SYMONS'S
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A CHANGEABLE MAY.

THE engraving, for which we are indebted to the courtesy of our contemporary the *Journal of Horticulture*, represents a May snow scene in Northamptonshire—of equal interest to horticulturists, naturalists and meteorologists; and the most remarkable feature was that this snow-storm followed within less than five days a hot spell, in which the max. had for two days been within a few tenths of a degree of 80° in the shade, and in some places even above 80°. At Camden Square the shade max., on May 13th, was 80°·2, and the shade min. at 5 a.m., on the 17th, 30°·7—a fall of 49°·5 in less than four days.

The facts as to temperature may be thus briefly summarized :—

Sudden rise from min. on the 11th to max. of same day, especially noticeable at London, where it rose 29°·1—viz., from 47°·0 to 76°·1.

Max. of 12th still higher; 79°·7 in London; 75° or upwards at Oxford, Cambridge, York and Loughborough, reaching 81° at the last-named station.

On 13th max. in London still higher, 80°·2; and 75° was reached or surpassed at Hurst Castle, Oxford, Cambridge, Loughborough and York.

Within three days the max. had fallen 30°, or to below 50°, and on the morning of the fourth day, frost had occurred over the greater part of England and Scotland.

Besides the statements made in the Notes on the Month by our regular correspondents, on p. 79, we give a few typical extracts from letters with which we have been favoured, and arrange them in the usual order, except that we give precedence to the note which Mr. Gregory sent to the *Journal of Horticulture* along with the photograph which that journal so excellently reproduced. It is not everyone who is so sharp as Mr. Gregory at 4 a.m. on a snowy morning :—

HAZELBEACH HALL, NORTHAMPTON.—"The enclosed photograph, taken by myself at a quarter past four on Monday morning, May 18th, will give you an idea of a memorable storm. The Friday preceding was very stormy. On Saturday we had bright sun. Snow fell about 4 p.m., and covered the ground. Later in the evening the ground and shrubs were covered thickly. Sunday was very stormy, hail, rain, and snow fell frequently during the day; at noon heavy thunder with vivid flashes of lightning prevailed. During the evening snow again fell very heavily, and continued during the whole night and until about 6 a.m. on Monday morning (Whit Monday). Trees, shrubs, and fruit trees, the latter in full bloom, were laid flat upon the ground with their burden of snow, tall trees in leaf had branches broken off, hyacinths and tulips were broken down, but violas were none the worse for the covering. Damsons that were in full bloom are casting off their blossom. We have a row of fine clumps of pæonies 140 yards long, with from fifty to seventy buds upon each clump, which suffered the worst with the weight of snow."—*J. Gregory.*

EASTON MAUDIT, NORTHAMPTON.—

May 10. Exceedingly raw, gloomy day
„ 11. Rapid change to
„ 12. Extreme heat.
„ 13. „ „
„ 14. Cooling down.
„ 15. „ „ rain at night.

(The wind all this time ranging from N.W. to N.E. and generally nearly N.)

	Minima. Shade.	Maxima. Shade	Rain.
May 10	...	48·5	·08
„ 11	46·0	65·0	—
„ 12	39·0	75·0	—
„ 13	49·0	76·0	—
„ 14	49·5	69·0	—
„ 15	36·5	58·5	·24
„ 16	34·5	49·5	·01
„ 17	28·0	53·5	·68
„ 18	31·0	46·5	·01

„ 16. Cold and raw; a few slight showers, distinct snow flakes at 2 p.m., sky clearing in evening with every promise of frost, too much verified by minima of 28° in shade, 23° on grass!

May 17. Bright morning, but clouded over about 11; smart showers of rain at 11.30 and onwards; hail enough nearly to whiten the ground at 1.15 p.m.; more showers all afternoon, large drops, and with them large half-sodden snow-flakes, falling vertically and fast; wind dropped; rainfall up to 6 p.m., ·14 in.; more rain, now nearly continuous, which by 9.30 p.m. was largely mingled with straight-falling, sodden snow-flakes, going on I suppose all night.

May 18. At 4.30 a.m. I got up, and it was snowing fast—big, light flakes, no rain, apparently not thawing. Roads and paths clear; lawn deeply covered with snow, trees heavily laden, every twig carrying a good deal. At 7.15 a.m. it was thawing, masses of snow falling from trees; shrubs bowed to the ground under the weight. On lawn, on tops of wooden doors, on mat-covered garden frames, snow everywhere from 2½ to 3 inches deep, singularly uniform, though now sodden and consolidated. The snow was ceasing to fall; the grass thermometer, covered by snow, showed 32° minimum; a few drops of rain fell from time to time during the day, and the sun shone feebly in afternoon, brightly in late evening. Snow melted uniformly, and was nearly gone at noon from lawn, &c. Sky cleared entirely at night, grass white with frost at 5 a.m. (19th); minima, 30° in shade, 24° on grass.—*H. A. Boys.*

COVINGTON RECTORY, KIMBOLTON.—Hail and snow at intervals all the 17th; at 11 p.m. it was still snowing heavily and was over an inch deep on the lawn, and all trees and bushes were weighed down by it as in mid-winter. A nightingale singing merrily in a snow-covered tree.—*A. E. Watson, F.R.Met.Soc.*

THE ROOKERY, BLOFIELD, NORWICH.—On Saturday, the 16th, the thermometer did not rise above 47°, and the day was most winterly, with frequent storms of hail and sleet. An exceptionally heavy hailstorm occurred at 8.50 a.m., and at 9 o'clock ·22 was gauged. This ·22 included some slight showers of the previous evening. Dry bulb 9 a.m. 37°·2! On Sunday morning (17th) I chanced to wake at 3·30 a.m., and looking out, found the whole landscape in the garb of midwinter. Not only was my garden and lawn covered with over two inches of snow, but all the fields, as far as the eye could reach, were perfectly white. The oaks and ashes here were still leafless, and they were covered with as thick a coating of snow as on any day during the recent severe winter. The horse-chesnuts and beeches in their full spring foliage were perfectly weighed down with the weight of the snow. At 9 a.m. the snow had not all disappeared, and I found the min. thermometer had fallen to 29°·8 in the screen, and to 21°·5 on the grass. Dry bulb, 42°·0; wet bulb, 40°·0; rain during past 24 hours, ·25 in. During the morning the thermometer rose to 49°·8; but at 2 p.m., during a hail-storm, fell to 37°·4! On Monday morning (18th), at 6 a.m., the ground was again covered by a deep snow, which laid on the ground till 1 p.m., and in the roadsides till 6 p.m. At 9 a.m. I found the min. in the screen 32°, and on the grass 30°·2. Dry bulb and wet bulb both 36°·2! Rainfall during the past 24 hours ·87 in. Rain, sleet and snow fell continuously till 4 p.m.; ·15 in. falling between 9 and 4, or 1·02 inches between 9 a.m. on the 17th and 4 p.m. on the 18th. As the bulk of this was snow, there is no doubt that had it not thawed as quickly as it did, it would have lain a foot deep on the level. Temperature by 1 p.m. had only risen to 40°; by 4 p.m. to 41°, and by 6.30 p.m. to 42°, which, so far, is the max. for the day. I fear that the results will be disastrous to the fruit crop, which promised to be an unusually good one.—*Arthur W. Preston, F.R.Met.Soc.*

LYNGATE COTTAGE, WORSTEAD, NORWICH.—Three inches of snow on ground this morning at 6 a.m.; rain and snow during the night yielding ·94 in. of water. Ther. 32°; bar. 29·40; wind N.E. From what I can hear it is 54 years since a similar fall occurred in these parts in May; it then fell on either the 12th or 13th.—*Robert Cross.*

SOUTHAM VILLA, CHELTENHAM.—On Tuesday, the 12th, the heat was oppressive; the maximum temperature in shade reached 79°·0, the highest May temperature I have recorded during the past 14 years, and higher than that of any day in 1879, 1882, 1883, 1890. This morning was cold, wet and miserable; the hills were covered with snow, and the temperature at 1 p.m. was only 41°·0, rising, however, in the afternoon, to 48°·2, which is the lowest May maximum I have recorded later than the 10th.—*Richard Tyrer, B.A., F.R.Met.Soc.*

TEAN VICARAGE, STOKE-UPON-TRENT.—Bitterly cold on 16th and 17th, about 2 inches of snow on the ground on the morning of the 17th, and more fell during the day.—*G. T. Ryves, F.R.Met.Soc.*

THE HEATH HOUSE, STOKE-UPON-TRENT.—Snowed almost continuously from 3.30 a.m. till 2.30 p.m. on 16th, and again on 17th. —*J. C. Philips.*

ORLETON, TENBURY.—Even here in this warm, sheltered valley, the snow was 2 inches deep at 10 p.m. on Whit Sunday, and on the hills round 4 to 6 inches deep, and lay till 1 p.m. next day. I am afraid that the frosts and snow have injured the fruit and hops. An old woman who works for me tells me that on May 16th, 1833, there was snow 12 inches deep. She remembers it because her youngest brother was born then.—*T. H. Newport-Davis, F.R.Met.Soc.*

HAREWOOD LODGE, MELTHAM, HUDDERSFIELD.—May 13th: Shade maximum 73°·9.—15th: Severe storm of thunder and lightning at 4 o'clock in the afternoon, accompanied by a fall of large hail balls (these were hard snow, not ice) of more than half-an-inch diameter; the barograph curve for this day shews numberless small variations, with a jump of 0·06 in. at about 4 p.m.—17th: Shade maximum 45°·0; snow showers all the forenoon.—18th: Shade minimum 23°·8, grass 19°·8. This is by far the lowest temperature in May for the last 13 years, the next lowest being 27°·2 on May 2nd, 1887. Without exaggeration almost every leaf in the garden is damaged; I enclose you a sample taken from a large beech.—*Charles L. Brook, F.R.Met.Soc.*

BOOTHAM SCHOOL, YORK.—Min. in shade on 18th, 24°.—*J. E. Clark.*

YORK ROAD, DRIFFIELD.—Min. in Stevenson's screen on 18th 22°·1, and on grass 12°; terrible destruction of fruit.—*J. Lovel.*

Finally we have to consider whether this changeableness is to be pronounced unprecedented; we think not. Some of its features probably are. The temperatures at Driffield are very low, but no record for that station exists, except for two or three years. At York Mr. Clark has a minimum of 1° less than previously recorded in May in York, but the sites of the thermometers, and the thermometers themselves, have undergone many changes, and that 1° is not such a great difference after all. At Camden Square, May, 1867, was decidedly the more remarkable of the two, both the heat and the cold lasting longer, and the former being much greater.

MAXIMA, above 77°.				MINIMA, below 35°.			
1867.		1891.		1867.		1891.	
Date.	Degree.	Date.	Degree.	Date.	Degree.	Date.	Degree.
6	84·0	12	79·7	*22	34·3	17	30·7
7	83·2	13	80·2	23	31·8	19	33·4
8	82·0			24	33·1		
10	80·1			25	32·3		

* The day on which the Derby was run in a snow storm.

THE THEORY OF HALOS AND PARHELIA.

(*Continued from p.* 55.)

We have next to consider the horizontal white band passing through the Sun. This is accounted for by reflection from the vertical faces of the crystals. As there is no refraction, no colour is produced, and there is no change in the elevation of the image. The result is to produce a horizontal white band, which may be compared to the " path " of the Sun or Moon seen on the surface of rippling water, the difference being that in that case the reflecting surfaces (the faces of the wavelets) are arranged in a horizontal plane while the reflecting surfaces of the ice crystals are in a vertical plane.

The vertical white band passing through the Sun which is occasionally seen, is explained in a similar manner by reflection from the horizontal flat ends of crystals which have their axes vertical. But when this upright pillar of light is seen, it appears not unfrequently to constitute the whole of the visible phenomenon. An example of this is described and figured in *Met. Mag.*, vol. vi., p. 96. In such a case it appears probable, as conjectured by M. Bravais, that the result is produced by crystals of a peculiar shape having a flat hexagonal plate at each end. Crystals of this form are described and figured by Scoresby in his work on the Arctic Regions, and would be admirably adapted to produce this appearance by reflection from their flat extended extremities, but not so well suited to produce the other phenomena of the halo.

It may possibly be objected to the foregoing explanation that it represents the tangent circles and the white band through the Sun as horizontal, whereas, in fact, they appear to curve considerably upwards. It will not, however, be difficult to see that this curvature is an effect of the perspective or apparent figure of the sky. Horizontal lines on the sky, that is lines parallel to the horizon, are necessarily circles or parts of circles described about the zenith, and therefore the curvature increases with the elevation. A horizontal line of moderate length seen near the horizon would probably be described by many observers as straight, while one near the zenith would certainly be seen to be curved. In intermediate positions it is not unlikely that the same line might appear straight to one observer who referred it to the horizon, and curved to another who referred it to the zenith. This would account for the discrepancy in the observations of the halo of January 29th, 1890, some observers putting the mock suns, which are on the horizontal white band precisely level with the real Sun, others making the band curve upwards. (*Met. Mag.*, vol. xxv., p. 1).

We have spoken of the tangent circles as produced at the highest points of the circles round the Sun, by crystals which (in the case of the upper circle) have their axes all vertical. It is plain, however, that a set of parallel crystals having their axes inclined to the vertical at any constant angle would produce a similar tangent circle at some other point. Such an arrangement of crystals may occasionally occur under the influence of air currents, and obliquely placed tangent arcs are sometimes, though rarely, observed.

It remains to explain the parhelia or mock suns themselves. These are frequently seen at the points where the parhelic circle crosses the halo of 22 degrees, and it was therefore a simple explanation, and one that has often been accepted, to say that the illumination at this points is doubled, the effects of reflection and refraction being combined. Unfortunately, however, there is a fatal objection to this explanation in the fact, which is well attested by observation, that the mock suns are not always at the crossing of the two circles, but are sometimes observed to be as much as three or even four degrees outside the halo. The distance from the halo varies with the height of the Sun above the horizon, being greatest when the Sun is highest, while, when the Sun is low, the parhelia are seen at the crossing of the two circles. It is clear, therefore, that some other explanation is required, and this is furnished by the theory of M. Bravais, which is, that while the halo is formed by crystals having their axes perpendicular to the plane passing through the Sun, the eye, and the crystal, as already explained, the parhelia are formed by a similar refraction through crystals having their axes vertical. When the Sun is on the horizon this distinction no longer holds good, for in that case the eye and the Sun are in the same horizontal plane, and the parhelia will be on the halo at the points where it is crossed by the parhelic circle. But when the Sun has attained any considerable elevation above the horizon, it is evident that a ray which is so refracted through a vertical crystal as to reach the eye, must pass not in a plane perpendicular to the axis, but obliquely; and if the effect of cutting a prism by a plane inclined to the axis be considered, it will be seen that a ray so passing is refracted by an angle greater than 60°, and will therefore be more refracted than one traversing a plane perpendicular to the axis, and the parhelion will therefore be farther from the Sun than the halo. It is difficult to represent this in a perspective drawing, and the mathematical calculation involves formulæ of some complexity; but it may be illustrated by a simple experiment, which any one interested in the subject can easily repeat. For this purpose we require a prism so mounted that it may be easily rotated about its axis. I have found the following a simple and efficient arrangement:—Take an ordinary glass prism, and cement one of the flat ends to a glass "slide," 3 in. × 1 in., and secure this on a brass turn-table, such as is used in making cement cells for microscopic objects. Also mount the cap taken from the eye-piece of a microscope upon any convenient stand. The object of this is to keep the eye in the same plane throughout the experiment. Place the cap at the distance of about 20½ inches from a dark screen, and exactly opposite to it fix a small white wafer on the screen. If the prism is now introduced between the eye-cap and the screen in a suitable position, which will easily be found by trial, two images of the wafer will be seen, one uncoloured, formed by reflection from the surface of the glass, and the other coloured, produced by refraction. By rotating the prism slowly on its axis, the position of least deviation for the coloured image will be found to be about 16 inches from the wafer itself, corresponding to an angular distance of 38°. This represents the position of the mock sun and of the portion of the halo which is then coincident with it, when the Sun is on the horizon. If, now, another wafer be placed 9½ inches above the first, answering to an angular elevation of 25°, and its image looked at in the prism occupying the same position as before, the white and coloured images will still be seen in the same horizontal line with the wafer itself, but the coloured image will be about 20 inches from the wafer. This corresponds to an angular distance of about 42°, and represents the position of the parhelion when the Sun is 25° above the horizon. Next let the bed of the turn-table be tilted up until it points in the direction of the wafer representing the Sun. The axis of the prism will then again be perpendicular to the plane in which refraction takes place, and the image will return to a distance of about 17½ inches from the wafer, which, as the distance from the eye to the wafer is now 22½ inches instead of 20½ as at first, will correspond to the same angular distance of 38°, and will represent a point on the halo. Thus it will be seen that with a prism of glass instead of ice, the elevation of the Sun being 25°, the distance of the halo from the Sun will be 38°, and the distance of the parhelion 42°. The greater distances are of course accounted for by the fact that the index of refraction of glass is greater than that of ice. If we reduce the radius of the halo from 38° to 22°, and reduce the distance of the parhelion in like proportion, it will be found to be about 24°; or, in other words, when the Sun is 25° above the horizon the parhelion should be 2° outside the halo, which corresponds very nearly with the results of exact mathematical calculation.*

Some other points of interest about the solar halo may be illustrated with the same simple apparatus. For this purpose it is better to use a small flame instead of the white wafer. A candle at the distance of five or six feet, or a gas burner turned down low will answer the purpose. The eye-cap may be dispensed with. If now the coloured image be observed, and brought to the position of least deviation, it will be found that the prism may be turned a considerable distance, as much perhaps as ten degrees without producing any perceptible movement in the position of the image; but when once the image does begin to move, it moves rather rapidly as the prism is turned further. From this it appears that if in the place of one prism we had a number of small prisms, all with their axes vertical, but variously turned about their axes, a considerable

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* M. Bravais gives 23° 59′ as the calculated distance of the parhelion from the Sun at an altitude of 26°.

number of them would throw the image almost, though not exactly, on the same spot, at and near the position of minimum deviation, while beyond that position only one prism would throw the image to any given point. Several facts connected with the halo and parhelia are explained by these considerations.

First, with regard to the parhelion, the bright end nearest the Sun is produced by the crystals at and near the position of least deviation throwing their images one upon another. The pale end, the tail as it may be called, is produced by crystals passing from the position of minimum to that of maximum deviation, which throw the images further apart, so that they do not fall so much one upon another, and thus give a less degree of illumination. This may be seen by rotating the prism rapidly, the colourless images produced by external and internal reflection will combine into the white band of the parhelic circle.

We may suppose the ice crystals floating in the air to be in every possible position both with regard to the inclination of the axes, and the rotation of the crystal, but the long needle-shaped crystals would have a natural tendency to assume a vertical position under the influence of gravity. Hence there would be a much larger number perpendicular to the horizontal plane then to the other inclined planes in which the refraction must take place to produce the halo. This accounts for the greater brightness of the parhelia, and also for the fact that no fringe corresponding to the tails of the parhelia is seen round the halo, its illumination being (from the comparatively small number of crystals forming it) too faint to be observed. The faint colours of the halos, as compared with the tangent arc, is explained by the overlapping of the images partially reproducing white light. In the upper tangent arc especially there will be no such overlapping, the refracting angles being all in the same position.

The Ice Crystals.

A few words may be said in conclusion about the form and distribution of the ice crystals. We have seen that the theory requires (1) Refracting angles or 60° and 90°. (2) Numerous crystals in all possible positions, so that among them a sufficient number may occur in those positions which are requisite to produce the halos; just as in a shower of rain a sufficient number of drops are found to occupy those exact situations which are necessary to produce the rainbow. (3) A preponderating number of crystals with their axes horizontal to produce the lower tangent circle, and a preponderating number with their axes vertical to produce the upper tangent, the parhelic circle, and the parhelia. It is a mistake, however, to suppose, as some have done, that in order to make Bravais' theory workable it would be necessary "to go up and arrange the prisms after our own fancy, putting all those in one region with their axes vertical, all those in another region with their axes horizontal, and all those in a third region with their axes in every possible direction." (*Met. Mag.*, vol. vi., p. 78.) On the contrary, there is good reason to believe that the necessary conditions with respect to the refracting angles and the inclination of the axes would occur spontaneously; the separation into regions is altogether unnecessary.

First, with regard to the angles. The most common form of ice crystal is the hexagonal with flat ends, and this is also the form best suited to the theory. The angles between the flat ends and the sides are angles of 90°, and there will be twelve such angles in every crystal. The angle between two adjacent sides is 120°, but no light could be refracted through so wide an angle;* the effective angles are those between the alternate sides, which are of 60°, and of these there are six in each crystal. Then there are in all eighteen effective angles in every crystal, from which it follows that there are numerous positions in which the crystal might serve to produce some part of the halo. Next, as to the inclination of the axes. There are two distinct varieties of hexagonal crystals, namely, the acicular form, in which the axis is much longer than the breadth of the crystal, and the lamellar form in which the axis is very short, so that the crystal is a flat hexagonal plate. Under the influence of gravity the acicular crystals would naturally have a tendency to fall with their axes vertical, and the lamellar with their axes horizontal. It can hardly be doubted that there are also intermediate forms with their axes nearly equal in length to the breath of the crystal, and then, having no special tendency to fall in any particular position, would be found with their axes in all directions.

Lastly, as to the number of the crystals. The crystals themselves are very minute; a snow flake consists of many such crystals variously united, and a snow shower must contain millions of them; but we do not require such immense numbers to produce the halos. All the phenomena hitherto discussed are regarded as produced by light which, having been once refracted, comes straight to the eye without being intercepted by a second crystal. It is clear that the presence of too many crystals would interfere with this, for the rays which should have reached the eye to form the image would probably be again intercepted by other crystals. Thus no halo is produced in an ordinary snow storm. In fact, snow has been called opaque. It is opaque in the same way in which broken glass is opaque. Each separate piece is transparent; but the light which is refracted by one falls on another, and then again on a third, and so on, there being a certain loss at each refraction until the whole is dissipated. In the higher region of the atmosphere, however, where air and aqueous vapour are both of greater tenuity, the ice crystals would not be united into snow flakes, but would fall at greater intervals from each other; and even then it is probable

* The widest angle through which refraction can take place in a crystal of ice is 100°. If the angle be greater than this, the light is internally reflected from the second surface.

that only a thin veil of such frozen mist is required to produce the halo. Whether any of the phenomena of the halo are produced by light which, after being refracted by one crystal falls upon another, and is a second time refracted, is a doubtful question. Mock suns are occasionally, though rarely, seen in connection with the halo of 46°. With regard to these M. Bravais considered it uncertain whether they were caused by two successive refractions through an angle of 60°, or by one refraction through an angle of 90°, though he inclined to the former explanation. In order to determine the point, he required a fuller and more accurate series of measurements of the distances of these parhelia from the Sun at various altitudes, and this, I believe, is still a desideratum. Some other rare phenomena of the halo are probably to be explained by the occurence of other refracting angles in less usual forms of ice crystal.

A. K. CHERRILL.

Upton House, 123 *Adelaide Road, N.W.*

ROYAL METEOROLOGICAL SOCIETY.

The usual monthly meeting of this Society was held on Wednesday evening, May 20th, at the Institution of Civil Engineers, 25, Great George Street, Westminister; Mr. Baldwin Latham, M. Inst., C.E., F.G.S., President, in the chair.

Dr. M. G. Foster, M.A., and Mr. J. Robinson, J.P., were elected Fellows of the Society.

The following papers were read:—

1. "On the Vertical Circulation of the Atmosphere in relation to the formation of Storms;" by Mr. W. H. Dines, B.A., F.R.Met.Soc. After giving an outline of the circulation of the atmosphere, the author referred to the two theories which have been suggested to account for the formation of storms, viz.: (1) the convection theory, which is, that the central air rises in consequence of its greater relative warmth, this warmth being produced by the latent heat set free by condensation, and (2) the theory that the storms are circular eddies produced by the general motion of the atmosphere as a whole, just as small water eddies are formed in a flowing stream of water. The author is of opinion that the convection theory is the more probable of the two, but that more information about the temperature of the upper air is greatly needed.

2. "On Brocken Spectres in a London Fog;" by Mr. A. W. Clayden, M.A., F.R.Met.Soc., F.G.S. During the dense fogs in February last, the author made a number of experiments with the view of raising his own 'spectre.' This he ultimately succeeded in accomplishing by placing a steady lime-light a few feet behind his head, when his shadow was projected on the fog. He then made some careful measurements of the size and distance of the "spectre," and also succeeded in taking some photographs of the phenomenon.

3. "An Account of the 'Leste,' or Hot Wind of Madeira;" by Dr. H. Coupland Taylor, F.R.Met.Soc. The "Leste" is a very dry and parching wind, sometimes very hot, blowing over the island from E.N.E. or E.S.E., and corresponds to the Sirocco of Algeria, or the hot north winds from the deserts of the interior experienced in Southern Australia. During its prevalence a thin haze extends over the land, and gradually thickens out at sea until the horizon is completely hidden. It is most frequent during the months of July, August and September, and usually lasts for about three days.

Mr. Shelford Bidwell, M.A., F.R.S., exhibited an experiment shewing the effect of an electrical discharge upon the condensation of steam. The shadow of a small jet of steam cast upon a white wall is, under ordinary conditions, of feeble intensity and of a neutral tint. But if the steam is electrified, the density of the shadow is at once greatly increased, and it assumes a peculiar orange brown hue. The electrical discharge appears to promote coalescence of the exceedingly minute particles of water contained in the jet, thus forming drops large enough to obstruct the more refrangible rays of light. It is suggested that this experiment may help to explain the intense darkness, often tempered by a lurid copper glow, which is characteristic of thunderstorm prevalence.

THE GREAT SNOWSTORM OF MARCH, 1891.

To the Editor of the Meteorological Magazine.

SIR,—Perhaps the statement in your Magazine for April, p. 40, that you had "only three records of the density of the snow," refers only to the storm of the 9th and 10th March; but if it was intended also to cover the storm of the 7th and 8th March, you must have overlooked my remark on p. 24 in the March number that here the 14½ ins. of snow represented about 0·94 in. of water (= 15 : 1). It is true the water was not measured simultaneously with the snow; but as there was no drifting it may be taken as very close to the truth. But I can give you some other measurements of the same storm, which show how much the density depends on the time elapsed. At 0.50 p.m. on the 8th, though the snow had continued to fall with little intermission, the depth was reduced to 12½ ins., which yielded 1·07 in. water (12 : 1); and at 5.50 p.m., when it had again increased to 13·7 ins., this gave 1·29 in. water (11 : 1); I am told that it had rained a little in the meantime, though I saw only snow. This measurement was about 22 hours after the snow began to fall.

Yours truly, T. W. BACKHOUSE.

West Hendon House, Sunderland, June 6th, 1891.

[We had overlooked the remark; but when writing were thinking solely of records from southern counties, where the storm was most exceptional. For further details see ante p. 64.—ED.]

CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE, NOV., 1890.

STATIONS. (*Those in italics are South of the Equator.*)	Absolute. Maximum. Temp.	Absolute. Maximum. Date.	Absolute. Minimum. Temp.	Absolute. Minimum. Date.	Average. Max.	Average. Min.	Average. Dew Point.	Average. Humidity.	Absolute. Max. in Sun.	Absolute. Min. on Grass.	Total Rain. Depth.	Total Rain. Days.	Aver. Cloud.
	°		°		°	°	°	0-100	°	°	inches		
England, London	58·1	23	20·8	29	48·8	37·4	39·9	89	87·5	17·8	1·62	17	6·9
Malta	73·4	...	45·9	...	66·0	55·1	50·9	77	128·2	37·6	1·87	12	4·6
Cape of Good Hope	84·3	23	44·0	14	72·3	55·9	...	...	...	...	1·41	...	3·7
Mauritius	82·2	29	63·0	17	79·7	68·3	64·9	76	137·0	58·0	2·80	15	5·8
Calcutta	82·7	4, 9	57·4	15	80·1	62·7	63·7	78	144·0	48·3	·01	1	1·8
Bombay	89·1	1	69·0	21	85·7	73·3	68·9	71	137·0	53·9	1·25	4	2·3
Ceylon, Colombo	88·4	20	70·8	19	85·4	72·9	71·0	80	147·0	67·0	12·32	24	5·8
Melbourne	94·5	6	45·3	16	67·0	50·8	49·0	71	141·3	37·0	4·88	13	6·6
Adelaide	96·1	6	45·7	14	73·8	54·4	48·4	57	153·1	38·8	2·20	11	5·6
Wellington	74·0	26	39·0	5	64·8	48·0	46·3	70	129·0	34·0	2·86	12	3·7
Auckland	71·5	25	47·0	5	66·3	53·6	49·5	69	138·0	40·0	3·48	12	6·0
Jamaica, Kingston	91·6	20	68·8	29	88·1	71·4	69·2	74	...	...	2·73	...	...
Trinidad	...	...	...	...	...	...	...	...	...	...	...	...	...
Toronto	59·0	9	15·9	28	43·7	30·4	30·7	79	...	9·9	3·59	17	7·0
New Brunswick, Fredericton	55·6	8	7·9	24	39·5	23·5	27·5	77	...	...	2·81	16	6·9
Manitoba, Winnipeg	55·9	4	— 1·1	30	39·0	18·8	23·8	79	...	...	·43	9	5·1
British Columbia, Esquimalt	55·2	21	33·0	6	50·6	40·4	44·4	95	...	...	1·74	18	6·9

NOVEMBER REMARKS.

MALTA.—Mean temp. 59°·1 ; mean hourly velocity of wind, 10·8 miles ; sea temp. fell from 70°·5 to 65°·0. TSS on 3 days ; L on 7 days. On 29th a strong after-glow, lasting till 1 hour 10 minutes after sunset ; very similar to the after-glows of 1883.
J. SCOLES.

Mauritius.—Mean temp of air, 1°·1 below ; dew point 0°·7 above, and rainfall ·82in. above, their respective averages ; mean hourly velocity of wind, 9·5 miles, or 1·4 below average ; extremes 19·8 on 9th and 0·0 on 20th ; prevailing direction, S.E. by E. ; from 16th to 23rd inclusive N. and W. winds prevailed. L on 8th and T on 28th and 29th.
C. MELDRUM, F.R.S.

Ceylon, Colombo.—TSS occurred on 17 days, and L was seen on 7 other days.
J. C. H. CLARKE, Lieut.-Col., R.E.

Melbourne.—Mean temp. of air 1°·6 below average ; temp. of dew point 0°·4; humidity 4, amount of cloud 0·7, and rainfall 2·34 in. above their respective averages. Prevailing wind S., strong on 7 days ; heavy dew on 3 days ; hail on 29th, thunder and lightning on 6th and 29th ; thunderstorm with heavy showers on 24th.
R. L. J. ELLERY, F.R.S.

Adelaide.—Mean temp. 2°·8 below the average of 33 years ; mean max. temp. and also mean daily range, the lowest on record for November. Rainfall 1·21in. above the average, and the greatest fall in November since observations began, 33 years ago.
C. TODD, F.R.S.

Wellington.—R below the average. Showery in the early part of the month, and fine during the latter part, excepting very heavy rain with a N.W. gale on 26th. Prevailing wind, N.W., frequently strong, especially on the 11th and 26th. On the whole tolerably fine. Lightning on 2nd. Temp. very near the average, but rainfall 1·31 in. below it.
R. B. GORE.

Auckland.—On the whole a cold, showery and squally month. R about ·50 in. in excess of the average; mean temp. slightly below the average.—T. F. CHEESEMAN.

SUPPLEMENTARY TABLE OF RAINFALL, MAY, 1891.

[For the Counties, Latitudes, and Longitudes of most of these Stations, see *Met. Mag.*, Vol. XIV., pp. 10 & 11.]

Div.	STATION.	Total Rain.	Div.	STATION.	Total Rain.
		in			in.
II.	Dorking, Abinger Hall.	2·75	XI.	Builth, Llanwrtyd Wells	3·56
,,	Margate, Birchington...	3·13	,,	Rhayader, Nantgwillt..	4·14
,,	Brighton, PrestonvilleRd	2·62	,,	Corwen, Rhug	3·54
,,	Hailsham	2·33	,,	Carnarvon, Cocksidia ...	1·74
,,	Ryde, Thornbrough	3·04	,,	I. of Man, Douglas	1·48
,,	Alton, Ashdell...........	2·93	XII.	Stoneykirk, ArdwellHo.	2·26
III.	Oxford, Magdalen Col...	2·15	,,	New Galloway, Glenlee	2·71
,,	Banbury, Bloxham	...	,,	Melrose, Abbey Gate...	1·91
,,	Northampton	2·82	XIII.	N. Esk Res. [Penicuick]	...
,,	Cambridge, Fulbourne..	3·95	XIV.	Ballantrae, Glendrishaig	1·81
,,	Wisbech, Bank House..	2·77	,,	Glasgow, Queen's Park.	2·75
IV.	Southend	2·09	XV.	Islay, Gruinart School..	1·77
,,	Harlow, Sheering	2·99	XVI.	Dollar.......	2·08
,,	Rendlesham Hall	2·65	,,	Balquhidder, Stronvar..	2·65
,,	Diss	2·15	,,	Coupar Angus Station..	1·60
,,	Swaffham	3·19	,,	Dunkeld, Inver Braan..	2·41
V.	Salisbury, Alderbury ...	2·94	,,	Dalnaspidal H.R.S. ...	3·81
,,	Warminster	3·16	XVII.	Keith H.R.S.	3·79
,,	Bishop's Cannings	2·73	,,	Forres H.R.S.	2·50
,,	Ashburton, Holne Vic....	4·84	XVIII.	Fearn, Lower Pitkerrie.	2·34
,,	Okehampton, Oaklands.	3·82	,,	Loch Shiel, Glenaladale	2·78
,,	Lynmouth, Glenthorne.	3·52	,,	N. Uist. Loch Maddy ...	2·19
,,	Probus, Lamellyn	2·11	,,	Invergarry	1·12
,,	Launceston, S. Petherwin	...	,,	Aviemore H.R.S.	2·90
,,	Wincanton, StowellRec.	2·72	,,	Loch Ness, Drumnadrochit	2·93
,,	Wells, Westbury.........	...	XIX.	Lairg H.R.S.	3·02
VI.	Bristol, Clifton	3·78	,,	Scourie	3·62
,,	Ross, the Graig	3·73	,,	Watten H.R.S.	2·19
,,	Wem, Clive Vicarage ...	3·73	XX.	Dunmanway, Coolkelure	3·88
,,	Cheadle, The Heath Ho.	2·91	,,	Fermoy, Gas Works ...	2·51
,,	Worcester, Diglis Lock	3·51	,,	Darrynane Abbey.........	3·39
,,	Coventry, Coundon	3·34	,,	Tipperary, Henry Street	3·43
VII.	Ketton Hall [Stamford]	2·88	,,	Limerick, Kilcornan ...	2·03
,,	Grantham, Stainby	3·22	,,	Ennis	2·23
,,	Horncastle, Bucknall ...	2·57	,,	Miltown Malbay.........	1·62
,,	Worksop, Hodsck Priory	3·27	XXI.	Gorey, Courtown House	3·08
VIII.	Neston, Hinderton	2·35	,,	Mullingar, Belvedere...	3·04
,,	Knutsford, Heathside...	3·16	,,	Athlone, Twyford	2·87
,,	Lancaster, Southfield...	...	,,	Longford, Currygrane...	2·71
,,	Broughton-in-Furness..	2·75	XXII.	Galway, Queen's Coll...	2·12
IX.	Ripon, Mickley	2·21	,,	Crossmolina, Enniscoe..	3·48
,,	Scarborough, West Bank	2·92	,,	Collooney, Markree Obs.	3·32
,,	EastLayton[Darlington]	2·12	,,	Ballinamore, Lawderdale	2·57
,,	Middleton, Mickleton..	1·65	,,	Lough Sheelin, Arley ..	2·04
X.	Haltwhistle, Unthank..	1·31	XXIII.	Warrenpoint	1·56
,,	Bamburgh................	1·17	,,	Seaforde	2·69
,,	Shap, Copy Hill	...	,,	Belfast, New Barnsley..	3·92
XI.	Llanfrechfa Grange	4·93	,,	Bushmills, Dundarave...	2·79
,,	Llandovery	3·42	,,	Stewartstown	3·33
,,	Castle Malgwyn	3·21	,,	Buncrana	2·65

MAY, 1891.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average. 1880-9.	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.	London (Camden Square) ...	2·72	+ ·82	·66	17	19	80·2	13	30·7	17	1	5
II.		Maidstone (Hunton Court)...	2·60	+ 1·22	·47	20*a*	20	...	...	...	...	...	...
,,		Strathfield Turgiss	3·18	+ 1·31	·45	17	21	80·3	13	29·2	17	2	11
III.		Hitchin	3·18	+ 1·23	·85	17	19	75·0	13	31·0	17	1	...
,,		Winslow (Addington)	3·62	+ 1·52	1·11	17	19	76·0	13	28·0	17	2	7
IV.		Bury St. Edmunds (Westley)	2·67	+ ·92	·90	17	15	72·0	12*d*	26·0	17	...	...
,,		Norwich (Cossey)	3·17	+ 1·50	·80	17	15	73·0	14	26·0	17	3	...
V.		Weymouth(LangtonHerring)	2·08	+ ·47	·49	23	17	71·0	11*d*	34·0	17	0	...
,,		Barnstaple	2·78	+ ·58	·41	17	14	76·0	12	31·0	19	...	...
,,		Bodmin (Fore Street)	4·44	+ 1·91	·68	7	21	...	...	...	...	...	...
VI.		Stroud (Upfield)	4·46	+ 2·42	·70	24	19	78·0	13	32·0	16*f*	2	...
,,		ChurchStretton(Woolstaston)	3·69	+ ·82	·80	21	22	74·5	12	30·0	17	3	7
,,		Tenbury (Orleton)	3·75	+ 1·20	·65	21	22	79·8	13	27·5	19	2	7
VII.		Leicester (Barkby)	2·64	+ ·67	·40	25	17	79·0	13	27·0	18	6	11
,,		Boston	1·88	+ ·16	·40	24*b*	15	85·0	13	27·0	17	3	...
,,		Hesley Hall [Tickhill]	3·20	+ 1·16	·54	21	16	76·0	12	26·0	18	5	...
VIII.		Manchester(PlymouthGrove)	2·40	+ ·05	·33	28	20	75·0	12	30·0	17	2	3
IX.		Wetherby (Ribston Hall) ...	1·37	— ·58	·41	24	11	...	...	...	...	...	...
,,		Skipton (Arncliffe)	3·41	— ·31	·59	1	19	74·0	13	22·0	17	4	...
,,		Hull (PearsonPark)	3·31	+ 1·43	·64	24	19	...	...	...	...	..	...
X.		Newcastle (Town Moor)	1·84	+ ·09	·70	26	14	...	...	...	...	...	...
,,		Borrowdale (Seathwaite)......	5·46	— 3·15	·92	28	18	...	...	...	...	...	...
XI.	WALES.	Cardiff (Ely)	5·18	+ 2·33	1·23	23	17	...	...	...	...	...	...
,,		Haverfordwest	4·03	+ 1·67	·64	24	20	70·0	13*e*	29·0	19	3	6
,,		Carno (Tybrith)	2·63	— ·62	·39	28	18	71·0	11	24·0	17	11	...
,,		Llandudno	1·98	+ ·05	·43	28	17	68·1	31	32·4	18	0	...
XII.	SCOTLAND.	Cargen [Dumfries]	2·51	— ·01	1·09	27	13	75·6	12	26·0	18	3	...
,,		Jedburgh (Sunnyside)	1·83	— ·07	·33	27	17	75·0	12	30·0	17	2	...
XIV.		Old Cumnock	1·97	— ·47	·35	14	18	...	...	...	...	...	...
XV.		Lochgilphead (Kilmory)......	1·89	— 1·46	·51	1	15	...	...	...	...	...	...
,,		Oban (Craigvarren)	1·72	...	·58	1	14	68·8	11	34·0	17	0	...
,,		Mull (Quinish)	1·54	— 1·41	·31	1	16	...	...	...	...	...	...
XVI.		Loch Leven Sluices	1·90	— ·66	·30	1*c*	9	...	...	...	...	...	...
,,		Dundee (Eastern Necropolis)	2·35	+ ·69	·75	1	9	71·3	12	31·1	17	1	...
XVII.		Braemar	2·12	— ·29	·47	1	15	68·2	12	28·0	17*f*	7	20
,,		Aberdeen (Cranford)	2·90	...	·45	18	23	70·0	12	29·0	16	2	...
XVIII		Strome Ferry	1·65	— 1·70	·39	14	12	...	...	...	...	...	...
,,		Inverness (Culloden)	2·06	+ ·56	·78	2	4	70·0	12	31·0	17	1	12
XIX.		Dunrobin	2·22	+ ·12	·39	17	12	70·0	12	32·0	16	1	...
,,		S. Ronaldsay (Roeberry)......	2·72	+ 1·00	·83	26	20	64·0	12	30·0	15*g*	2	...
XX.	IRELAND.	Dromore Castle	...	...	...	...	...	...	...	...	...	..	...
,,		Waterford (Brook Lodge) ...	3·79	+ 1·56	·77	7	18	71·0	12	32·0	21	1	.
,,		O'Briensbridge (Ross)	2·18	...	·41	7	21	73·0	12	33·0	21	0	...
XXI.		Carlow (Browne's Hill)	3·49	+ 1·15	1·05	7	19	...	...	...	...	...	...
,,		Dublin (FitzWilliam Square)	2·79	+ ·86	·60	28	17	67·8	12	32·8	18	0	6
XXII.		Ballinasloe	2·49	— ·20	·53	28	21	68·0	12	27·0	18	8	...
,,		Clifden (Kylemore)	5·94	...	·89	22	24	..	...	...	...	...	...
XXIII		Waringstown	3·64	+ 1·20	·69	7	20	80·0	12	24·0	10	5	9
,,		Londonderry (Creggan Res.).	3·14	+ ·62	·66	7	19	...	...	...	...	..	...
,,		Omagh (Edenfel)	3·22	+ ·75	·65	7	20	70·0	12	34·0	16*h*	0	5

a And 24. *b* And 25. *c* And 2,3,30. *d* And 13. *e* And 14. *f* And 18. *g* And 16. *h* And 17, 20

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

METEOROLOGICAL NOTES ON MAY, 1891.

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

ENGLAND.

STRATHFIELD TURGISS.—A cold ungenial month, with ground frosts up to the very last day.

HITCHIN.—Such an instance of winter and summer in one week must be without a parallel. Sunday, the 10th, snow; Wednesday, a hotter day than was ever before recorded so early in May, and snow again on the Friday, Saturday and Sunday following.

ADDINGTON.—A very unseasonable month. Rainfall only twice exceeded during 20 years—namely, in 1878, when 4·89 in. fell, and in 1886, when 4·35in. fell. A very damaging frost occurred on the 17th, doing much injury to both fruit and vegetables.

COSSEY.—Snow fell on the 17th to the depth of 6 or 7 inches.

LANGTON HERRING.—Mean temp. 2°·5 below the average of 19 years. The changes of temp. from the 13th to the 17th were sudden and great. A little snow fell on the 16th with R. Solar halos were seen on 20th and 23rd, and distant T was heard on 26th. Barometer generally low.

BODMIN.—A very cold month. Sharp frost on the 19th; sleet and hail on the 16th; T and L on the 21st; N. and N.W. winds prevailing—more like March than May.

STROUD.—Everything very backward; the tops of potatoes cut off by frost. Ash trees came into leaf on the last two days.

WOOLSTASTON.—A month of varying temperature. The first ten days were cold and chilly; but the temp. rose suddenly, and the 11th and two following days were very hot; the temp. then fell as suddenly as it had risen, and on the 15th, after very severe storms of H, snow began to fall, and fell heavily at intervals during the two following days. The remainder of the month was cold and wet; mean temp. 48°·6.

ORLETON.—A month full of changes, and with great extremes of temp. The first ten days about the average, then four very hot days, the max. on the 12th and 13th being higher than on any day in the whole of the summer of 1890. Much colder from the 14th to 16th, with heavy storms of S on the latter day, and a depth of two inches on 17th; hard frost on the 19th, doing much damage to potatoes, hops, fruit, &c.; from thence to the 27th very cold, but slightly warmer at the end of the month. T on 19th, 20th, 23rd and 27th. Mean temp. of the month 2°·5 below the average.

LEICESTER, BARKBY.—A variable month. Potatoes and other things severely cut by the frost on the 18th. T on 15th and 27th, with H on the latter day; S on 16th and 17th.

BOSTON.—A sharp frost occurred on the 17th; the min. temp. falling to 27°, the lowest recorded in May during 27 years.

HESLEY HALL.—Vegetation of all kinds very backward; frosts on the 17th and 18th doing much damage; S on 16th and 17th. T on 28th.

MANCHESTER, PLYMOUTH GROVE.—Summer-like weather on 7th, 8th, 12th, 30th and 31st. S and H showers on 16th, and 17th; T and L on 15th and 28th. Mean temp. 50°·5.

HULL, PEARSON PARK.—The weather during the month was generally cold, E. winds prevailing. Usually fine, with light clouds from the 1st to the 14th, and showery from the 15th to nearly the end of the month.

WALES.

HAVERFORDWEST.—A large number of fine, bright but cold days, with a large number of wet nights; a very hot bright period from the 13th to the 17th, followed by a sudden and abrupt fall of temp., with four or five sharp frosts in shade. Prevailing winds N. and N.N.E. Owing to the large amount of rain, vegetation, in spite of the cold, made rapid strides. Lowest temp. on grass 25°.

SCOTLAND.

CARGEN.—A month of extremes. With four exceptions, the max. temp. of 75°·6, on the 12th, is the highest recorded in May during 31 years; and the min. temp. of 26°, on the 18th, is the lowest—a range of temperature of 49°·6 in six days. On one or two occasions the range of temp. was from 25° to 30° in 12 hours. Notwithstanding the two or three very warm days from 11th to 13th, the mean temp. of the month was 2°·7 below the average. S fell on the 16th, 17th and 20th. The H storm on the 27th was the heaviest experienced for many years, and did much damage to the fruit blossoms, &c. TSS occurred on the 5th, 15th, 23rd, 27th and 28th.

JEDBURGH.—The weather was very cold and ungenial, more so than is remembered in May by elderly people. Vegetation, though greatly retarded, was not much injured. Want of grass was much felt. S on hills on 15th; H on 16th, 17th, 19th, 20th and 23rd; T and L on 28th.

OLD CUMNOCK.—Frost on the 4th; T, H and R on the 15th. Hills covered with H on 16th, and the low ground on 17th.

OBAN.—The month was very cold and dry, with northerly and easterly winds prevailing. In the middle the cold was quite severe, with occasional frost. Vegetation of all kinds most backward.

MULL, QUINISH.—A cold, withering, parching month from first to last; all vegetation very backward.

INVERNESS, CULLODEN.—The month was very ungenial, and the pastures were exceedingly backward.

S. RONALDSAY, ROEBERRY.—Very rough and cold weather during the middle of the month; the beginning and latter part fine.

IRELAND.

WATERFORD, BROOK LODGE.—T on the 21st, 23rd and 27th, with L, and H showers. Potatoes damaged by frost on the 17th. Mean temp. 48°·9.

O'BRIENSBRIDGE, ROSS.—It was a cold and ungenial month, made more distinctly evident by the contrast of one real summer's day on 12th. There were several slight frosts, damaging fruit blossoms, early potatoes and other tender plants.

DUBLIN.—Cold for the most part, showery and unsettled, with an overwhelming prevalence of polar wind and frequent falls of H. Only from the 10th to the 13th inclusive was there anything like summer heat. Mean temp. 49°·6, or 2°·4 below the average of May for 25 years. A solar halo was seen on the 8th, and a lunar halo on 17th. High winds on 8 days; S or sleet on 16th and 17th; H on 8 days; T on 28th.

BALLINASLOE.—A cold and harsh month, with constant frost up to the 20th, and high wind from the 21st to the 31st. H on 15th and 16th.

EDENFEL.—The month commenced in fairly seasonable weather, and during the second week the thermometer marked a higher temperature for the date than has been recorded in 27 years, except in 1871 and 1881. From the 14th to the end all these conditions changed as far in the other direction, and a cold, cheerless, inclement period followed, with H, rain, S and frequent night frosts, and strong polar and easterly winds during the day.