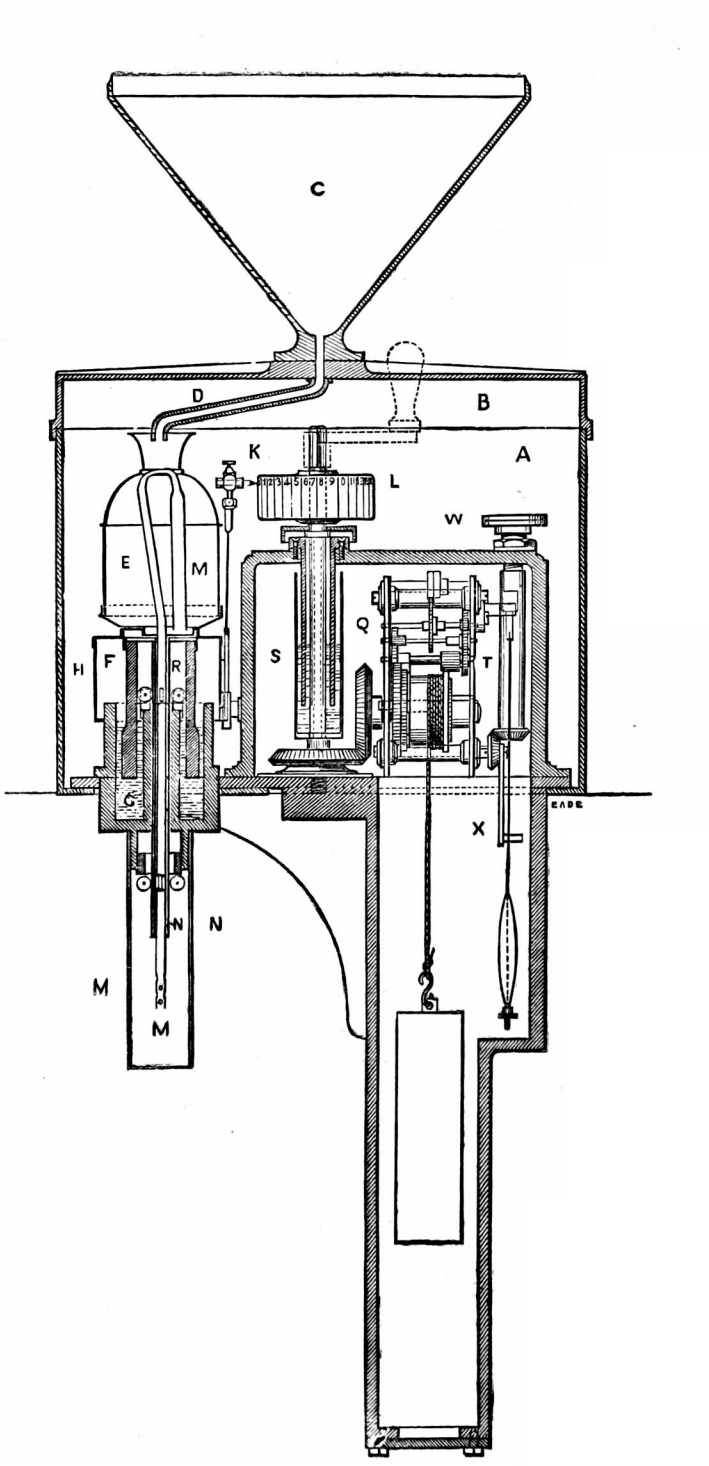

BECKLEY'S SELF-RECORDING RAIN GAUGE.

SYMONS'S
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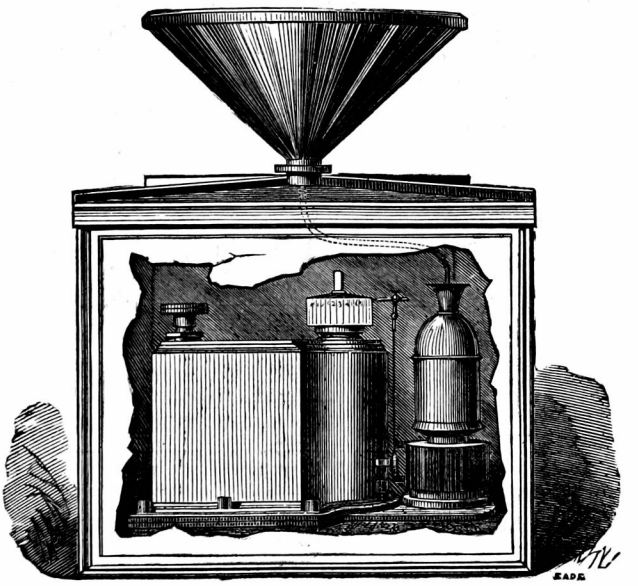
BECKLEY'S SELF-RECORDING RAIN GAUGE.

We are glad to find from several recent communications that the importance of adopting, at several widely scattered stations, self-recording rain gauges is being recognized by observers. In compliance with more than one request, we now reprint from the Report of the Meteorological Committee, for 1869, the full description of the rain gauge adopted by them. Mr. Beckley's mechanical skill is so well known as to create a favourable impression on behalf of any instrument which he designs; in the present case (not having personally worked the instrument) we are not in a position to say whether this impression would or would not be correct.



DESCRIPTION of a SELF-RECORDING RAIN-GAUGE, invented by ROBERT BECKLEY, of the Kew Observatory; made by JAMES HICKS, London.

The instrument is shown in the annexed plate, a section being given of the whole:—

(A) is a cubical box of thin cast iron, 13 inches square and 11 deep, furnished with a loosely-fitted hinged cover (B). The top of the cover is stiffened by four

ribs which meet at a boss in the centre, into which the funnel (C) is screwed. The funnel is also of cast iron, but its interior surface after having been turned is enamelled, in order to prevent rusting. It is provided with a lip to retain the splashes, which is $1\frac{1}{4}$ inches deep, and is turned accurately to a circle of $11\frac{1}{4}$ inches diameter, giving an area of exposure of 100 square inches. A small aperture in the bottom of the funnel opens into a pipe (D), which conducts the water, as it is collected, into the copper bottle or receiver (E); this is supported by a hollow ebonite cylinder (F) floating in mercury contained in the annular vessel or cistern (G). As water enters the receiver the float descends in the cistern, displacing more mercury the further it goes; the relation between the area of the cistern and float being so proportioned that the entrance of equal quantities of water into the vessel (E) shall cause its descent to take place through equal spaces. A cover (H) fixed to the top of the float supports on one side a spring, the upper extremity of which is adapted to hold a pencil (K) which presses against a cylinder (L) covered with waterproof paper, marking on it vertical lines as the float with the receiver rises and falls. When the level of the water in the receiver reaches the neck of the vessel (E), which has then descended to its lowest point, the syphon (M) comes into play, and rapidly discharging the water, enables the receiver to rise and resume its original position, while at the same time the pencil (K) marks a line from the bottom to the top of the cylinder. As the receiver (E) has a capacity of 20 cubic inches this occurs whenever two-tenths of an inch of rain has fallen. The syphon (M) acts on the principle of the intermittent syphon, modified and adapted so as to enable it to act accurately and with certainty in the present case. As the water enters the vessel (E) it rises in the short leg (M) of the syphon, driving the air before it through the long leg (M'M). This continues until it reaches the bend at the top, when it flows down the long leg and brings the syphon into play, and then runs until the vessel (E) is quite emptied (a small depression in the bottom materially assisting it), and the air can enter at the lower extremity of the short leg. The flattened contracted bend of the syphon answers the double purpose of preventing the entrapment of an air-bubble in the bend, and also of ensuring that the vessel shall always be emptied immediately the water in it arrives at a constant fixed height, while at the same time sufficient area is left not to retard the flow of water through it. In order to prevent the retention of a few drops of water by capillary action in the lower extremity of the tube, several small apertures are made at (M); these, by admitting air and also allowing the lateral escape of the fluid, effectually prevent all stoppage from this cause. The action of the syphon as thus constructed is so certain and constant that it is found on experiment that if the water running out of the receiver, when it is discharging itself, be caught in some vessel and returned to the receiver, the syphon will not commence to act until the last drop is poured back. The long leg of the syphon, on issuing from the under side of the receiver (E), passes down a brass tube (NN), through the centre of the mercury cistern guided by rollers (R) fixed to the cistern, which serve to keep the float and receiver perfectly vertical and central. In the experimental forms of this instrument some difficulty was caused by the oxidation of the surface of the mercury in the cistern preventing the moving of the float with sufficient ease and freedom; but a suggestion of Mr. Hicks completely removed this source of annoyance. It consists in pouring a small quantity of glycerine over the surface of the mercury, which by acting in a measure as a lubricating fluid causes the movement of the float to be extremely delicate. The registering part of the apparatus consists of a clock (Q) turning a cylinder (L) at an uniform rate, the pencil (K) marking on the cylinder. The pencil is a piece of ordinary black-lead pencil fixed in a holder capable of being raised and lowered by an adjusting piece. This piece is fastened to the top of a flat metal spring which terminates below in a small brass bar screwed to the cistern cap, and running up and down between two friction rollers (R) to destroy any lateral movement. The cylinder (L) fits easily on the clock spindle, but is capable of being fixed in any position on it, and the paper with which it is surrounded is divided by engraved lines into 24 hour spaces. The clock (Q) is contained in a hermetically closed case, the two places where communication takes place between the interior and exterior being guarded by mercurial stuffing boxes (S and T). S is

the vertical axis supporting and giving motion to the cylinder, being driven round by the clock once every day. By means of a peculiar adaptation of the wheel-work of the clock, a reversal of this motion winds it up, a handle (shown by dotted lines in the figure) being temporarily fitted on to the end of it, which is made square for that purpose. The upper bearing of this axle is formed of a tube which surrounds it loosely for the greater part of its length. This tube is again contained in a larger tube closed at the lower extremity and fastened to the axis. Mercury is then poured into the tube, half filling it, and so preventing the passage of air either into or out of the clock case, but allowing it to expand under varying changes of temperature, whilst at the same time freedom from friction of the axle in its bearings is retained. A similar arrangement at (T) serves to put the pendulum in motion. On turning the milled head (W) on the exterior of the case, movement is imparted by bevilled wheels to a small arm (X), which pressing against the pendulum rod forces it out of its vertical position; immediately the pressure is removed from the head (W) the arm (X) falls back to its original place by its own weight, leaving the pendulum vibrating freely. The clock case is recessed at the bottom to a sufficient depth to allow the weight to fall for one day. The clock mechanism can readily be altered so as to go any number of days, and the time scale can be made of any desired length; but in the present instrument the time scale adopted is that chosen by the Meteorological Committee for their other self-recording instruments.

We can quite understand the desire of the Committee to keep all their curves to a uniform scale, and for ordinary rains the present scale (0·4 inch = 1 hour, and 0·3 inch = 0·1 inch of rain) will answer very well, but with heavy rains, such as several of those quoted on page 93 of *British Rainfall*, 1870, the record would be almost unintelligible. It is satisfactory to find that a more open scale can be adopted by those who desire to be prepared for all emergencies.

SOLAR HALOS ON APRIL 5TH.

CORONÆ, in which the sun or moon are *closely* surrounded by prismatic circles, are very common, in fact occur with more or less distinctness whenever a thin cloud partly veils the principal luminaries. HALOS, or circles of light, at distances of about 10°, 22½°, 45°, and 90°, are occasionally seen, those of 22½° being very frequent. SYSTEMS OF HALOS, such as those engraved in the *Meteorological Magazine*, Vol. V., p. 1, are much more rare. Another modification of these systems is shown in Vol. IV., p. 145, in which we have a nearly horizontal circle passing through the moon,—and still another modification is that described in the following letters and cuttings. It seems to be simply an ordinary halo of 22½° radius, with the addition of a portion of a vertical circle passing through the sun. This vertical circle is called by Kaemtz, the parhelic circle. It is infrequent, except in higher latitudes than ours, but is not, by any means, without precedent, as we proceed to show. We give a few illustrations, which will be interesting for comparison. Figs. 1, 2, and 3, are reduced from Mr. Lowe's "Treatise on Atmospheric Phenomena," which contains a very long chapter on Halos, copiously illustrated. Figs. 1 and 2, represent appearances seen near Thirsk (Yorkshire), on April 19th, 1840, at 7, and at half-past 7, p.m. The observer says:—

The sun appeared to be in the centre of the circle, and the circumference of the circle was almost entirely visible when first noticed. The bow was *prismatic*, and

after the sun had set a clear bright light emanated from the highest part of it. This bright light was, probably, there all the time of the phenomenon, but not apparent on account of the superior brightness of the sun.

Another observer describes (in the same work, p. 88), the appearance at Leeds, which differed from that at Thirsk only in two points, he states (1) that the red rays were nearest the sun, (2) that at 90° from the vertex of the halo there were two parhelia (or mock suns), and that they afterwards extended both internally and externally, but not sufficiently to complete the chord. Fig. 3, copied from the same work, p. 98, shows the appearance as sketched by Mr. Lowe himself, on February 8th, 1845; fig. 4 is from Buchan's excellent *Handybook of Meteorology*; and, lastly, fig. 5 is from the sketch kindly forwarded to us, with several cuttings, and the following letter by the Rev. I. H. Gosset:—

To the Editor of the Meteorological Magazine.

SIR,—I enclose some scraps touching a most remarkable and beautiful sight we had here on April 5th. It was seen for at least an hour-and-a-half by myself and several gentlemen who were playing golf on the Burrows, a large common adjacent to the sea. I concluded it was some kind of parhelion. I regret that I did not watch the phenomenon until the sun set. It must have been about 5.15 p.m. when I first observed it. The sun, as it sank towards the west was surrounded at a very considerable distance by a species of rainbow, the prismatic colours being very apparent; and, as in a rainbow, they were plainer and wider from the sides to the base, but the whole arch was perfect and prismatic above. Its shape was that of a large horse-shoe, or Moorish arch. As the sun got lower, an upward set of rays, quite white, shot up in addition. My barometer (mercurial), at 100 ft. above sea level, stood at 9 a.m., at 30·02, and at 9 p.m. at 29·97, the temp. varied from 50° to 40°. The day was bright, clear, and almost cloudless. Probably you have received other accounts. —Faithfully yours. I. H. GOSSET.

The Priory, Westward Ho! Bideford, N. Devon.

ATMOSPHERIC DISTURBANCE. (*To the Editor of the Standard.*)—Sir,—This afternoon, about an hour before sunset, my attention was drawn by a labourer to a remarkable appearance of the sky, and to some peculiar atmospheric disturbances, the most noticeable of which were currents of alternately cold and warm air. On ascending a hill at 6 30 I witnessed the most extraordinary sunset I ever saw. The sun's rays were not diffused, but concentrated into a column of intensely white light, which was reflected downwards, towards the nadir, when half the sun had set, as though the horizon had been transparent. On each side of the pillar of light was darkness such as is usual about an hour after sunset, amidst which (though the orb had not wholly disappeared) three or four bright stars were seen, not by myself, but by five or six friends at my side. I saw a similar remarkable column of light above and below the moon at rising. In about half an hour parts of a lunar rainbow appeared, the brightest portions of which were the north and south ends of the arc. This was visible for nearly two hours. The barometer continued all the time stationary, at 29·28, but the thermometer fell permanently from 60 to 45 degs.—I am, Sir, yours. J. H.

Poyntington Rectory, Sherborne, April 5.

THE HALO OF APRIL 5th. (*To the Editor of the Standard.*)—Sir,—Will you allow me, through your columns, to offer a short explanation of the vertical halo

seen by your correspondent, the "Rector of Poyntington"? Each ray of the sun, which is not absorbed by a raindrop, either passes through the centre or not. Those rays which *do* pass through the centre proceed afterwards as if the drops were not there; so that the only effect of raindrops upon *this* class of rays is to diminish the number of those rays which have any chance of reaching the eye of a spectator; or, in other words, the sun is less dazzling than usual. The other class of rays, which do *not* pass through the centre of the raindrop, will be best understood by dividing them into groups, each group or "pencil" being cylindrical before incidence on the drop, and, *therefore, conical afterwards.* Now, all the rays of each pencil will have the same absolute intensity, and, although the rays of one pencil will have a different intensity from those of another, this will not embarrass us, for we can consider any *one* pencil by itself. Roughly speaking, the eyes of all spectators are in a horizontal plane; if, therefore, a halo be seen, it must be caused by a maximum number of rays out of each pencil (so far, at least, as this explanation is concerned), falling within a given space in that horizontal plane. A moment's thought will show that this happens at the vertex of the conic section which the horizontal plane makes with the cone. And since the vertex of the conic section is in a vertical plane passing through the sun and the raindrop, therefore the maximum brightness is in the same vertical plane, and this plane cuts the heavens apparently in an upright pillar, or vertical halo. I have spoken of the sun as a point; if it were, the halo would be only a line of light, but each point of the sun causes a similar line of light, and hence the whole sun produces a vertical halo of its own width. If any one finds it difficult to understand what I have said, let him place a terrestrial globe with its north pole towards the sun; then all the sun's rays which fall on the same parallel of latitude belong to the same group or "pencil" of rays, and the smaller the latitude the less will be the intensity of the group if refracted, and the opposite for reflected rays. These vertical halos are now and then seen out of the Arctic and Antarctic regions. I made the following notes:—"Canterbury, March 4, 1861, at 5.30 p.m.—A white halo through the sun of the same breadth, the wind across it. Canterbury, March 27, 1861, at 5.40 p.m.—A white halo through the sun of the same breadth. Bishop Stortford, October 19, 1862, at 6.45 a.m.—A halo of the same breadth and colour as the sun, through the sun, but not that part adjacant to the sun, the part visible being on a dense cloud which had a 'wind edge' (by which I meant that smooth kind of edge which always betokens a strong wind). The weather was very stormy indeed on the 19th, 20th, and 21st, her Majesty being detained at Lacken Palace, near Brussels, as the sea was unsafe." All these are under the heading "Halos vertical." The halos, whether vertical or horizontal, which pass through the sun are always white. Coloured halos, however, both vertical and horizontal, as well as other halos, having the real sun or a vistual sun for their centre, are sometimes seen, and even the ordinary rainbow is sometimes blown (on one side at least) into the upright. The wind in such a case is always nearly at right angles to the direction in which the upright pillar is seen. The same drop sends its rays to us in such a case, not from one point only, but from each point in the long line through which the wind drives it before the eye has lost the impression of its first rays. I could say much more, but lest I should weary your readers instead of interesting them, I subscribe myself your constant reader, J. B. KEARNEY, Bourton, Shrivenham.

A PHENOMENON. Sir,—Did any of your readers see, and if so could they explain, a very beautiful phenomenon that appeared in the western sky a short time before sunset this evening? About 6.20 I was walking towards Stonehouse along the Millbay-road, when I perceived, a few degrees south of the sun, a column of prismatic light, the line of colours being vertical to the zenith.—
Plymouth, April 5th, 1871. Yours truly, S. E. E.

THE SOLAR PHENOMENON ON WEDNESDAY.—The phenomenon in the western sky on Wednesday evening appears to have been seen in West Devon and Cornwall. "P. L.," writing from Collaton, says the phenomenon seemed to him to partake of the character of the halos sometimes seen in the polar regions. There were two short columns of prismatic light, evidently forming the ends of a bow, of

which the remaining portion was faintly traceable. The violet was outside, and the red within. The angle between the two ends of the bow was about 45 degrees. At the same time two lines of yellowish light were observed proceeding from the sun—one vertical, and the other horizontal. There was no appearance of mock suns, by which these halos were accompanied in the polar regions. What he had described continued to be visible for some time after the sun was below the horizon.—The Rev. J. R. Hoare was walking near Trendall, about one mile and a half from Bissick, on Wednesday evening, about six o'clock, when he perceived a perpendicular line of coloured light in front of him, and looking towards the west was an apparent rainbow, turned upside down, the ends being north and south, the bend to the earth. The sky was all but cloudless with the clear, brilliant sunshine usual when N.E. winds prevail in spring. He watched it for about a quarter of an hour, long enough to take a rough pencil sketch of the relative positions of the lines of light, which he had since set on paper in colour.—"R.," writing from Newquay, says he also observed the prismatic column to the south of the sun, but that visible on the north of the sun at the same time was from the point at which he observed it (between Bodmin and St. Columb) by far the most remarkable, the iridescent colours being far more marked and varying from time to time in their degree of intensity. He suggested to his companion, who first pointed out the singular appearance, that it seemed to be of the nature of a halo which was not unfrequently seen to surround the moon, and which was generally supposed to forebode rain.—Our Helston correspondent writes that a beautiful parhelion, or mock sun, was visible for upwards of an hour at Helston on Wednesday afternoon, and at the same time what may be described as a vertical rainbow.—The Rev. R. Mildren, Newquay, says the parhelia were plainly visible there, and answered precisely to the description given of such phenomena in Milner's "Gallery of Nature," and to the representation given, figure 2, page 531.—"J. G.," while crossing from Turnchapel to Plymouth, saw the phenomenon—"a clearly defined circle within the radius of a few degrees around the sun."—"C." writes that the solar phenomenon was also seen at Truro.

SOLAR HALOS.—E. R. Colby, Esq., M.A., Exeter, writes: Many of your readers may have missed the beautiful halo I saw on the evening of April 5th, on the road from Torrington to Bideford, the sun's altitude being about 20 deg., as nearly as I could judge. It consisted of a complete circle, with a vertical column of white light passing through the centre, and its duration was considerable. I mention this circumstance now, particularly because to-day's issue of the *Standard* contains an explanatory letter from a correspondent, in answer to the Rector of Poyntington, enquiring about the phenomenon as seen, same time or nearly so, near Sherborne.

ALTITUDE ABOVE SEA LEVEL.

We regret to state that the proposal on this subject which we made in *British Rainfall*, 1870, pages 58—63, has met with so few acceptances that it is not expedient to repeat the work of 1867. Our practised observers have cheerfully, and in most districts sufficiently, agreed to supply the requisite accurate data, but those observers who do not know the altitude of their stations have been conspicuous by their non-acceptance of a proposal made solely for their benefit, and to add to the completeness of their observations. Possibly in some cases the offer has been overlooked, but we can hardly think this has been the case to the extent indicated by the paucity of applications. However, to meet that possibility, we will not abandon the design until three days after the publication of this number, and should anything like "fifty applications" reach us by May 20th, we will undertake to issue the forms on the 22nd or 23rd.—Could we do more?

THE WONDERFUL SHOWER AT BATH.

To the Editor of the Meteorological Magazine.

SIR,—I have just read the paragraph enclosed, from *Lloyd's* newspaper, of 7th May, the particulars of which you have no doubt received.

As the phenomenon does not seem to have been confined to Bath, I beg to forward a few remarks of what came under my observation at this station. On Saturday, 29th April last, we had almost incessant rain, and the next day at 9 a.m., a gauge, 6 inches above the ground, yielded 0·31 inch, but I was somewhat surprised on measuring the contents of the first gauge, for there appeared to be numerous air-bubbles in the glass measure, such as I have never seen before. I came to the hasty conclusion that the glass was greasy, and washed it, but only to obtain the same result. I soon found that it was of a gelatinous substance, which floated from the bottom of the measure to the top, and though the water was poured steadily into the measure, the foam was several hundredths of an inch; had it not been Sunday, I should probably have examined the substance microscopically. The wind blew with a mean velocity of 12 miles per hour, and a perpendicular rain-gauge (the funnel at 6 ft. moved by a vane, and which registered the amount from eight points of the compass) was as follows:—S., 0·01 in.; S.W., 0·12 in.; W., 0·06 in.; N.W., 0·09 in. The barometer was steady, 29·240 in. all day. On Sunday afternoon, we had a storm of rain and hail, attended by thunder and lightning. The hailstones were of a most prodigious size.—Yours obediently,

JOHN ARNOLD, F.M.S.

Meteorological Observatory, Aldershot Camp, May 9th, 1871.

EXTRAORDINARY STORM AT BATH.—A most violent storm of rain, hail, and lightning visited Bath on Saturday night. The rain descended in torrents, causing the Avon to overflow its banks in the lower districts, especially at Salford, where whole tracts of land were laid under water. The storm was accompanied by a similar phenomenon to that of the previous Sunday; myriads of small annelidæ enclosed in patches of gelatinous substance, falling with the rain and covering the ground. These have been microscopically examined, and show, under a powerful lens, animals with barrel-formed bodies, the motion of the viscera in which is perfectly visible, with locust-shaped heads bearing long antennæ, and with pectoral and caudal fin like feet. They are each an inch and a half long, and may be seen by the curious at Mr. R. Butler's, The Derby and Midland Tavern, where scientific men, on inspecting them, pronounce them to be marine insects, probably caught up into the clouds by a waterspout in the Bristol Channel.

[On receipt of the above we wrote to some of our correspondents at Bath, and have been favoured with the following letters.—ED.]

To the Editor of the Meteorological Magazine.

SIR,—I received your note this morning, and should be glad to know from what newspaper the cutting is taken.* The actual facts are as follows:—On Sunday morning, 23rd April, a gusty wind blew from W.S.W., force about 8; during the morning a quantity of what are described as "myriads of small annelidæ" fell upon the platform of the Midland Railway station here, and created some consternation and

* We do not know in what newspaper it first appeared, but we have seen it in at least half-a-dozen different ones.

speculation amongst the porters and officials. Of course all sorts of stories were told about these marvellous creatures which had "fallen from the clouds," but it was very soon discovered that they were nothing more than the pupa of the common gnat, which had been raised by the gusty wind from the surface of the adjoining river, and deposited upon the station platform. It appears that the same occurrence happened on the following Sunday and Saturday night, but to a less extent.

As to the violent storm described, the writer's descriptive powers have again carried him somewhat beyond the mark. At 8.55 p.m., on Saturday evening, April 29th, a storm of rain, accompanied by hail, set in from W., which lasted five minutes. There were two flashes of lightning, and no more, one a brilliant one, followed by distant thunder. The storm was over at 9 o'clock. At 1.15 a.m., Sunday morning, April 30th, there was another, but slighter, thunder shower. The rain collected at 9 a.m., amounted to 0·105 in. The previous morning (29th), 0·215, and on the 28th, 0·360 in. As to the overflowing of the river as Saltford, not Salford, six miles from Bath, I have not heard of its occurrence, and from the previous low state of the river, and dryness of the land, think it highly improbable that 0·680 in. of rain in three days would cause such an event, which, as a rule, happens only after heavy and continuous rain, or the sudden melting of snow in spring.—I am, dear Sir, yours very truly,

C. S. BARTER, M.B.

27, *The Paragon, Bath, May* 11, 1871.

P.S.—Since writing the above, I find that the water in the river rose 5ft. above its ordinary level on the 20th April; possibly at that date the Saltford meadows may have been partially flooded.

To the Editor of the Meteorological Magazine.

SIR,—I have already sent a statement to the Entomological Society (in consequence of seeing in the *Athenæum* that the subject had been mentioned at their last meeting), of so much as I know respecting the phenomenon alluded to in the newspaper cutting received from you this morning. But my knowledge of it is limited, from the circumstance of my having been far away from Bath at the time the storm happened. On my return home, a few days after, hearing what had occurred, I applied to the party mentioned in the paragraph as posessing some of the worms that had fallen with the rain, requesting to see them. He showed them to me accordingly, and they were still alive and active, in a tumbler of water, but having (he said) already parted with a considerable number to different applicants, he would not allow me to take any away for closer examination at home. I could only, therefore, ascertain so much as was to be learnt by a brief inspection of them with a pocket lens. The statement respecting the size of the worms is greatly exaggerated. They are very small, though distinguishable with the naked eye; and my full belief is that they are *not annelidæ*, as stated in the account you sent me, *nor the larvæ of gnats*,

as stated in another newspaper report of the phenomenon I saw, but infusorial worms belonging to the old genus, *vibrio*, and identical, so far as I could determine without higher microscopic powers than I had about me, with the *Vibrio undula* of "Muller's Animalcula Infusoriæ," which is well described and figured in that work, and the peculiar character of which is to congregate in gelatinous masses, as represented in one of his figures, and as noticed by myself in the specimens I saw, as well as mentioned in the newspaper cutting. There was a squall of wind (so I was told) before the storm came on, and they were, probably, borne upwards, by a gyratory movement of the air, from some shallow pool, or puddles of water, in the neighbourhood, where the worms had been bred. A few other particulars are mentioned in the letter I sent to the Secretary of the Entomological Society, which will probably be read at their next meeting, and, perhaps, appear in the "Proceedings."—I am, truly yours. L. JENYNS.

Belmont, Bath, May 11th, 1871.

To the Editor of the Meteorological Magazine.

SIR,—There is, as you suggest, some small amount of truth in the sensational paragraph from the *Standard*, but mixed up with a large proportion of the marvellous. We had on the 22nd of April, the day on which the phenomenon occurred, no "violent storm of rain, hail, and lightning" as described by the writer; my register of rainfall on that day was only 0·115 in. There was, however, heavy rain on the 18th and 19th, amounting in the two days to 1·163 in., and on the 20th the river had swollen in consequence 59 inches above its mean level, but had fallen to 31 inches by the 22nd. The gelatinous substance which was found scattered over a comparatively small area has been erroneously stated to be larvæ of the gnat, but there can be no doubt that the patches were capsules or eggs of a species of annelidæ which had been drawn up by a gyration of the air, from some contiguous pool, and deposited with the rain.

I remain, yours very sincerely,
CHAS. P. RUSSELL.

Bath Royal Literary and Scientific Institution, May 12th, 1871.

P.S.—I omitted to mention, that we had a thunderstorm on the evening of the 29th, and about 1 o'clock p.m. on the 30th, but I have not heard that the phenomenon of the 20th was repeated.

HAIL ON MARCH 8TH, 1871.

To the Editor of the Meteorological Magazine.

Barometer 9 a.m. (at 32° and sea level) 29·880 in.; dry bulb, 44°·2. wet bulb, 41·3. Weather stormy, unsettled, wind N., average velocity = 14·5 miles per hour, from 9 a.m. to 1 p.m. At 12.26 p.m. a few drops of rain, and hail fell, and again at 12.29 p.m. Barometer, 30·013 in.; dry bulb, 48°·0; wet bulb, 41°·8 max. of day, 52°·0; min. 39°·0.

FRANCIS NUNES.

Heathfield Lodge, Chislehurst.

ERRONEOUS MINIMUM TEMPERATURES.

To the Editor of the Meteorological Magazine.

SIR,—I regret exceedingly to observe in your number for March last, a letter from the Rev. C. Maxwell, commencing as above, and reflecting in most erroneous terms not only upon the action of his own thermometers, but including all other minimum thermometers of every kind.

If standard spirit minimum thermometers are not so sensitive as the mercurial, Mr. Maxwell, as an old observer, ought to know that when used as they should be, they are most trustworthy as well as valuable and excellent instruments.

What a pity it seems that after such extended experience, Mr. Maxwell should appear still to be unacquainted with the proper method of using his instruments, for certainly had he attended to the plain instructions, both verbal and printed, which are given with even the most simple registering thermometers, he would have found an effectual remedy for preventing error, by simply slanting the bulbs of his thermometers, say $\frac{3}{4}$ to 1 inch lower than the upper part, and thus avoiding the error of a lower reading by preventing the vapour of the spirit from forming in detached globules in the stem. Again, had he adopted the well-known plan of comparing his spirit thermometers, from time to time, say monthly or quarterly, by suspending a good mercurial thermometer beside them, of course placing the bulbs close together, and as much as possible under the same conditions, or better still, immersing them for a few minutes in a quart or two of water, for comparison, no such mishaps as those he complains of could have possibly occurred. Indeed, I quite understood that, as advised by me, Mr. Maxwell had the mercurial thermometers for this purpose.

As to "one month's exposure having completely bleached the colour from every instrument," it is always at the option of observers to have their thermometers with either plain or coloured spirit in them, but standard instruments, as is well-known, are usually preferred without this colouring, which is mostly employed in those for popular use, and is well-known to fade on exposure to the sun.

From the further tone of Mr. Maxwell's letter, I should infer that he had entirely overlooked the important effect of radiation, and the difference caused by the bulbs of his thermometers being more or less covered or shielded from the clear radiation of the sky, all of which, as you know, would naturally alter the result.

In conclusion, the mercurial minimum thermometer referred to, though a great scientific achievement, has been always spoken of by me as requiring great care in its use, and with this care, I must say that its action is not only interesting but admirable, as it affords the means of a quick and sensitive corroboration of the true action of the spirit minimum thermometer, a result which I believe had not been hitherto obtained.—I am, Sir, your obedient Servant,

LOUIS P. CASELLA.

Hatton Garden, May 8th, 1871.

THE CAUSE OF THE DECREASE OF RAINFALL WITH ELEVATION.

To the Editor of the Meteorological Magazine.

SIR,—While we are all throwing up our hats for joy at the solution of "the problem which has baffled observers for more than a century," (to quote your own words in *British Rainfall*,) let us be quite sure that we are not jumping hastily to a conclusion. For my own part, I confess that the proposed solution of the problem baffles me not less than the problem itself. Mr. Stow tells us, as the result of his experiments, that the decrease of rainfall with elevation is due mainly, if not entirely, to the difference of angle at which the rain falls at different heights, and this result he considers established by the observation that whereas the upper of two horizontal gauges shows almost always a decrease, the upper of two vertical gauges similarly placed shows with equal regularity an increase. That the rain does fall at different angles at different heights I have not the least doubt: we know that the strength of the wind is in proportion to the elevation, and it is matter of familiar observation that the driving of the rain is in proportion to the strength of the wind, indeed it cannot be otherwise. Now, a vertical gauge, when compared with a horizontal gauge at the same level, is simply a measure of the amount of driving of the rain, that is, of the deviation of the path of the drops from the perpendicular. It is clear, therefore, that whatever relation is found to obtain between the receipts of a horizontal and of a vertical gauge at one foot above the ground, such relation will be modified in favour of the vertical gauge when the comparison is made at an elevation of ten feet. This seems to me to be a proposition to which it would be impossible to refuse assent, though it were placed before one purely as a matter of inference. But do the experiments prove anything more than this? I have no wish to underrate their importance or interest, and am willing to admit that the law just stated, although capable of independent proof, might nevertheless have escaped distinct recognition if the experiments had not been made, but I cannot bring myself to see that the experiments prove anything beyond that law. We knew before that the rainfall received on a horizontal surface decreases as we ascend; we know now (and might have known at any time, if we had chosen to think,) that the deviation of the rain from the perpendicular increases as we ascend. But the link necessary to connect these two things, as cause and effect, appears to me to be still wanting. Suppose, for the sake of argument, that the old-fashioned view were correct, and that the difference of rainfall at different elevations were due to the drops acquiring increased volume in their descent by condensation of vapour. Would it not still be possible to obtain all the results that Mr. Stow has obtained? He says that if that hypothesis were true, the decrease of rain with elevation must affect both horizontal and vertical gauges alike. I submit that this is not strictly logical. There would be a cause of decrease affecting both gauges alike, but in the

vertical gauges there would be also the cause of increase first referred to, and the latter would be equally powerful to neutralize the former, whether the two were essentially identical or altogether independent of each other.

So much for the experimental view of the question. The theoretical difficulties in the way of the proposed solution are to my mind insuperable. Suppose a cloud, exactly a square mile in extent, discharging rain uniformly from every part of its lower surface for the space of one hour. Suppose, in the first instance, that the rain drops fall vertically to the ground. It is clear that the ground watered by the rain will be exactly a square mile in extent, and the fall will last exactly one hour. Suppose, secondly, that the rain drops, having fallen vertically for a certain distance, become suddenly deflected by a current of air to an angle of 45°, which angle they maintain until they reach the earth. The space of ground watered will still be a square mile, and the duration of the downfall will be one hour. That is to say, exactly the same quantity of rain will fall that fell in the first instance, and it will fall in the same time. But what is true of that square mile is equally true of every square foot within that square mile, and of every circle of 8 or 5 inches diameter. And hence it seems to me to follow that the quantity of rain received by a horizontal surface does not in theory vary with the angle at which the rain falls. In other words, the horizontal section of a falling shower being unaffected by any changes in the angle at which it falls, a given surface placed horizontally to intercept it will, so far as the effect of angle is concerned, intercept the same quantity at every point in its course.

GEORGE F. BURDER, M.D.

Clifton, 25th April, 1871.

[Dr. Burder is such a competent critic that it is with no little dismay that we find him sceptical as to the solution of "the problem which has baffled observers for more than a century." We shall doubtless hear next month what Mr. Stow has to say upon the subject, but as our words may be regarded as the text of Dr. Burder's remarks, we may as well state our own opinion at once. We think that Dr. Burder has not clearly realized the problem, and therefore is naturally baffled by the solution. We take the state of the question to be somewhat this :—

FACT OBSERVED.—Since 1765, it has almost invariably been found that rain gauges of the usual shape (*i. e.* whose orifices are horizontal) *collect less rain* if placed on lofty buildings than similar ones on the ground.

INFERENCE.—From the above fact it has been *assumed* that *less rain falls* the higher we rise above the ground.

REAL PROBLEM.—To determine why an elevated horizontal gauge *catches* less than one on the ground.

WHAT WE THINK THE EXPERIMENTS HAVE PROVED.—(1) That there is no sensible decrease in the amount which really falls within the

first 20 or 30 ft. of the earth, although there is a decrease in the amount collected by horizontal-mouthed gauges. (2) That elevated horizontal rain gauges *collect* less because the rain falls at a greater angle with the vertical.—ED.]

RAINY DAYS AND RULE XII.

To the Editor of the Meteorological Magazine.

SIR,—Having been the first member of your Rainfall Parliament to draw your attention to the loophole for misunderstanding that exists between the instructions contained in Rule XII. and the heading "Days on which ·01 or more fell," perhaps you will kindly allow me an opportunity of suggesting a very simple way of filling up this little gap, without interfering with any of the present rules or headings, and yet at the same time answering finally a question which many thought was decided long, long ago, but which still continues to puzzle some observers, and that is,—"What constitutes a rainy day?"

I propose, therefore, with all due deference to the opinions of older and more experienced members than myself, that all observers who, in accordance with Rule XII., enter small quantities between ·005 and ·010 as ·01, be directed in future to place a distinguishing mark—a note of interrogation, (?) as expressing doubt, would, I think, be an appropriate one—on the right-hand side of all such quantities, at the time of entering them in their journals, and to omit all ·01's so marked, when reckoning the number of rainy days, as being less than full one-hundredths; but *not* when calculating the aggregate rainfall of the month.

I need scarcely say, that this slight innovation, if adopted, would not in any way affect the practice of those observers who now read even the smallest quantities to the thousandth part of an inch.

I remain, Sir, yours faithfully,

EDWD. MAWLEY.

Richmond, S.W., May 4th, 1871.

REPORT OF THE RAINFALL COMMITTEE OF THE BRITISH ASSOCIATION.

By the kindness of the Association, copies of the above Report, containing the tables of monthly rainfall in 1868 and 1869, as well as an elaborate analysis of some of the rain gauge experiments, and results of the examination of rain gauges during 1869 and 1870· have been placed at our disposal. We shall have much pleasure in supplying copies to such of our correspondents as may apply for them.

APRIL, 1871.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average 1860–5	Greatest Fall in 24 hours. Dpth	Date.	Days on which ·01 or more fell.	TEMPERATURE. Max. Deg.	Date.	Min. Deg.	Date.	No. of Nights below 32°. In shade	On grass
			inches	inches.	in.								
I.	ENGLAND.	Camden Town	2·84	+ 1·71	·71	18	18	66·0	12†	28·3	7	3	5
II.		Maidstone (Linton Park)	2·80	+ 1·58	·42	17	15	70·0	14	32·0	7§	...	...
,,		Selborne (The Wakes)	4·55	+ 3·05	1·28	18	16	60·5	29	21·0	8	3	5
III.		Hitchen	2·14	+ 1·14	·54	18	17	63·0	13	24·0	8	5	...
,,		Banbury	2·65	+ 1·49	·80	18	17	64·0	14	27·5	7	5	...
IV.		Bury St. Edmunds (Culford)	3·70	+ 2·95	·58	16	15	64·0	26	22·0	8	6	7
V.		Bridport	4·96	+ 3·48	1·05	18	16	61·0	27	30·0	5	2	...
,,		Barnstaple	3·83	+ 1·82	·54	28	18	62·0	14†	33·0	6	...	...
,,		Bodmin	5·82	+ 4·12	·79	20	20	60·0	26	33·0	5	0	1
VI.		Cirencester	3·65	+ 2·36	1·00	18	13	...	...	...	...	...	...
,,		Shiffnal (Haughton Hall)	2·92	+ 1·77	·42	15	18	64·0	14	25·0	8	6	...
,,		Tenbury (Orleton)	2·84	+ 1·30	·63	18	18	64·2	13	25·7	7, 8	4	7
VII.		Leicester (Wigston)	2·76	+ 1·46	·55	19	15	68·0	16	24·0	6	6	...
,,		Boston	2·60	+ 1·63	·47	18	17	64·5	22	29·5	8	4	7
,,		Grimsby (Killingholme)	3·06	..	·58	18	20	61·0	12‡	29·0	8, 9	4	...
,,		Derby	3·72	+ 2·29	·87	28	17	64·0	13	28 0	7, 8	3	...
VIII.		Manchester	3·52	+ 1·76	·51	22	21	62·0	27	29·8	7	3	6
IX.		York	2·76	+ 1·66	·71	18	18	63·0	13	31·0	5, 8	4	...
,,		Skipton (Arncliffe)	3·95	+ ·91	·80	23	16	...	...	...	...	...	...
X.		North Shields	3·79	+ 2·48	·87	18	19	58·0	27	30·6	7, 11	4	7
,,		Borrowdale (Seathwaite)	6·36	— ·54	1·20	23	16	...	...	...	...	...	...
XI.	WALES.	Cardiff (Town Hall)	...	...	...	...	...	...	...	...	...	...	...
,,		Haverfordwest	4·44	+ 2·58	1·00	28	11	66·1	3	32·0	4	1	2
,,		Rhayader (Cefnfaes)	6·15	+ 4·26	·70	18	19	59·0	...	27·0	...	...	...
,,		Llandudno	2·57	+ 1·07	·61	15	15	66·5	14	34·3	8	...	...
XII.	SCOTLAND.	Dumfries	4·55	+ 2·88	·58	19	19	64·0	29	28·0	11	6	...
,,		Hawick (Silverbut Hall)	4·08	...	·82	19	17	...	...	...	...	...	...
XIV.		Ayr (Auchendrane House)	3·34	+ 1·12	·65	22	16	58·0	12‡	27·0	8	6	9
XV.		Castle Toward	5·43	+ 2·93	1·17	18	16	58·0	29	32·0	6	1	4
XVI.		Leven (Nookton)	5·17	+ 3·92	1·04	22	19	59·0	4	26·4	11	9	17
,,		Stirling (Deanston)	4·40	+ 2·65	·65	26	18	61·1	12	24·9	11	12	15
,,		Logierait	2·55	...	·41	16	15	...	...	...	...	...	...
XVII.		Ballater	3·24	...	1·10	19	13	61·5	12	19·0	6	20	...
,,		Aberdeen	5·00	...	1·26	26	21	59·2	12	27·6	6	3	17
XVIII		Inverness (Culloden)	1·96	...	·54	20	17	55·0	12	31·8	6	1	18
,,		Portree	2·10	— 3·17	·49	12	18	...	...	..	...	...	...
,,		Loch Broom	1·41	...	·33	18	11	...	...	...	...	...	...
XIX.		Helmsdale	3·41	...	·78	19	23	...	...	...	...	...	...
,,		Sandwick	1·74	— ·01	·73	14	16	51·0	15	29·3	6	7	15
XX.	IRELAND.	Cork	4·48	...	·79	17	18	...	...	...	...	...	...
,,		Waterford	4·51	+ 2·28	1·04	11	22	60·0	13‖	36·0	4, 5	...	...
,,		Killaloe	4·92	+ 2·79	·51	19	22	68·0	8, 30	29·0	4	1	...
XXI.		Portarlington	3·17	+ 1·15	·48	15	24	61·0	13	31·0	7	2	...
,,		Monkstown	2·68	+ 1·04	·58	18	14	...	...	...	...	...	...
XXII.		Galway	3·44	...	·37	16*	20	63·0	17	36·0	30	...	...
,,		Bunninadden (Doo Castle)	4·18	...	·90	16	18	65·0	12	29·0	8	1	...
XXIII		Bawnboy (Owendoon)	...	...	..	...	...	...	...	...	..	...	..
,,		Waringstown	2·76	...	·52	11	16	66·0	16	28·0	8, 9	4	14
,,		Strabane (Leckpatrick)	3·29	...	·40	27	20	...	...	..	...	...	...

* And 18. † And 27. ‡ And 13. ‖ And 21. § And 8, 11.

+ Shows that the fall was above the average ; —that it was below it.

METEOROLOGICAL NOTES ON APRIL.

ABBREVIATIONS.—Bar for Barometer; Ther. for Thermometer; Max. for Maximum; Min. Minimum; T for Thunder; L for Lightning; T S for Thunderstorm; R for Rain; H for Hail S for Snow.

ENGLAND.

CAMDEN TOWN.—T on 27th.

LINTON PARK.—First 11 days bright and very dry, the remainder mostly dull and showery, but mild, so that vegetation was in a forward state throughout; very slight frosts on the 7th, 8th, and 11th; T on 27th and 30th. Cuckoo heard on 10th, being one day earlier than I have any record of. Apple in bloom on 21st, and hawthorn on 30th, the latter not so early as on one or two former years. Winds mostly S.W. and W., but never high.

SELBORNE.—Swallow on 6th, Cuckoo on 12th, T with R at 3 p.m. 29th, and T from 2 to 3 p.m. 30th.

BANBURY.—Cuckoo first heard on 24th. T on 27th. Aurora on 9th.

CULFORD.—Latter half of the month wet and deficient in sunshine, nevertheless exceedingly favourable weather for the light land in this part of the country. The swallow was first seen on the 20th, the nightingale and cuckoo heard about a week previous to that date. Mean temp. of month 47°·8; T S on 17th, 22nd, and 27th, on the latter day accompanied by H.

BRIDPORT.—First ten days of the month fine, afterwards stormy but mild. Swallow first seen on 15th, cuckoo first heard on 13th; horse chesnut in leaf on the 19th.

BODMIN.—Average bar. of month, 29·85; average temp., 50°·8.

SHIFNAL.—Although the month opened with the much desired R from the N.W., the wind returned to the E. on the 6th, on which night the ther. fell to 27°, and next night to 25°, with frost till the 12th, when the wind changed to W. and S.W., and R fell daily, with one exception (13th) till the 23rd; the genial temperature that came with it, brought on vegetation uninterruptedly to the end. Wood anemone in flower on the 4th, blackthorn on 5th, wild cherry on 8th, pears in blossom on 16th, crabs on 27th; first swallow seen on 12th, white butterfly and willow wren on 17th, cuckoo heard on 20th, first martin seen on 26th, young rooks fledged on 30th.

ORLETON.—Fine growing month, with much R, cuckoo on 15th; sand-martens on 11th, and willow wrens on 17th; bright aurora on 9th. T on 17th and 29th.

WIGSTON.—Brilliant dry weather to the 14th, with frosty nights, since that time very showery and growing; vegetation forward, and everything giving promise of an abundant season. A heavy T S on the afternoon of the 28th.

BOSTON.—Ice half-inch thick on 7th and 8th, wheat in some parts much injured.

GRIMSBY.—Almost as much R fell as in the three preceding months. Grass abundant, but warm weather much wanted. Grand auroral arch at 10.50 p.m. on 9th. Swallows first seen on 16th, willow warbler arrived on 19th, cuckoo heard on 26th, first swarm of bees in this neighbourhood on 27th. Apples began to blossom on 27th. T at 10 a.m., and T and L at 1.45 p.m. on the 28th, when a tree was struck.—*Erratum.* In last month's remarks for Barrow-in-Furnace (*sic*), read Barrow-on-Humber. [We regret the blunder, but those who know Barrow-in-Furness will enjoy the accidental pun.—ED.]

DERBY.—The month, unlike the April of the last few years, was that of our recollection of former years; although no R fell on the first 10 days, we have had continual showers alternating with sunshine ever since, producing a rapid development of vegetation such as we have not lately seen. Fruit trees about a week earlier than last year. Rainfall 1·84 + average of 31 years; Mean temp. 1°·5 in excess.

MANCHESTER.—T S on 22nd at 12.50 p.m., and on 28th at 1.50 p.m.

NORTH SHIELDS.—Rose-coloured aurora on 1st, and again on 9th. Distant lunar halo on 1st; S on 3rd and 9th; T on 27th.

SEATHWAITE.—S on the mountains on 4th, and again on 18th; T on 16th, 17th, and 25th.

WALES.

CEFNFAES.—Cold and stormy weather during the month; wind N.E. or S.E.; frosty nights, and frequent hailstorms; Cuckoo heard on 19th.

LLANDUDNO.—On 7th, at 10.15 a.m., difference of wet and dry 12°; 9th at 9 p.m. very light to N., and streak of white aurora stretching from zenith to S.E., at 11 p.m. the colours most brilliant; streak of aurora on 13th at 10 p.m.; a splendid rainbow forming a complete arch at 6.40 p.m. on 15th; cuckoo heard on 12th; lilac in flower on 18th; apple on 19th; white broom on 21st; hawthorn in full flower in the hedges on the 26th; laburnam in flower on 28th; oak almost in full leaf on 27th; landrail heard on 27th.

SCOTLAND.

DUMFRIES.—With the exception of the 3rd, the first 10 days of the month were dry with frost at night; the rest of the month wet, only two days on which no R fell. On 19th the hills were white with S, and on the 27th there was S on the higher ground, and not quite gone at the end of the month; mean temp. 2°·38 below that of April, 1870; rainfall 2·66 in. + average of previous five years. At the close of the month, vegetation had made good progress, crops looking well; swallows seen on 21st; cuckoo heard on 28th.

SILVERBUT HALL.—A cold, wet month with East winds prevailing. The first nine nights were frosty in succession; swallows first seen here on 24th; hills white with S on the 20th.

AUCHENDRANE.—Aurora on 9th, rivers still have plenty of water; swallow on 18th, and landrail on 30th.

CASTLE TOWARD.—A fine month; scarcely any frosts; but wet from the 11th to the 28th; fruit trees of all kinds flowering most abundantly; grass is plentiful; all kinds of crops are healthy and strong. A smart shock of an earthquake was felt along the Clyde on Saturday the 12th at 7.55 p.m.; the houses here, at Dunoon, Blanmore, and, I am told, as far as Dumbarton, were shaken.

DEANSTON.—Weather dry and cold till the 11th, with frost at nights; sunshine during some days; then wet and cold E. winds; gale on the 19th with rain-sleet, and heavy S on Ochills and Grampians; heavy R towards the end of the month; frost at night and cold E. wind; swallows seen on 28th.

LOGIERAIT.—Cold E. winds with little intermission; S shower on the 18th; cuckoo on 26th; swallow on 28th.

ABERDEEN.—Red auroræ on 1st and 10th; temp. on grass 17° on 6th; temp. in sun (in vacuo) 130·3 on 24th; fog on eight days; S on four days; sleet on two days; T at 4.40 p.m. on 29th, and at 11 a.m. on 30th; the wettest April on record during 42 years; a cold ungenial month; bar., temp. and wind pressure rather below the average; rainfall, and N., N.E., and S.E., winds above the average.

PORTREE.—The coldest April on record; frost from 5th to 11th, and from 17th to 26th; S from 3rd to 7th, and on 19th and 20th; heavy gale from N.E. on 19th; berry bushes, and garden shrubs and trees all frostbitten; early potatoes blackened and cabbages browned by the frost.

LOCHBROOM.—This has been a singularly dry month, and very propitious to the grazier and agriculturist.

SANDWICK.—Very cold month; fine sun pillars on 5th, 7th, and 9th, that on the 5th lasted twenty-five minutes after sunset, and was 20° high; that on the 7th thirty-five minutes, and was 15° high; and that on the 9th lasted fifty minutes.

IRELAND.

MONKSTOWN.—A variable month; frost on the night of the 7th; a humming bird sphinx moth seen about the 20th.

DOO CASTLE.—Fine to 11th; and remainder of month one incessant downpour of R, which has retarded all agricultural operations in this locality; oats have been put in so late as the 1st of May. Four waterspouts were observed to west of Doo Castle on the 16th; a few peals of T also.

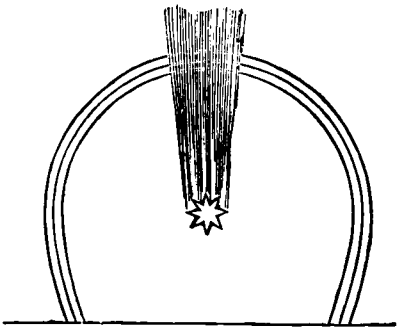


Fig. 1.

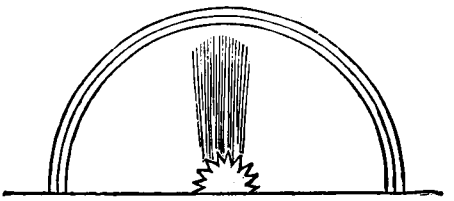


Fig. 2.

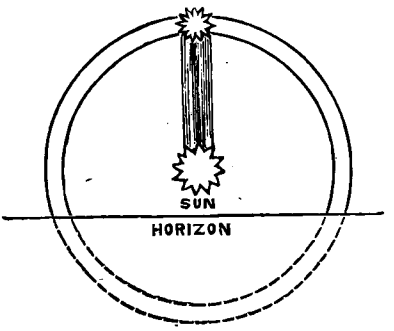


Fig. 3.

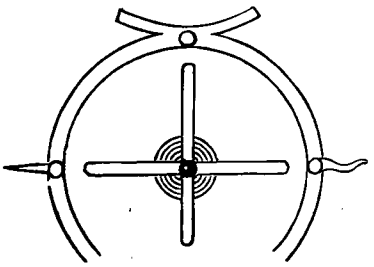


Fig. 4.

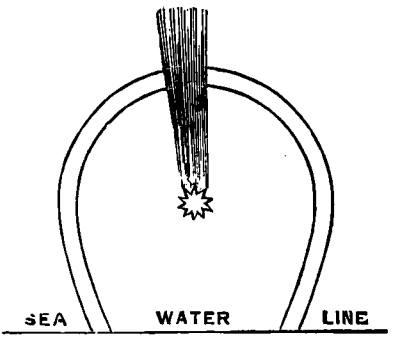


Fig. 5.

DIAGRAMS OF SOLAR HALOS AND PARHELIÆ.