

## PAPER V.—THE CANADIAN ECLIPSE PARTY, 1869.

BY COMMANDER ASHE.

(Read before the Society on the 27th April, 1870.)

Before giving an account of my proceedings in reference to the eclipse, I think it only right, in justice to our party, to state that the arrangements were made very hastily, as it was not until the last moment that would admit of my reaching the station allotted to me by the American astronomers, viz., Jefferson City, that I was informed that \$400 had been appropriated for the purpose of taking my telescope to Iowa.

The party consisted of Mr. Douglas, Mr. Falconer, and myself.

As we had only three days to get ready, there was much to be done, dismantling the telescope and making cases for the several parts, and carefully packing photographic materials. Instead of the stone support for telescope (eight inches aperture and 9 feet focus) I had one made of wood, but as the centre of gravity was raised so high by using wood, I had to take great care in the formation of the base; however, the stability was excellent. Our arrangements were all complete by the 26th of July, and we started that evening by the Montreal boat.

For the benefit of those who may undertake an expedition of a similar kind, it may be well to mention a few incidents that occurred during our journey, which, although trifling in themselves, may prove useful to future eclipse parties. I may mention that two of the cases, containing parts of the telescope, were directed "Eclipse Expedition," with three i's in Expedition. This was pointed out to me at Montreal, but the mistake is excusable, for evidently

the more eyes we have in an astronomical expedition the better. With regard to original spelling, I will relate the following anecdote, which would have suited "Artemus Ward."

The boatswain of a man-of-war has to keep a rough expense book of the different stores that he uses, and this is checked by the master, who on one occasion sent for Mr. Parks, and when he came, he said: "Oh, Mr. Parks, you have expended too much rope for those 'jib guys;' it will surely be found fault with; you had better reduce the quantity;" and on handing him the book, he said: "By the bye, b-l-o-x is not the way to spell blocks." The boatswain took the book very sulkily; and after he had taken two steps towards the door, he turned round, and said: "Well, sir, if b-l-o-x don't spell blocks, what do it spell?"

We started on our journey by the evening train. When we arrived at Port Huron our first difficulty occurred; the Custom-House officers would not pass our baggage, although we pointed out the great importance of our party, and also, that the moon would not wait an instant for us. They did not see it; so our baggage was locked up for the night. We took rooms at a small inn, and then Mr. Douglas and I went by rail to Huron, to see the head of the Customs. After going up two flights of stairs, we were shewn into a room which two gentlemen occupied. The chief was smoking, with the chair resting on its two hind legs and his resting on the table. We told our story, and shewed him a certificate from the American Consul at Quebec. He looked very hard at me, took the cigar out of his mouth, wrote a pass which he handed to me, and then resumed his cigar and former position. We began to thank him, but as he hid himself in smoke, we retreated down stairs.

I never was more struck with the kindness of our American cousins than I was during this trip. On all occasions, they did all in their power to promote our convenience. In the

morning we had time to see Mr. Muir, the director of the railway, who kindly gave us a free passage over his line, a kindness that was shewn to us by all the directors of the different lines that we travelled on. I may remark that the cases with the heavier parts of the telescope were broken, and I much feared that the instruments would be seriously damaged. Mr. Muir very kindly had outside cases put on, and I carried the most valuable part (the object glass) in my hand. After we left Chicago, and before going to bed, we left word to be called before crossing the Mississippi. It is not fair to judge of scenery from a view taken through the window of a railway car, but I must say that I was disappointed,—shallow, sluggish, and muddy; but then I ought to remember that I live on the banks of one of the finest and most beautiful rivers in the world.

In the morning we were on the prairie, which is not so flat as I had expected to see it, but it is a beautiful undulating country, and if there were trees upon it nothing more could be desired. It was explained to me by a gentleman who was travelling with us, the reason why trees do not grow on this beautiful land. It appears that on the eastern bank of all rivers and streams only do trees grow; now without entering into the cause of the prairies catching fire, I will only say that in September, when the long grass is quite dry, they do catch fire, and then burn until it is stopped by a river, and as it always burns to windward, and as the wind generally blows in one direction, we have a solution why the trees only grow on one side of a river; and once the primeval forest is removed, it never has a chance of growing again, as the young trees are sure to be burnt, and the beautiful black soil of the prairie is enriched by the deposit of burnt grass.

At one station where we stopped to water our engine, I saw two children of the soil; they have good reason to complain at their lot. The buffalo and antelope driven away, and if they are hungry they are told to go and dig;

dig, how can they dig? let us reverse the picture. Suppose that our cities and towns were by the Indians turned into a prairie, and when we were hungry they told us to go away and catch a buffalo, a pretty hand I should make of catching a buffalo. The sooner the poor fellows are shot down or killed by small-pox, the sooner they will go to their happy hunting grounds.

As the Norway rat kills all other rats that it meets, so the savage must disappear, and the Northern races of Europe will exterminate them.

There is one exception, the African negro, and no matter what you do to him he thrives under the treatment; whether free or in slavery he multiplies and is happy. Strange that rum which kills the Indian, only makes him fat.

But the king of savages—the New Zealander—has the fairest island, in the most favored clime, taken from him, and civilization forced upon him.

There is no getting away from this civilization now. But I am thankful to say that I was at San Francisco before it arrived there. When out shooting I saw the fresh foot-prints of a grizzly bear, and did not know how far the gentleman might have been from me at that moment. Now, I should like to know how far you would have to travel, and how much you would have to spend, before you could experience the same delightful sensation.

I have seen real Indians with real bows and arrows, in Vancouver's Island; and the place where I then saw them, now has become the head-quarters of the Pacific squadron; and the Indians, instead of flattening their heads, no doubt have put on the Grecian bend. Where is all this to stop?

It was pointed out to me that most of the telegraph-posts were struck by lightning; no wonder; for that king of natural



forces, that for so many thousands of years has reigned supreme—splitting the granite rock, and shivering the mighty oak at his will—now to be brought into existence at the will of an apothecary boy, placed in two cups and locked up in a cupboard, and then made travel day and night, over hill and dale, and under the vast ocean, to carry messages at the bidding of man,—no wonder, I say, that he should try and knock the whole concern into a cocked hat!

“Boonsboro! twenty minutes for dinner!” Now, then, we shall have something in keeping with the prairie,—I suppose a deer roasted on a stake. Nothing of the sort. I went into a nice dining-room; saw a quantity of pretty girls, or rather young ladies, with short sleeves and low dresses. “Soup, sir! chicken, sir! peas, sir!” The station at Rugby is nothing to it. After twenty minutes of capital feeding, we heard, “all aboard! all aboard!” and as we left, the father of these young ladies was standing at the door, and obliged us by taking half-a-dollar, a great improvement on the English system, where, on asking the waiter for your bill, he asks: “What ’ave you ’ad?” and begins to add accordingly. The next station was Jefferson, 1,398 miles from Quebec. Here the boxes were again thrown out, and the train left for San Francisco. The boxes were left at the station, and we drove up to the hotel, about half-a-mile from the station. As this was Saturday, July 31st, we had exactly a week to select a site and to build an observatory—mount the telescope and take preliminary observations. The American parties were several weeks at their station before the day of the eclipse, and found it not too long to prepare.

Jefferson city is three years old, has about eight thousand inhabitants, and looks a thriving place. The next day, after church, Mr. Douglas and I rode across the prairie to a station situated about eight miles on the railway from Jefferson. As it was nearer to the central line of eclipse, we wanted to see if it would do for the site of our observatory.

I forgot to mention that the day before I left Quebec, in pulling off my boot I broke the tendon of the plantaris muscle, which made me quite lame. However, the six days' comparative rest made it much better, but still it was far from well.

We started for our ride across the prairie about two o'clock, and reached the station in about an hour and a-half. We crossed several streams and some marshy ground, and started several prairie chickens. After examining the place, and finding that it would be very inconvenient to get the material there, we thought that it would be better to remain at Jefferson, and we mounted to return. After we had left some time, and as I was suffering from my leg, and could not ride fast, I persuaded Mr. Douglas to ride on, and get back before sunset to keep an appointment with a carpenter, and not to mind me, as I could ride slowly back. He very reluctantly did so, and when I was left alone, I felt quite at home, steering my horse across the boundless prairie by the setting sun. Now, my horse had crossed many streams, and soft wet places in going out, so I took it for granted that he knew more about the prairie than I did, and would not allow me to get into difficulties, and consequently steered a straight course for that point of the compass in the direction of Jefferson. The sun had just touched the horizon. I was crossing some marshy ground with reeds up to my shoulders, when I saw my horse's nostrils distended, and his ears forward. I immediately put my helm down and brought him round, and just as I had done so, down he sank; I found myself up to my ankles in mud, and up to the calf of the leg in water; the horse was fixed immovable, no struggling, but snorting and dreadfully frightened. I have been in various situations of difficulty; but when I looked up and saw the tall reeds far above my head, and the sun setting, I must confess that I thought my case a serious one. I remembered the fate of a young French officer of the combined fleet that was at anchor at the entrance to the "Dardanelles," who went on shore to shoot, and as he did not return that night, we landed in the

morning to look for him, and not far from the ship, we found him in a bog up to his waist, his gun a few feet in front of him, and he quite dead. I knew that if a man once gets up to his waist, it would be impossible to extricate himself; however, when I dismounted I sank up to my knees, and although that was not the place to philosophize, still I did so, and I began to think what is the reason that a man in struggling works himself down, and I immediately discovered that on raising the heel I produced a vacuum, as the mud prevents either water or air getting underneath the foot, and so with 15lbs. to the square inch, in addition to your weight you soon disappear. That being the case, I did not attempt to raise the foot, but moved it backwards and forwards in a horizontal position until I made the hole so big, that water got under the foot, when I could lift it up with the greatest ease. After extricating myself I tore down some reeds and made a platform round my horse, then I patted his neck, and spoke good-naturedly to him, and then went astern, and by means of his tail worked him backwards and forwards with a rolling kind of motion to let the water well round his feet, and lastly went ahead, passed the bridle over his neck, and sat down with it in my hands right ahead. Now, then, old boy, "up she rises," the horse began to struggle, I kept the head-ropes taut, and he was freeing himself bravely. If I let go the bridle too soon, he would go back; if I held on too long, he would be upon me, and not only kill me but bury me, so at the critical moment I let go, and rolled over and over amongst the reeds, and the horse floundered past me. When I got on my feet no horse was to be seen, but only the tops of the reeds moving as he was making his way out. I thought I had not improved my situation much, for with my leg I could not walk a mile, and, of course, the horse had shaped his course for the stable. However, when I emerged from the reeds, I saw the dear old fellow standing as still as if he were in his stable. But now came another difficulty with my lame leg, I could not put a foot into the stirrup, perhaps he might have been in a circus and

taught to lay down, so I began kicking his forelegs and lifting up one and then the other—but no—he had no idea of it: then I thought I would lash his feet together with the bridle and throw him down, but there might be some difficulty in my remaining on his back when he floundered to get up, well, if the worst comes to the worst, I will lash myself to his tail and make him tow me home; but an idea struck me, I lengthened the near stirrup to about a foot and a-half of the ground, and then lengthened the other and brought it over on the same side, and here I had a nice little ladder to walk up which I did, and then knelt on the saddle and dropped into my seat. I could not help shaking hands with myself, and patting my steed on the neck, I then commenced my journey home, which I reached just before dark.

We had agreed to erect the observatory about half a mile from the station, on a rising part of the prairie; carpenters were engaged, and an arrangement made with a lumber merchant, who would supply what I wanted and take it back when I had done with it, only charging us for the damage done to the stuff. Early on Monday morning, the instruments were carted out and unpacked; and at sunset the four walls of the observatory were up. Now, as we thought it not advisable to leave all these things open on the prairie, it was agreed that some one should sleep there—and, of course, it was my duty to remain. They sent down a mattress, pillow, and blanket; there was no wood to build a large fire outside, but I collected some chips, and lit a small fire inside, and placed my mattress alongside. A little after sunset a musquito looked over the wall, and then sounded the assembly; on they came, and I with my head in the smoke kept blowing the fire, putting on wet grass to make a smoke; but, after half an hour at this work, I found out the fact that man was not intended for a pair of bellows, and although I assisted the action by compressing my sides with my hands, still at the end of the half hour that I blew I found that I was blown. When once my head was out of the smoke, the musquitoes



flew at me ; I stood up to fight them, but in so doing I had to fight myself also. Now an army was drawn up in contiguous columns on my cheeks, the skirmishers advancing through my eye-brows ; at their first volley I felt as if I was struck with a hackle. I really think that they work their stings like the needle of a sewing machine. Maddened, I struck myself a fearful blow with both hands in the face, and had the satisfaction of making them "leave that," and so I fought myself and the mosquitoes for some time : still they attacked me with an impetuosity truly marvellous, and where one fell two took his place. I was getting weak ; a storming party had now taken possession of my right ear ; I clenched my fist, and with a swinging blow, cleared the ear, but knocked myself down. Exhausted and worn out, I put my hands into my pockets, and gave them my head. In that half-dreamy state, the long, long hours were passed ; and after they had breakfasted, dined and supped, they began to discuss me. "Ah," said one, "if you want a good drink, strike between the corner of the eye and the nose." "No, no," said a large party ; "if you want a draught of good sparkling astronomer, sink your pump in his temple." "You are wrong," said a dissipated old fellow with frayed wings ; "just creep up his cuff, and harpoon his wrist, and there you will drink until you lift yourself off your legs." Then they sung the following

## SONG.

"The blood of the Indian is dark and flat,  
 And that of the buffalo hard to come at ;  
 But the blood of the astronomer is clear and bright :  
 We will dance and we'll drink the live-long night.

Chorus :—"How jolly we are with flights so airy ;  
 Happy is the mosquito that dwells on the prairie."

And then they quarrelled and fought with each other, and made speeches,—and so the dreary hours dragged along ; but when the eastern horizon was tinted with beams of light, they staggered off to their respective marshes—some to die of apoplexy, others of *delirium tremens*. Verdict—served them

right. From dawn until six, I had a refreshing sleep, and when my relief came, I awoke up, and began to think whether I had heard all this, or only dreamt it. I suppose I dreamt it.

The work now made rapid progress: doors with locks, dark room settled, platform for telescope support firmly laid. The next day, began to mount the telescope, but when we came to screw in the object-glass, we found out that the brass seat in the tube had been pressed into an oval. What was to be done? No one in Jefferson that knew anything about it; too late to send it anywhere; here was a great break-down. However, a Mr. Kelly said he would try; and after some hours' hard work, he got the object-glass screwed home, but could not be unscrewed; so the nuts that hold the bolts that secure the object-glass to the telescope could not be put on, but we secured it as well as we could.

It is important to mention that before arriving at Jefferson, we made the acquaintance of a Mr. Vail, from Philadelphia, who was going to Des Moines to observe the eclipse, and as I had a 42-inch telescope by Dolland, without an observer, I asked him to join our party and observe the eclipse with it, which he kindly consented to do; and his report is of the very greatest consequence, as it confirms, in a most striking manner, the details that are seen in the negatives.

By Friday night, all preparations were made, and we retired to rest with great doubts about having a fine day. However, Saturday came at last, and the morning was hazy and overcast; but about eight, the clouds began to break and Mr. Vail and I took some observations for "time." The afternoon was cloudless; but still a haze near the horizon. At half-past three, we "Beat to quarters." Mr. Douglas shut himself up in the dark room; I took charge of the telescope; Mr. Stanton, with a light cloth, covered and uncovered the "object glass;" Mr. Vail had his telescope nicely adjusted; and Mr. Falconer was seated in a very good position to

observe the dark shadow crossing the country, and to note any other phenomena. At 3h. 38m. 40s., local mean time, the first contact took place, and the first photogram taken, shewing a slight indentation on the sun's limb. We took the partial eclipse with an eye-piece, giving a 3-inch picture ; but as it was hazy, I removed it before totality, and took the photograms in the principal focus.

I may remark that no one could have had a better view of the eclipse than I had. As I stood in rear of the telescope, I had only to count the double beats of the pendulum of the "Driving Clock," which I did without taking my eyes off the moon.

I exposed the plates of totality for ten seconds, then withdrew the holder, and handed it to Mr. Douglas. We took several photograms of the partial eclipse before totality, four during totality, and two after ; but the weather had become so hazy, immediately after the sun made its appearance, that we could hardly get a picture. As all the reports are published, it only remains for the Jefferson party to give theirs, and the eclipse of 1869 can be fully discussed. There are one or two points that the negatives of our party will throw a light upon.

With regard to the bright band on the sun, bordering the moon, in the pictures of the partial eclipse, it is well known that there is nothing surrounding the moon that could produce that effect ; and also, that the photograms taken at Burlington, shew, beyond a doubt, that it is no optical illusion. Dr. Curtis has suggested that it is caused by diffraction ; still, I very much doubt if diffraction could produce such a uniform dark broad band, so well defined, as is seen in those photograms. One of the photograms of the partial eclipse that we took before totality, shews the cusps and edge of the moon to be double, giving the appearance of a band surrounding the moon. This is caused by the reflection of the moon from the second or underside of the

glass, which happens when the sun is not in the centre of the field; and by holding the negative of a partial eclipse so that the light will fall obliquely on it, you will see a dark band surrounding the moon's limb, from the same cause.

“BAILEY'S BEADS.”

In the eclipse of 1860, I had the honor of being attached to the American Expedition that went to the coast of Labrador. Professor Alexander, Dr. F. A. Barnard and myself, who were observing with telescopes, all exclaimed at the same time, “Bailey's Beads!” It is very true, that at Otumwa a picture at the last instant, just before totality, was taken, “shewing the sun's edge cut by the peaks of the lunar mountains into irregular spots;” but these were not the Bailey Beads that I saw in Labrador, and I am confident that neither Professor Alexander nor Dr. Barnard will accept that solution. In the report of Mr. W. S. Gilman, junr., who observed the eclipse at Sioux city, Mr. Farrel gives a description and drawing of Bailey's Beads; and what he saw in 1869, I saw in 1860, the film of light broken into rectangular pieces, which appeared to swim along the edge of the moon like drops of water.

A crowd had followed us from the town, and took a position near the observatory, as, no doubt, they thought that we would select the best place for observing the eclipse.

On the last glimpse of day-light vanishing, the crowd never fail to give expression to their feelings with a noise that is unlike anything else that I have ever heard. It is not like the noise that a crowd makes on seeing a lovely rocket burst, or that which they make on seeing some acrobat perform a wonderful feat. No; there is an expression of terror in it. It is not a shout; it is a moan.

Before giving a description of the photograms of the Total Eclipse, it will be necessary to refute some opinions that



have gratuitously been given respecting them. After I had carefully examined the negatives, and made drawings, I had the drawings and the negatives compared by Mr. Langton, who expressed his opinion that they were faithful copies; and when I found that it would be many months before I could get funds to print my Report, it was agreed upon, after consulting some friends, that the negatives of totality should be sent to England. Unfortunately, I selected Mr. De la Rue as the fittest person to examine them. He never acknowledged the receipt of them, and, after many months, Mr. Falconer, who had returned to England, sent me a copy of a letter to him, from Mr. De la Rue :

“ THE OBSERVATORY, CRANFORD, MIDDLESEX,

“ Dec. 27th, 1869.

“ My Dear Sir,—I am very sorry to have caused any uneasiness to Commander Ashe; but one circumstance and another have delayed my writing to him. I have received his papers, which I sent to the Astronomical, and later on, the original negatives, which arrived safely, although Commander Ashe had neglected the precaution of protecting them with a covering of glass. There is evidence in these negatives of the telescope having moved, or, perhaps, followed irregularly, during the exposure of the plates, and this renders the dealing with the negatives very difficult; moreover, it contradicts the theory set forth by Commander Ashe in respect to a certain terrace-like formation in the prominences, and also the rapid shooting out of a certain prominence. The American photographs are very much more perfect than those sent by Commander Ashe; in fact, they leave nothing to be desired. To correct the defects of duplication in Commander Ashe's photographs, would entail some expense,\* and much trouble; and it would be necessary for him to re-write his paper.

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\* I understand that Mr. De la Rue has spent £300, in patching up Major Tennant's photograms.

"I have only returned to my house (after an absence of a year) a few months ago, and have had Major Tennant's paper to see through the press; so that my correspondence has fallen greatly into arrears. Wishing you the compliments of the season, I am, with best regards,

"Yours sincerely,

"WARREN DE LA RUE.

"Alexander Pytts Falconer, Esq.,  
"Bath."

Here is a very serious charge. I am accused of foisting on the public a marvellous account of the eclipse, which my own negatives contradict; but I shall have no difficulty in shewing conclusively that Mr. De la Rue has made a blunder, when he says that "there is evidence of the telescope having moved, or, perhaps, followed irregularly." It would have been better had Mr. De la Rue produced his evidence before he takes upon himself to assert that the negatives contradict my statements.

But the crimes I am charged with are, that on the 7th of August last, some person or persons did, accidentally or maliciously, disturb the telescope, during the exposure of plates Nos. III. and IV., and that the said plates mislead, and are not faithful representations of the phenomena seen; and also, that they contradict the statements of Commander Ashe, with regard to the "rapid shooting out of a certain prominence."

In clearing myself of these heavy charges, I shall divide my evidence into two parts—negative and positive.

In the first place, the telescope was firmly placed upon a platform made by the heavy sleepers borrowed from the railway station, and surrounded by boards, as may be seen in the photograms; and Commander Ashe has been too long at sea to travel 1398 miles with a heavy telescope, and then

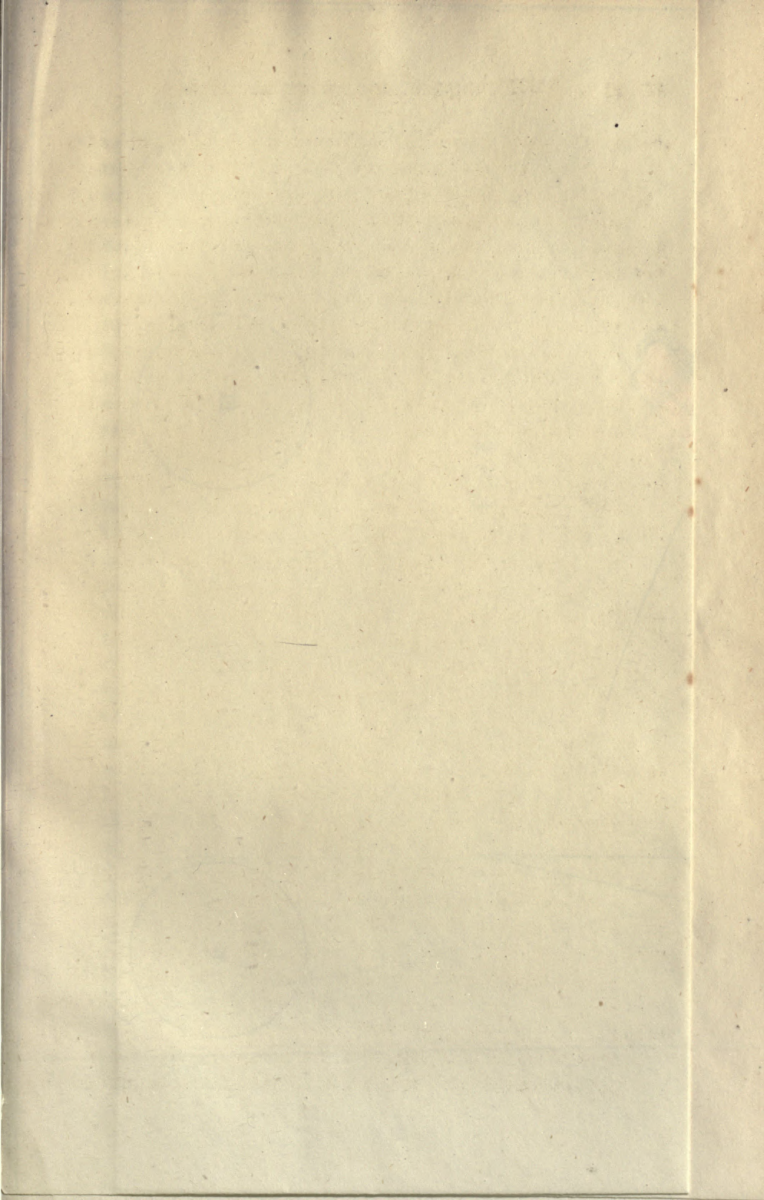
not to be able to give it stability. There were four persons inside the building—Mr. Falconer, seated some distance from the telescope, observing the general appearance of the eclipse with the naked eye ; Mr. Stanton upon a platform, ready to uncover and cover the object-glass with a light cloth ; Mr. Douglas in the dark room, and myself at the telescope, which was firmly clamped in hour-angle, and declination. The people outside were at a distance upon an elevation, and were quite still. The telescope, if it moved, must have moved in hour-angle, or declination, or in both ; if it moved in hour-angle, the endless screw must have tripped upon the driving-wheel, which it could not do without making a noise, which would have been heard by me. If it moved in declination, Mr. Stanton must have moved it in uncovering the object-glass ; but in so doing, he must have given the telescope a pretty hard blow, of which he must have been aware. But neither Mr. Stanton nor myself are aware of any disturbance of the telescope. There was no wind, which would only have caused a vibration, and given a blurred image. In examining Nos. I. and II. photograms, the limb of the moon may be clearly traced, and there is not a shadow of suspicion of any relative motion in the telescope. Here we have proof that the driving-clock was performing its duty well for the first half of totality ; and no one will have the hardihood to say that it altered its rate in the next minute and a-half. In looking at No. IV. photogram, we see that a point of light is double. Now, we will suppose this duplication was caused by the telescope receiving a smart blow ; then, by drawing a line through the two positions of the same object, we get the direction of the motion. Now, look to the right and we see a protuberance with a triplicate form. Here, then, the telescope must have received two blows ; and by drawing a line along the top of the three figures, we get the direction of the motion, or disturbance ; and on looking at the different directions of the two motions, we see that the telescope moved two ways at once, and also, that one part of the plate was disturbed once,

whilst another part of the same plate was disturbed twice—which is absurd; and lastly, Mr. Vail who had not seen the photograms when he wrote his report, gives a description of certain lines and cracks that are to be seen in the negatives when they are examined by a lens. How is it possible to get over this? Here, an American gentleman sees with a telescope exactly what is photographed. But this is negative testimony; I will now prove, conclusively, giving geometrical evidence, that Mr. De la Rue has made an egregious misstatement. The reader will have it in his power to corroborate this testimony. Place a piece of paper behind the photograms III. and IV. (taken in the principal focus), and with a needle make holes in four or five different places, taking care not to mark the bottom of a protuberance, which is a notch, but where you can see distinctly the limb of the moon; then remove the paper and find the centre of three holes, and draw a circle through them; and if it passes over the other holes, you have positive proof that the centre did not move during the exposure. Now, look at the lithograph, and you will see a circle drawn through five marks made upon the limb of the moon of No. III., and through four marks made upon the limb of the moon of No. IV.—*Q. E. D.*

Having proved that the very remarkable photograms taken at Jefferson are correct representations of the phenomena seen at that place, I will proceed to describe the details of the four negatives that are to be seen when examined with a lens.

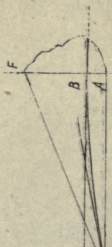
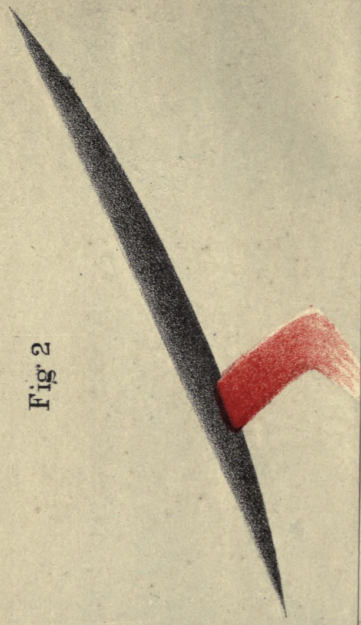
The moment the sun disappeared, out flashed the corona, which resembled an aurora, and no doubt belongs to the sun, and not to the moon. No. I. shews the continuous mass of red matter with the flame-like appearance of the so-called "Ear of corn;" a little to the left are seen two detached red lumps, like glowing coals; and underneath is seen the slightest trace of a prominence that is to play a conspicuous part in the eclipse. No. II., the limb of the moon, is seen





face p 101

Fig. 2



completely round, and a little more is seen of the prominence underneath. Now, it is time to remark that the flame-like mass in No. I., and the detached prominences in Nos. I. and II., appear to cut in upon the limb of the moon. Dr. Curtis, after trying several experiments, is firmly convinced that this appearance is entirely due to a photographic effect, by excessive over-exposure of the plates. I have to remark, that nothing was more conspicuous than the indentations of the glowing masses upon the limb of the moon. Remember that these protuberances were not dazzling lights, but could be contemplated with the greatest comfort; and the eye is so fastidious, that in running round the limb of the moon, it immediately detects the sudden break in the circumference. But I have a theory, and it is dangerous to trust the eye of a man with a theory, without good support. Directly after the eclipse, some of those outside joined us, and the conversation was upon the extraordinary shooting-out of the prominence, which they were all describing. In the midst of the conversation, a carpenter touched me on the arm, and said: "But what were the notches on the moon?" Now, this is conclusive evidence, and would be taken in any court of law. Remember, the word "notches," (the language of a carpenter) is his own, and no other word do I think so applicable. I answered that I did not know, and that nothing puzzled me more. On examining the negatives with a lens, I saw the limb of the moon distinctly through the prominence; and further, that the part on the moon was a similar and inverted figure to the upper part, and I was convinced that the "notch" was caused by reflection of the protuberance on the surface of the moon.

Let  $BF$  be the height of the protuberance, and  $LB$  the line of sight, tangent to the point  $B$ , and let the lines of sight, both direct and reflected, be considered parallel to each other; now, through the point  $D$  draw a tangent, and let the incident ray,  $FD$ , and the reflected ray,  $OD$ , make equal angles with it; then, the exterior

angle,  $ODC$ , is equal to the angles  $DAC$  and  $ACD$ ; take away the right angles,  $D$  and  $A$ , and we have the remaining angles,  $ODE$  and  $C$ , equal; and  $BA$  (the depth of the notch) is equal to the versine of the angle of reflection.

In measuring the enlarged photogram,  $BC$  was 1.87 inches, and  $BF$ , 0.07 inches; and as  $BC$ , the moon's semi-diameter on the 7th August, subtended an angle of  $16'.29'' = a$ . Let  $CF$  subtend an angle  $= y$ .

$$\text{Then cotan. } y = \frac{1.87 \text{ cot. } a}{1.94} = \frac{17.54}{16.29} = y.$$

$$\text{Angle subtended by protuberance} = 1.25''.$$

As Mr. Douglas had no one to help him in the dark room, there was some delay in getting No. III. plate; but whilst I was waiting for it, out shot an enormous flame from the bright point before mentioned. It shot out in about three seconds, not unlike a jet of gas from a coal in the grate; and when it reached its greatest height (about one-third higher than that seen in photogram), it was blown off to the left, just like a flame acted on by a "blow-pipe," and came to a point. The part blown off was a bright white flame. (See lithograph.) Now, as my veracity, after Mr. De la Rue's letter, is doubtful, and as this phenomenon was not seen any where else besides Jefferson, I must substantiate the fact. Mr. Falconer, in his report to me, gives a drawing which is very similar to fig. No. 2; he says: "It assumed the shape of a red-hot crooked bar of iron; this, resting on the dazzling silvery coronal light, gave a strange and wondrous addition to the glorious scene we now beheld." But it was seen by all, and can be attested to by hundreds.

When No. III. plate was ready, it had lost about one-third of its height, and its flame-like appearance.



When No. III. plate is examined with a lens, all the lines that are shewn in fig. 3 are seen ; and here I must make an extract from the report of Mr. Vail, who was observing the eclipse with an excellent 42-inch telescope, by Dolland, and who made his report long before I had examined the negatives with a lens. In speaking of this protuberance, he says: "Its outlines were perfectly well defined, and were not curves, but rather irregularly broken straight lines, and throughout it seemed marked by similar lines. It reminded me of the appearance one sometimes sees on the face of a cliff, where the rock is broken by horizontal and vertical lines." Now, it is most evident that Mr. Vail saw with a telescope what I photographed ; and further, it would be impossible to have these delicate lines in a photogram, if there was any relative motion. Without entering into any discussion about what the protuberances are, or are not, I will only say that when the flame burnt out, the residium was a cinder, and which is shewn in photogram No. III.; this quickly tumbled down into a great heap, as seen in No. IV.

But the fault of the Canadian party consists in not having photograms similar to those of the American astronomers, which all more or less agree with each other. This is extremely hard, and although I congratulate those gentlemen on their well earned reputation, still I trust that our photograms, instead of contradicting one another, will be found consistent.

I believe that Jefferson City was the most westerly place where photograms of the eclipse were taken, and directly totality finished with us, it commenced at Des Moines, so that the photograms taken there must be compared with ours.

There is a general belief that the protuberances do not change their form, at least but slowly, so it is of great consequence to substantiate my statement, which is, that whilst waiting for No. III. plate this protuberance shot out,

and when No. III. photogram was taken it had lost its flame-like appearance, and about one-third its height. No IV. photogram shews the great prominence much reduced in height and increased in breadth, as if it had tumbled into a heap of burning matter. I cannot say whether all prominences are formed by the shooting-out of a flame, and then tumbling into a heap, but I do say that the great protuberance was formed in that manner. In looking at the Des Moines photogram, taken near the end of the eclipse, (I don't mean the engraving,) you see a great heap, not very unlike that seen in No. IV.; and Dr. Curtis remarks "that there is the same appearance of vast volumes of matter tossed up into an irregular heap by the ejecting force, and sinking back again on all sides in long vertical rolls." This is a very good description of what actually took place. Unfortunately, the long exposure of sixty-six seconds gives a softened appearance, and what should have appeared as a heap of cinders, now looks like a fluid.

I now come to the most remarkable photogram that has ever been taken of an eclipse. No. IV. was taken as near the limb of the sun as it is possible to take one, for on shutting down the slide, out burst the sun. In this photogram you can see two luminous concentric bands running from A to E, separated by a dark space, or rather a dark band, which takes its origin on a part of the protuberance A. (See fig. 3.) These bands are crossed by numerous bright rays, all parallel to themselves and to the protuberances A and E. There are two bright beams, and both, together with the bright rays, are divided by this dark band. At E is seen the protuberance with a triplicate form, and appears to be three parallel planes of light; upon the upper one there appears a dark line, similar to those seen upon fig. 3. Now, on looking at the Des Moines photogram, you actually see the stumps of these three parallel planes; could anything be more satisfactory? I will leave it to others to discuss these various phenomena, which will throw much light on the physical constitution of

the sun, but will recapitulate some of the facts deduced from our observations. The corona belongs to the sun, and not to the moon. Some of the protuberances are formed by the shooting of a flame, which burns out, leaving something that looks like a cinder, which crumbles into a heap, and then retains that form for some time; that there are luminous gases that surround the sun in concentric strata divided by a non-luminous layer; that the notches on the limb of the moon are the reflections of the upper part of the protuberances from the surface of the moon; that at a great distance from the sun there is a violent current of gas in an opposite direction to the motion of the sun upon its axis; that the light band surrounding the moon's limb in photograms of the partial eclipse, may be caused by the reflection from the second or under side of the plate.

In conclusion, I congratulate those gentlemen who so kindly assisted me on our complete success, especially my dear friend and old ship-mate, Professor Stephen Alexander, without whose assistance no Canadian party would have been formed; and also, Mr. Vail, of Philadelphia, who kindly joined our party, and whose annexed report gives such ample proof of the value of our negatives.

E. D. ASHE,  
Commander, Royal Navy,  
Director Observatory, Quebec.

June 22nd, 1870.

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REPORT OF MR. VAIL.

"BOSTON, August 21, 1869.

"*Commander ASHE, Quebec Observatory.*

"DEAR SIR,—I owe you an apology for not writing earlier, and communicating my observations on the eclipse; but since I parted from you at Detroit, I have been so constantly

on the move, as to seem to have no opportunity. I will now state briefly a few phenomena that I noticed at the time of the eclipse, most of which I think were communicated to you verbally before.

“After the clouds that partially obscured the sun on the morning of the 7th had passed away, I observed that though the atmosphere was hazy, and the sky by no means blue, there was an unusual stillness and freedom from agitation in the air, so that the outlines of the spots on the sun were clearly defined in the small Dolland telescope that I had under my charge, and this satisfactory condition of the air for telescopic observation continued until after the end of totality. The first contact was at 3h. 38m. 10s. local time. It was probably about 3s. after this, before you were notified that the eclipse had begun, two or three seconds being lost in determining whether it was the limb of the moon, indenting the edge of the sun, or not. Your first photograph was therefore probably five or six seconds after the beginning. The passage of the edge of the moon over the larger spot on the sun, I noted as follows :—

	H. M. S.
Contact with the Penumbra.....	4 3 34
“ “ “ Umbra.....	4 3 56
Complete obscuration of Umbra.....	4 4 34

“The time both of the beginning and end of totality, for reasons verbally stated to you, I failed to note. Of the phenomena during totality, those which I most noted were, first, the disappearance of the last rays of the sun in an irregular broken line of light, succeeded at or near this point by a band or corona of a silvery white light almost as bright as the face of full moon. This though much wider at this point than elsewhere, was soon observed to extend in an entire ring around the dark body of the moon ; from this luminous ring, rays of light seemed to shoot out at right angles on every side, diverging as it were from the centre of it. In



some places they seemed to extend out nearly half the diameter of the moon from the bright ring; in others, not one-fourth so far. But the most remarkable appearance of all, and that which attracted the attention of every one who witnessed the eclipse, whether seen with the naked eye or with the telescope, were the red protuberances that shot up immediately on the disappearance of the sun, from various places, on the edge of the moon; their position your photograph will fix better than I describe. The largest was on the lower edge of the moon, and was by my estimate, when highest, not less than two minutes in altitude from the edge of the moon, or about 55,000 miles. Its colour was a bright *pinkish red*, its outlines were well defined, and were not curves, but rather irregularly-broken straight lines, and throughout it seemed marked by similar lines. It reminded me of the appearance one sometimes sees on the face of a cliff where the rock is broken by horizontal and vertical lines. The same or nearly the same appearance would be presented if one were to view columnal basaltic rocks, from a point where the rocks in the rear would rise above those in front. I would therefore suggest whether these lines may not have a similar origin, and each be the outline of a vast column of luminous matter thrown up above the atmosphere of the sun. There was a constant fluctuation in the height of these coloured protuberances during the total eclipse; the large one was the only one that was seen throughout the whole time, and that remained visible for some time after the edge of the sun appeared.

The general phenomena, such as the darkness, the shining of the stars, &c, I had less opportunity of noticing than yourself and others, who were without a telescope, and will therefore say nothing about them. I have made no attempt to put my observations into any regular form, but have hastily written such as I thought might be of use to you, leaving it entirely to you to make any use of them.

“Very truly yours,

“HUGH D. VAIL.”

## MR. FALCONER'S OBSERVATIONS.

*To Captain ASHE, R.N., &c., Observatory, Quebec :*

“Dear Sir,—As requested by you, I now give you the results of such observations as were made by me on the 7th of August last, during the progress of the eclipse.

The limbs of the moon could be clearly defined beyond the S. and S.E. limbs of the sun. Shortly before totality, there appeared on the sun's northern limb several watery-looking globules, which merged into each other as they passed from West to East, and then disappeared. At this instant, also, appeared distinct long, brilliant, yellow, rays of light, running East and West, and far away, and as straight as if ruled ; others again ran North and South, and reminded me of the glory ancient painters depict around the heads of Saints. On the Southern limb appeared, just at totality, a large circular opening, or ring of bright silvery light, which assumed the shape of a red-hot crooked bar of iron. This, resting on the dazzling silvery coronal light, gave a strange and wondrous addition to the glorious scene we now beheld. Several constellations shone brightly forth, and a star or two low down on the Western horizon. I must not omit the strange protuberances seen at this moment : on the Eastern side was one like a tongue bent upwards, with streaks of a reddish hue ; the others the shape of knobs, dark and colorless, and rugged in outline.

“I now come to the general appearance of the land and sky, and the changes that took place over the vast prairie, stretching far and wide, upon which you had erected your observatory. It was long before any appearance of gloom or darkness occurred, not till 4h. 22m., when a hazy gloom gradually spread over the broad expanse which surrounded us. At 4h. 34m. was seen a dense cloud approaching from the N.W. and S.W., rolling along in its course and obscuring everything around. Indeed, it had the appearance of a coming storm, and seemed in part to issue from the prairie.

It did not reach or envelope the observatory. In front of this was a lurid, unearthly glare, clear and bright, of a greenish tinge; the dense prairie grass around might have contributed to this effect. Presently, when totality took place, all became comparatively dark; every tongue was hushed amongst the groups of persons who had come out on foot, or were seated in their waggons, from Jefferson and the country around.

And what did they behold? A wondrous sight! At the moment of totality, burst forth the beautiful coronal light of the brightness of burnished silver! Upon the Southern portion of this ring of light, rested that curved, elongated protuberance, of a fiery redness, rendered more ruddy in contrast with the dazzling silvery light of the corona.

“Several constellations shone bright and clear; several stars also were observed above the Western horizon. All these gave the scene a magnificence and grandeur. Wonder and admiration sat upon every face uplifted to the sky. Every voice was hushed. Sublime, indeed, was the scene presented. In reverential awe the groups stood mute. Each one seemed to ponder within himself over the glorious scene in front of him.

“Presently, the light of the sun suddenly bursts forth; the clouds which covered the vast prairie lift, and gradually roll away. Then along the Western horizon are displayed long bright streaks of light, as seen at the approach of coming day. The purple hue upon the distant prairie vanishes. The stars also disappear, and the momentary night is turned into day!

“A murmur is now heard, and voices arise, proclaiming the sublimity of the scene they had just witnessed, one of the most wondrous and imposing sights presented to the human eye, in the firmament of heaven! The words of the Psalmist involuntarily fell from the lips: ‘The heavens declare the glory of God, and the firmament sheweth his handiwork.’



"At the approach of totality, the station-master informed me his poultry quietly went to roost. In Jefferson City, the swallows flew down upon the ground, amidst the granite boulders, and remained till the light returned, when they arose and flew wildly about.

"It remains only for me, in conclusion, to thank you and Mr. Douglas for inviting me to join this highly-interesting expedition, and to congratulate you and Mr. Douglas upon the great success which attended your photographic operations.

"I have to thank you for beholding the wondrous and vast prairies west of the Mississippi. 'Hæc olim meminisse juvabit.'

"I remain, dear Capt. Ashe, yours very faithfully,

"ALEX. PYTTS FALCONER.

"GLENALLA, QUEBEC, August 28th, 1869."