the most substantial in the town, carrying off and blowing articles of every description about, killing one child, and wounding ten or fifteen individuals."

From persons residing on the track, or in its vicinity, no definite idea of the approach of the meteor can be obtained; some describe it as a cloud with green and red flame; others, green and blue. Mr. Stitt, who resides about the centre of the track, says the cloud appeared on fire at the bottom, like a large pile of burning brush, and that it rolled under and over; his wife felt the house lifted up and down several times. During the passage of the storm he opened the eastern door of his house, but speedily closed it from fear, for he saw the planks of his well spinning round eight or ten feet from the ground, and one of them was carried in a northeasterly direction, 400 yards, to the place marked in the map. All who reside on the track describe the destruction as the work of a moment; a person standing in his house, looking to the north, saw the trees thrown down, and at the same moment turning south, saw the trees falling there also. Persons in the woods describe the crash as so terrific, that, to use their own words, "they could hear nothing," by which I understand that they could not distinguish, amid the war of sounds, any sound in particular.

Referring to the observations made by myself, during the passage of the tornado, at New Harmony, five miles north of the axis of the track, I find that at 3 o'clock on April 27, the barometer stood at 29.587, the thermometer at 61°, and the force of vapor at .250 of an inch. On the 30th, at 3 o'clock, the barometer had fallen to 29.090, the thermometer had risen to 80°, and the force of vapor to .622 of an inch. The sky had been cloudy all day, and at this time the clouds were coming from the south, and the wind was nearly calm; sounds of distant thunder were now heard, and at 4 P. M. the first flash of lightning was perceptible, with thunder at an interval of twenty seconds, and slight rain. From this time the lightning was a continued glimmer, and the thunder a constant roll. The barometer had now risen .050 of an inch, and the thermometer had fallen 2°. At 4.30 P. M. the rain fell in torrents, the wind blew in all directions, with incessant flashes of lightning, and peals of thunder, and showers of driving hail, of which some stones measured eight inches in circumference, and weighed one-quarter of a pound; the panes of every window in the town, having a westerly exposure, were broken; there was now a further rise of .030 of an inch in the barometer, and a fall of 4° in the thermometer. At 5 P. M., after a few minutes' cessation, the storm still continued, though with abated violence. At 5.45 the sky was clear, the wind calm, the thermometer standing at 68°, and the barometer had fallen to the point at which it stood at the commencement of the storm. The force of vapor at 9 P. M. was diminished one-half.

While the tornado was raging here, so little inconvenience was experienced five miles to the north, from either wind or rain, that persons were able to continue ploughing during the whole passage of the storm. This was also the case at Mount Vernon, which is about the same distance, nine miles south of the axis of the track. The case was similar nine miles from the axis at Golconda; little of either wind or rain was experienced.

Considering these facts, and observing, as represented in Fig. 2, that on a square mile only of the track, thousands of trees, many of them having a stem at least fifteen feet in circumference, lie prostrated by a force operating simultaneously in opposite directions; considering, also, that the time of passage of the meteor from New Harmony to Leavenworth could not exceed 1½ hours, and that the velocity must therefore have been at least sixty miles in an hour, or one mile per minute, we may form some conception of the enormous and astonishing power with which this tornado, of whose presence at ten miles' distance there is not an indication, passed through the atmosphere, leaving behind a desolated track of one mile in breadth, on which trees, and among them the monarchs of the forest, were laid low at the rate of 7,000 a minute.

"In this vast country, where," as the Committee of the French Academy of Sciences say, "enlightened men are not wanting to science, and which is, besides, the home of these fearful meteors," it is surprising that a power like this should not have earlier attracted the attention of scientific men; for, according to Dr. Hare, it was not until 1835, that "the immediate mechanical causes of the devastation produced by tornadoes were well ascertained, by Professors Bache and Espy, from observations made by means of a compass at New Brunswick." Since then, the question of tornadoes has been much agitated, and it still remains a vexed one, and notwithstanding the hope indulged in by several investigators of this class of phenomena that their researches would solve the problem, the ultimate solution of the question is as much involved in difficulty as ever.

Before we can arrive at a satisfactory conclusion on this subject, we must first ascertain if the general phenomena in tornadoes be uniform, or dissimilar. For this purpose I will refer to the accounts of various tornadoes published in Silliman's Journal. I shall pass by the Providence tornado, in 1838, because the observations are too few in number.

The New Haven tornado, in 1839, was examined by Professor Olmstead, who considers his observations the result of better opportunities, and of more elaborate and careful investigation than is usual in storms of this class; he says: "With very few exceptions, the prostrations of all the trees are inwards, on both sides, to the centre of the track; near the centre they coincide with the direction of the storm." Out of forty prostrations which he represents on the north side of the axis, there are twelve exceptions of trees lying *outward* from the centre; and he says: "In a few instances, in very limited spots, the prostrated bodies lie in all directions."

The tornado at Mayfield, in Ohio, in 1842, had its track surveyed by Professor Loomis, who observes that tornadoes, in addition to their progressive motion, have a vertical, and two horizontal motions, one in the direction of, and the other at right angles to, a radius. These four motions have a variable ratio to each other; the

upward, and centripetal, nowhere disappears, and at Mayfield was exhibited in unequal strength. In some places the motion at right angles was strongly marked, in others "well nigh masked." He says that, having discovered a true *experimentum crucis*, for analyzing the phenomena of tornadoes by means of groups of crossed trees, "the peculiarities of a well-marked tornado can hardly escape detection," and concludes that though the motion at right angles to a radius may sometimes be quite small, compared with the centripetal motion, yet that it "can ever become mathematically nothing, is infinitely improbable." To prove the rotation of the wind, the Professor measured the bearings of seventy prostrate trees extending across the track; he "did not take the bearings of all indiscriminately, because it was a hopeless task, the prostrate trees being counted by thousands." He searched for trees crossing each other, and found but one case on the right side of the track near the middle; but on the left side the phenomena were very different; here was no difficulty in finding crossed trees, and he measured few others. The Professor gives the bearings of these, and the order in which they overlie each other. (See Silliman's Journal, XLIII, 285.)

A reference to the phenomena of these tornadoes shows that there is a general uniformity in their character, and that it is contrary to fact to say that the "trees, amid all their variety of bearing, always point towards the centre of the path, or a point occupied by the axis of the tornado," as affirmed by some; for out of forty prostrations on the north side of the axis at New Haven, Olmstead gives twelve exceptions of trees lying outwards from the centre; and on the north of the axis, at Mayfield, Loomis gives at least twenty trees pointing directly outwards from the centre, out of fifty prostrations; and the like effects are exhibited at New Harmony, as shown in Fig. 2.

It is improbable that any one can come to a right conclusion regarding the order in which the wreck of a tornado lies, without plotting a portion of it from instrumental survey. Knowing the tendency which exists in most minds to see chiefly those facts which favor a preconceived hypothesis, it seems to me that to select a few groups of trees out of thousands, would not afford sufficient evidence to others, however satisfied one might be with the truthfulness of his illustrations. I therefore present the plot of a square mile of track on which some 7 or 8,000 prostrated trees are represented in their relative positions, with the hope that the means will thus be furnished for more satisfactorily determining whether the "immediate mechanical cause of devastation in tornadoes" be a spirally involuted rotating moving column of air, or a vertical current at the centre of the tornado with a horizontal conflux from surrounding space to the moving axis.

To further this object, and to more readily compare the phenomena with the hypotheses, I have appended diagrams, illustrating the rotating cylinder, and the up-moving column, with prostrated trees, in accordance with these hypotheses respectively.

Fig. 5 of the map illustrates the rotating cylinder, which Redfield theoretically describes as follows: "The involuted lines or arrows represent the motion of the wind at the bottom of the cylindrical vertical portion of the tornado. The motion of a particle of air, as at *a*, quickens as it approaches the centre *f*, describing in its

spiral revolutions from *a* to *f*, equal areas in equal times; if the whirl was stationary, its force would be concentrically equal; but, if it have a constant progressive motion in the direction of the axis *c*, *c* at $\frac{1}{5}$ of the average rotative velocity, the force of the whirl will be increased on the right, and diminished on the left side, of the axis. Suppose the stationary velocity to be 80, then taking two equally distant points on each side of the axis, the force will be increased to 100 on the right side, and diminished to 60 on the left when the cylinder is advancing. The consequence of the rotative motion coinciding with the progressive is, that the prostrating power extends much further on the right of the axis than on the left, where, from the rotative being retarded by the progressive motion, the extent of the prostrating power is lessened." "With these views," continues Mr. Redfield, "follow the track of a tornado; and if it is a whirlwind, the result is a series of prostrations, pointing almost invariably onward and inward, with various degrees of inclination to the course of the tornado on one side; while the left of the axis presents a narrow band or belt of prostrations, also inclined mainly inward and onward, but showing a greater inclination from the line of progress, with frequent cases more or less backward, and sometimes outward, from the path."

Now the prostrating effect of this rotating cylinder will be best understood by a reference to the prostrated trees in Fig. 5, which correspond with the direction of the involuted lines in the whirl. Making allowance for a little more onward direction, owing to the progressive motion, we may deduce the following general conclusions: that on the right of the axis there cannot be any prostrations of trees with their tops to the west;[1] that those prostrated to the east cannot lie at a greater angle with the direction of the track than 45°, unless they be very near the axis; on the left of the track there cannot be any prostrations with the tops of the trees to the east, except near the axis; and in the case of crossed trees, those on the right of the axis, prostrated by the advanced portion of the whirl, will be undermost with a N. E. direction; and those thrown down by the rear, will have a S. E. direction, and overlie the northeasterly prostrations; on the left of the axis, the S. W. prostrations will lie over the northwesterly.

Apply these general principles to the square mile plot of the track at New Harmony, in Fig. 2, and observe if the conditions of the rotatory hypothesis are fulfilled. On the contrary, there are numerous prostrated trees with the tops to the west on the right of the axis; many southeasterly and northeasterly prostrations, making a greater angle than 45° with the direction of the course; there are also many northeasterly lying over southeasterly prostrations, as the groups of crossed trees show where numbered, the lowest numbered being the first prostrated, or undermost tree; the same opposition to the rotatory hypothesis exists on the left of the axis, as may be observed.

Turn now to Fig. 6 of the map, which is an illustration of the bottom of an upmoving column of air with horizontal conflux from surrounding space to the moving centre. Let *o* be the centre, and *a o*, *b o*, *c o*, &c., represent the horizontal conflux; the action of this moving column, according to Espy, will be to prostrate the trees, as

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[1] It must be recollected that in the drawing the top of the map is north.

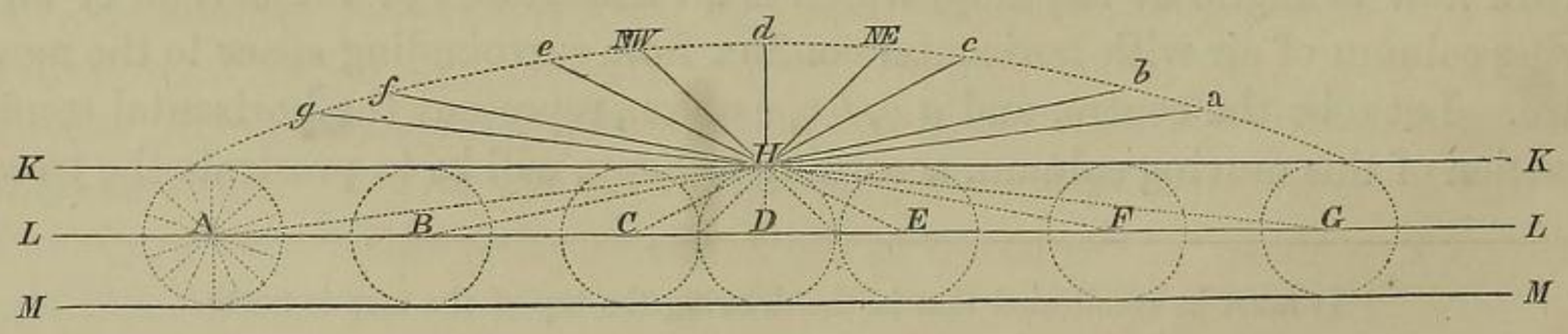
shown in diagram 6, and as described in his Meteorological Reports: "The manner in which the trees are thrown down where the tornado passes through a forest, will demonstrate the direction of the wind. The trees at the sides of the path of the tornado, as it moves in this latitude to the east, or a little north of east, will be thrown *inwards* towards the centre of the path, and those in the centre of the path will be thrown right backwards contrary to the motion of the tornado, or right forwards, according as some of them will be thrown down by the front part of the meteor, where the wind blows backwards, or by the rear, where the wind blows forward; and, as those which are thrown down by the front of the tornado must fall first, they will, of course, be found, where there is any overlapping, *under* those which fall forwards."

On comparing this description with the track at New Harmony, Fig. 2, we find the phenomena there represented totally at variance with it; on the north side of the path, adjoining the S. W. corner of Schnee's fence, there are numbers of trees prostrated to the north, and directly *outwards* from the centre of the path; the same thing occurs in many places on both the north and south sides of the path. In the centre of the path there are trees lying at right angles to the course of the tornado; and those trees, which Mr. Espy describes as being thrown down by the meteor where the wind blows backwards, in many cases lie *over* instead of *under* those that fall forwards; this will be seen by examining the groups of crossed trees where they are numbered, the lowest number indicating the undermost, and the highest number the uppermost prostration.

Seeing these discrepancies, we cannot wonder that Professor Loomis, when he witnessed at Mayfield, phenomena similar to those of the New Harmony tornado, should come to the conclusion that the wind in tornadoes blows round, and to the same point at one and the same time, each motion "well nigh masking the other." Yet I think if he had plotted those trees, of which he took the bearings, instead of calculating their mean numerical values, he would hardly have come to the conclusion that the Mayfield tornado was a whirlwind, rotating in the direction west, north, east; for his examples show that the rotation could be neither in one direction nor the other.

It is owing, I think, to the want of an accurate and sufficiently extensive description of the track of a tornado that the rotatory hypothesis prevails, for I believe there is nothing in the phenomena at New Harmony that cannot be explained by that of the ascending column. It does not appear to me to be inconsistent with this theory to suppose a tree on the margin of the track to be as likely to be prostrated *outwards* from, as *inwards* to, the centre of the path. Let *K K*, and *M M* (Fig. I), represent the right and left margin, and *L L*, the axis,

Fig. I.



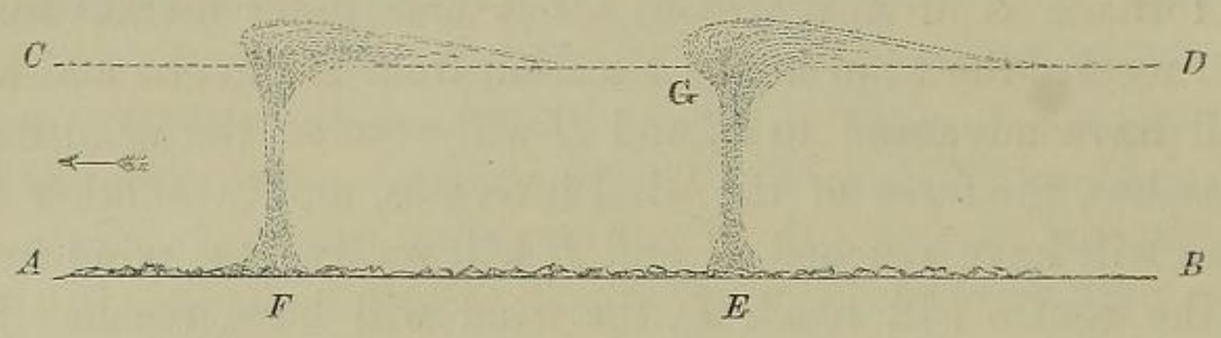
of the track of a tornado; suppose the track to be one mile wide. Let *H* be a tree standing near the left margin; let *A* represent the bottom of the ascending column, and the radii the afflux of air to the focal area; let this focal area have a progressive motion from *A* to *G*, at the rate of one mile per minute. When the centre of the tornado is at *A*, it will be about four miles distant from *H;* consequently *H* will receive the wind in the direction from *A;* in one and a half minutes the centre will have advanced to *B*, and *H* will receive the wind from *b;* as the tornado approaches, the force of the wind increases, and in another minute and a half the centre will have reached *C*, and *H* will receive the wind from *c;* in the next minute the centre will reach *D*, the wind will have reached its maximum force, *H* will receive the wind from *d;* the wind in the last minute having veered, with increasing rapidity, sixty degrees; this is continued for another minute, until the centre reaches *E*, when *H* will have the wind from *e;* in the last one and a half minutes the wind has veered, with maximum velocity, from N. E. to N. W.; and, during this rapid change, and greatly increased velocity, is it unlikely that, as the tree is successively swayed round, the force of the wind should at this moment be such as to prostrate the tree directly outwards, with the top of the stem at right angles to the centre of the path? This I think highly probable; and the prostrated trees show, more or less, that where they had the power to withstand the first impulse of the wind, they have been successively swayed round; this mode of action may be traced from one margin of the track to the other. Figs. 7, 8, 9, of the map, are illustrative of these points. Fig. 7 is a view near the north margin of the track, adjoining the S. W. corner of Mr. Schnee's fence, looking east; the trees are prostrated nearly due north, and exhibit the appearance of being suddenly twisted, and thrown outwards from the centre of the path, as described.

Fig. 8 is a sketch near the centre of the track, looking S. W.; here is a tree prostrated from the N. W., interlocked in the forks of one prostrated from the S. E., with three trees lying between them from the S. W., most clearly evidencing the simultaneous overthrow from opposite points. The tree in the front, in a northerly direction, and the illustration in Fig. 9, are further examples of the swaying round and twisting of trees. It is taken from near the centre of the track.

Another illustration in favor of the hypothesis of an ascending column, may be drawn, I think, from the barometrical observations made at New Harmony. It will be observed that the barometer fell half an inch from April 27 to the day of the storm, April 30. This fall was so gentle that it did not on any of those days mask the 9 A. M. maximum horary oscillation, and it may therefore be inferred that the disturbing cause was distant. At 3 P. M., on the day of the storm, one hour and a half previous to the tornado passing the meridian of New Harmony, the height of the mercury in the barometer was 29.090 inches; at 4.30 P. M., at the time of the passage of the tornado, it was 29.170; and at 6 P. M., one hour and a half after the passage, it was 29.090. This sudden rise and fall of 0.80 of an inch at the time, which is usually that of the minimum horary oscillation, is remarkable, and we may attribute it to the local action of the tornado, and account for it by Espy's hypothesis, as explained in the following paragraph.

Let *A B*, Fig. II, represent the track of a tornado, the dotted line *C D* the height or weight of the atmosphere at New Harmony, at 3 P. M., and at 6 P. M., one

Fig. II.



being one hour and a half previous, the other one hour and a half subsequent, to the passage of the tornado. Imagine *E G* to represent Espy's ascending column of air, with horizontal conflux at the base from the surrounding space; suppose the column to reach the top of the atmosphere, *C D*, and the air in the ascending column to be spreading out and overlapping the air in the surrounding regions, in the vicinity of the tornado, and by increasing the weight of the air around, causing the barometer to rise. Suppose *E* to be the meridian of New Harmony, over which the column, or tornado, is passing. Suppose *F* to be the meridian of Leavenworth, and that *F* is ninety miles distant from *E*, and now imagine the column in motion, and progressing towards *F* at the rate of a mile per minute; and that after an interval of one and a half hours, it has reached *F*. During this progress of the column we may conceive the translation of an atmospheric wave, and as the meteor passes on towards Leavenworth, we may imagine the gradual flowing away of the air, and the restoration of the equilibrium of the atmosphere to the degree that existed previous to the coming up of the meteor, or disturbing cause.

In conclusion, in referring to the different causes from which it is said tornadoes originate, my opinion is that the phenomena are incompatible with the rotatory hypothesis; and this opinion is strengthened by my inability to conceive, how any deflection of trade-winds by mountains, or action on the air by the different rotative velocity of the earth's surface, can originate these meteors: I cannot conceive the probability of the bodily rising, on a particular point of the intertropical plain of America, of an intensely heated column of air, with an ascensional force sufficient to carry it into the upper strata of the atmosphere, with the full westerly energy derived from the earth's rotative velocity; producing in its course a ripple, which, on its return, strikes far below into the lower current, creating the necessary condition of a rotatory storm, in which a mass of air, animated with immense velocity, forces its way through an atmosphere, either at rest, or moving in an opposite direction, creating vortices, subsisting and wandering over great tracks, long after the original impulse is withdrawn; I cannot conceive, whatever may be the velocity originally communicated to any body of air, how at 800 miles distance from the tropic, it could still have the power to subsist, and, without further support, have energy sufficient to continue its destructive career for 250 miles, tearing down trees at the rate of 7,000 on a mile, per minute.

Though I am inclined to believe in Professor Espy's idea of an ascensional column, of its origin, whether derived from the condensation of vapor, as affirmed by Espy, or from electrical action, as contended for by Dr. Hare, I do not offer an opinion. I chiefly desire that the contribution I here present may be useful in the establishment of correct opinions as to the mode of action in tornadoes, and to assist by facts any who are seeking to penetrate those depths obscure, in which the origin of meteorological phenomena are buried.

EXPLANATION OF THE QUARTO PLATE.

THE opposite quarto plate is intended to represent a group of trees, on the track of the tornado, about three hundred yards a little west of south of the five mile post on the New Harmony Plank Road. It is another view of the group represented in Fig. 8 of the map; that view is taken from the bottom of the hollow looking southwest: this one is taken from the top of the hill looking northeast to the side of the opposite hill.

The tree in front, parallel with the bottom of the picture, and marked No. 1, in the ground plan below, is the undermost tree, and was prostrated from the southeast. Nos. 2 and 3, in the plan, prostrated from the south-southwest, lie to the right out of the picture; they are shown in Fig. 8 of the map. The tree twisted off near the right margin, marked No. 4, in the plan, is from the southwest. The tree in the front of the picture, at the bottom, marked No. 5, in the plan, is from nearly west. Nos. 2, 3, 4, and 5 lie over No. 1. No. 6, in the plan, from the northwest, is the tree interlocked in the forks of No. 1, and overlying all the others; exhibiting the remarkable peculiarity of a southeasterly interlocked in a northwesterly prostration, and having four westerly and southwesterly prostrations between them.

PUBLISHED BY THE SMITHSONIAN INSTITUTION,

WASHINGTON, D. C.

APRIL, 1855.

T. Sinclair's lith. Phila.

GROUP OF TREES PROSTRATED BY THE NEW HARMONY TORNADO.