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THE AUTUMN CONGRESSES.

Is it permissible to the Editor of a scientific journal to suggest that there is too much activity in the branch of science which he is trying to advance? The answer is not easy; progress is what one ought to aim at, activity usually implies progress, and certainly there can be little progress without activity. On the other hand, the strain may be too great. The meetings of the great scientific societies run on from October to June, and the autumns used to be quiet and restful, but first the British Association, then the Social Science, and then the Sanitary Institute, started autumn meetings, and this year our French friends have brought matters to a crisis with 68 successive and partly simultaneous congresses. Of course with very few of these had meteorologists anything to do, but the following are all meetings which come within the province of this magazine :—

The British Association, Newcastle-on-Tyne, Sept. 11 to 18.
International Congress on Meteorology, Paris, Sept. 19 to 26.
The Sanitary Institute, Meteorological Section, Worcester, Sept. 24 to 28.
International Congress on Climatology, Paris, Oct. 2 to 10.

Obviously we cannot report fully upon all these meetings. With the exception of the British Association, full accounts of each will be published, and therefore we need give only brief notices of the others.

THE BRITISH ASSOCIATION AT NEWCASTLE-ON-TYNE.

This meeting was in point of numbers far below that held in the same city in 1863, but we see no signs of analogous depreciation in the quality of the papers read, though there was perhaps nothing exceptionally striking in them. As Prof. Cleveland Abbe favoured us with a copy of his paper, and we are not aware that it will appear elsewhere in full, we print it *in extenso*, and add abstracts of such of the other papers as we have been able to obtain.

THE DETERMINATION OF THE AMOUNT OF RAINFALL.

By Prof. Cleveland Abbe.

THE accurate measure of rain is a matter of equal importance to meteorology and engineering, but like all other problems in physics the accurate determination of any datum must be accompanied by a determination of the reliability of, or the confidence to be placed in, the numerical results. There must be some estimate or determination of the "possible error" or the "probable error" of the result of our measures, before we can safely make use of that result for any further deductions.

Many investigations have been made into the reliability of rainfall measures by means of comparative observations with gauges of various patterns placed in diverse localities with regard to surrounding obstacles and at different heights in respect to the surface of the ground or at different altitudes with respect to the surface of the sea.

The general result of these investigations so far as rain proper is concerned is about as follows:—

1. *As concerns the size and shape of the collecting funnel*, circular and square apertures of from ten to one hundred square inches area give results that vary only one or two per cent. among themselves.

2. *As regards the external shape of the gauge as a whole.*—Simple cylinders or cylinders with small rims or bulging rings, or conical flanges, vary but two or three per cent. among themselves on account of shape, but all catch decidedly less than cylinders with broad flanges or shields near their apertures as in the Henry and the Nipher gauge. The excess of the catch in these shielded gauges increases slightly in proportion to the force of the wind.

3. *As regards the location.*—Gauges on the ground close to the windward side of an obstacle catch more than those in the open field; gauges close to the leeward side catch less, while gauges a little farther to the leeward catch decidedly more; gauges on the top of the obstacle, such as the flat roof of a house, catch less when they are near the windward side, but the same or little more than the normal when they are nearer the leeward side of the roof. This shows that the presence of an obstacle in conjunction with the wind alters the distribution of what would otherwise be a uniform rainfall; the alteration increases more rapidly than the increase of the wind, and is approximately as the square of the velocity.

4. *With regard to elevation above sea level.*—Whether on an isolated mountain or on a broad rising plateau, on the windward side the rainfall increases up to a certain elevation and then diminishes rapidly, but on the leeward side there is only a rapid diminution from the summit downwards. In some cases this latter diminution causes an entire absence of rain over the greater part of the leeward side of the plateau or mountain; in many cases the available mountains are scarcely high enough to enable us to observe the diminution of rain above the belt of maximum precipitation.

5. *With regard to the altitude above ground.*—The higher gauges invariably catch less rain and the discrepancies caused by altitude are so large as to have hitherto been considered as the principal source of uncertainty in rainfall measurements, so that for gauges of uniform patterns exposed in unobjectionable locations in open fields the only method hitherto prescribed for securing comparable results has consisted in the adoption of a uniform small elevation above ground; but this rule, of course, gives us no assurance that our rainfall measurements are correct in any absolute sense. The general explanation of the fact that the higher gauges catch less rain, as given by Bache and Jevons, was that the wind causes eddies about the mouth of the gauge and carries past some of the raindrops. This explanation is undoubtedly true and suffices to explain many observed phenomena; but if true, it should be followed out to its logical consequences and be made to give us some method of correcting the record of a gauge for the influence of the wind so as to obtain a nearer approximation to the rain that has actually fallen upon the ground; this I will now attempt to do.

6. In the case of ordinary rainfalls the air is full of large and small drops intermixed, or of heavy and light flakes of snow; near the ground are additional fragments of drops broken up by spattering and again during snow storms with high winds the air is full of flakes that have been whirled up into the air after having once fallen to their resting place on the ground or trees. I shall for the present omit the consideration of spattering and drifting, hoping to treat of them at some future time, and will consider only the effect of the wind on the drops falling directly into a gauge whose mouth is high enough above the ground to avoid these two influences; in fact, spattering and drifting can only influence the local distribution of rain or snow, a gauge placed within their influence must have its readings thereby increased, and the true amount of precipitation is more easily obtained by the method I shall present, if the gauges are raised a few feet above the ground.

We therefore consider that there is falling into the gauge a quantity of drops or flakes of various sizes and various vertical velocities while the wind is blowing horizontally against the gauge.

7. Now, when the wind strikes the gauge the deflected current just above the mouth of the gauge acquires a vertical component that it did not have before it struck the gauge, and also has a horizontal motion more rapid than it had before, and more rapid than that of the wind a few inches higher up. The larger drops of the falling rain may descend with a rapidity sufficient to penetrate this swiftly moving layer and enter the gauge, but the smaller drops falling more slowly will be carried over to the leeward of the gauge, and failing to enter it will miss of being measured as rainfall, although they really go on and fall to the ground near by. Evidently of two masses of rain having the same proportion of large and small drops, or rapid and slow falling snow flakes, the proportion of small drops

that are carried by will be large in proportion as the wind is stronger, the deficiency in the catch of the gauge being very nearly proportional to the velocity of the wind. Again for the same gauges and the same velocity of wind the deficiency will be proportional to the relative percentage of small and slow falling drops that occur in any given shower. Thus we easily see that the deficiency will be greater in winter snows than in summer rains, greater in fine drizzling rains than in heavy downfalls, greater in windy localities, greater for elevated gauges than for low ones. The application of these ideas gives us a satisfactory general explanation of the numerous irregularities that have been observed in rainfalls. In fact, they explain every one of the most extreme cases, such, *e.g.*, as that recorded by the Signal Service observer at Kitty Hawk on the sandy beach of North Carolina, where nine experimental gauges were by request established in a cluster, fully exposed to the wind, with their mouths two or three feet above the surface of the sand. The windward gauges of the cluster caught less rain than the leeward, but they also caught very much more sand, showing that the strong winds which carried the light raindrops on beyond to the leeward gauges also stirred up the light surface sand and were just able to drop this into the windward gauges.

8. The numerical results of all rainfall observations at different elevations of the gauge have been collected by me in a memoir read before the Philosophical Society of Washington, in December, 1888; most of these are also given in the excellent memoir of Wild, in volume IX. of his Repertorium, 1885. These observations represent many years of rainfall in a great variety of climates in the United States and Western Europe, and continued as they were through summer and winter, they represent the average effects (due to the average proportions between the precipitations that descend rapidly and slowly with the accompanying winds) characteristic of the respective climates. The following table shows the numerical results. In the fourth column are given the catch of the respective gauges expressed in percentage of the catch of the normal pit-gauge; the fifth column gives the deficit of this percentage; the sixth column gives the square root of the altitude.

Now, the studies of Archibald and Stevenson have shown that for small altitudes the velocity of the wind increases very nearly as the square root of the altitude. If, therefore, our deficits are proportional to the wind, they should be proportional to the numbers in the sixth column. This turns out to be the case so exactly that the formula

$$\text{Deficit} = 6 \text{ per cent.} \times \sqrt{\text{altitude in meters}}\ P$$

almost perfectly represents the deficits given in the fifth column.

Although the co-efficient 6 thus closely represents the average of many years' work, yet it cannot be safely adopted for any one locality, or even for any one year, since it involves the proportions of rain, snow and wind that actually occurred during the observations above summarized; much less can it be adopted for any given month in the year, or any given storm. On the other hand, I conclude that for each wind, and for each style of precipitation, and for each style of gauge, there must be a special co-efficient to replace the figure 6. In other words, the co-efficient must be known for each individual rainfall or snowfall.

Location.	No. of Years.	Altitude. in Meters.		Relative Catch.		Relative Deficit.	Square Root of Altitude	$\sqrt{Alt}$
....		0		100		0	0	0
Calne (5 and 8 inch gauges)	4	1		90		10	1·00	6
Castleton (5 and 8 inch gauges)...	3	2		88		12	1·41	8
Rotherham (5 inch gauges)	8	3		86		14	1·75	10
St. Petersburg (10 inch gauges)..	10	4		85		15	2·00	12
....		5		85		15	2·24	13
....		6		84		16	2·45	15
London (Westminster Abbey) ...	1	9		77				
Enden	2	11		72				
St. Petersburg (Cent. Obs.)	1	13		68				
York (Museum)	3	13	13	80	79	21	3·61	22
Calcutta (Alipore Obs.)	7	15		87				
Walton-on-Thames (Woodside). .	1	15		73				
Philadelphia (Frankfort Arsenal)	5	16		95				
Sheerness (Water Works).........	3	21		52				
Whitehaven (St. James's Church)	10	24		66				
St. Petersburg (Cent. Obs.)	10	25		59				
Paris (Astronomical Obs.).........	40	27	28	31	64	36	5·29	32
Dublin (Monkstown)	6	27		64				
Oxford (Radcliffe Obs.)	8	34		59				
Copenhagen (Observatory).........	4	36		67				
London (Westminster Abbey) ...	1	46		52				
Chester (Lead Works)...............	2	49		61				
Wolverhampton (Water Works)	3	55	59	69	58	42	7·68	46
York Minster (Tower)......	3	65		60				
Boston (St. Botolph Church)......	2	79		47				

9. It is not difficult to devise a method of ascertaining this co-efficient at any moment. We have simply to establish two gauges at different heights, but near each other, and then, if they do not interfere with each other, and if the relative number of fine and large drops is the same at their respective elevations, and if the relative force of the wind at their mouths is known, we easily have the solution of the problem. If the gauges be placed above the roof of a flat building, we shall get the rainfall on that roof instead of on the ground.

It would be best to directly measure the relative wind velocity for each gauge-mouth by appropriate anemometers, or if this be not practicable, and if we have to assume some law, such as Archibald's, connecting wind and altitude, then it would be an improvement to use three or more gauges at different altitudes, so as to check this assumption, and determine the extent to which for any shower the deficit depends on the square or other function of the velocity, rather than on the simple velocity itself. But assuming, for simplicity, that only two gauges are used, our method of procedure would consist in measuring the catch of the gauges placed at different heights for each storm or each hour, and substituting these results as the known data in the simple equation that connects these with the respective wind velocities. This equation is—

$$\text{Catch of gauge} = \text{Catch of normal pit-gauge} \times \left(1 - k\sqrt{\text{altitude}}\right)$$

or

$$c = P\left(1 - k\sqrt{h}\right)$$

Two values, c_1 and c_2 for two altitudes h_1 and h_2, give us two equations, from which, by elimination, we determine P and k for each individual case. Of course, the values of k are of minor importance to the climatologist and the ordinary observer, who will be content to compute the value of P for each measured rainfall, and will enter it in the proper column of his daily register as the corrected precipitation, comparable in its scientific value with his corrected pressure or temperature.

The formula for this computation is easily deduced by elimination, and may be put in the following form, where c_2 and h_2 belong to the upper gauge :—

$$P = c_1 + \frac{1}{\sqrt{\frac{h_2}{h_1}} - 1}\left(c_1 - c_2\right)$$

The gauges being permanent as to their altitudes, and so high that any winter snow will not materialy change the h_1 and h_2, we may assume their ratio to be constant. Some one of the following combinations will naturally occur to the observer :—

For altitude {1 and 4, 2 and 8, 3 and 12, &c.} $P = c_1 + \left(c_1 - c_2\right)$

For altitude {1 and 9, 2 and 18, &c.} $P = c_1 + \frac{1}{2}\left(c_1 - c_2\right)$

For altitude {1 and 16, 2 and 32, &c.} $P = c_1 + \frac{1}{3}\left(c_1 - c_2\right)$

Thus from measured rainfalls of 2·11 and 1·96 units caught in gauges at elevations of 1 and 4 units, we find the rainfall to be 2·26 units; whereas if for gauges at elevations of 1 and 16 units we had measured 2·11 and 1·60, we should have computed the true rainfall to be 2·28 units.

10. We have thus provided for the approximate correction of the rain-gauge readings for the very large source of error introduced by the wind and the slowness of fall of the drops, and we find that this correction is, even for low gauges, quite as large as the quantities about which climatologists have had so much discussion, viz., the effect of forests and buildings, of the hour of the day, of the cultivation of land, of the sun-spots, and other suggested influences. None of these subjects can be properly studied until we correct the original catch of the gauge for the large error due to the influence of the wind. But the wind influence does not depend on altitude only, that is to say, the correction deducted for any pair of gauges at one spot cannot be transferred to a similar pair at a short distance, because the winds at that new position, during the falling of the rain, may have been different from those prevailing at the former location. A pair of gauges must be established and observed at every spot whose rainfall we would determine.

This leads me to remark that in such a case as is afforded by the valuable observations in the experimental rain field at Berlin, it is probable that the moderate differences in the horizontal distribution of rain are comparable with the differences due to the distribution of wind, so that the study of the uncorrected gauge readings is really a study into the effect of local winds on the catch of the gauge, and, in general, gauge readings do not show the geographical distribution of rain until they are corrected for the effect of the wind at the mouth of the gauge as for an instrumental error.

In the case of gauges placed above forests, the measured quantities will increase as the forests grow taller, because the gauges come to be nearer the level and shelter of the tree tops; a gauge within the foliage of a tree should have a correction nearly the same as one near the ground, because of the diminished force of the wind in its neighbourhood.

Professors Joseph Henry and F. E. Nipher have advocated the use of "shielded gauges," and Börnstein has advocated "protected gauges," all so constructed that eddies about the mouths are largely diminished. Such gauges, therefore, have smaller corrections than the simple cylinders, and a pair of such gauges mounted at different altitudes would give an excellent arrangement for studying the peculiarities of rainfall.

In the preceding, I have assumed that the rain at the level of each gauge contains an equal proportion of the small drops due to spattering and drifting, but this is not true for very low gauges, or for drifting snow, and a special discussion of that subject is reserved for future study.

TEMPERATURE OF RIVERS, &c.

The committee on variations of temperature in lakes, rivers and estuaries, reported that no formal meeting had been held, but some of the members had occasionally met informally, and the whole committee had been consulted by letter on all the arrangements which had been made. It is inadvisable to attempt at present to summarise the results of observations made, as, although more than a year's observations are available on some rivers, it is only a few months since the work was begun on others. At the end of another year it is expected that sufficient data will be found to justify a comprehensive report on the subject. Several members of the committee have taken much trouble in collecting observations. Dr. Sorby has collected and discussed a great mass of temperature observations which he had made from his yacht *Glimpse* in the estuaries of the south-east of England during the summer months of five successive years. That will be published separately. Prof. Fitzgerald took charge of the observations in Ireland, where he induced a number of observers to take up the work. Mr. Willis Bund had already inaugurated similar researches on the Severn. Rev. C. J. Steward and Mr. Isaac Roberts rendered important services in their districts. The committee have to thank Mr. John Gunn for his services in forwarding thermometers and observation books and corresponding with observers. The committee ask to be re-appointed with the addition of the name of the Rev. Mr. Andson, and with a grant of £50.

SOLAR RADIATION.

The Committee on Solar Radiation reported that the actinometer devised by the late Prof. Stewart for the continuous measurement of solar radiation, which was described in the report of the Association for 1887, is now ready for the preliminary trials, the internal thermometer with a flat bulb of green glass having been made since the date of that report. The construction of this thermometer occasioned more trouble than had been anticipated. No attempt has at present been made to render the instrument self-recording, as it would obviously be unwise to incur the outlay which any construction for this purpose would involve, unless the results of preliminary trials were such as to encourage a hope that the instrument might be really useful if rendered self-recording.

(*To be continued.*)

WATERSPOUTS.

To the Editor of the Meteorological Magazine.

SIR,—It is, I believe, well authenticated that electrical phenomena are sometimes observed in connection with waterspouts; but are we therefore at liberty to conclude that they are formed by electricity? I think it is an effect rather than a cause, and it may be doubted whether electricity causes, at least directly, any phenomena besides those which we at once recognise as strictly its own.

A waterspout is a whirlwind at sea, and a whirlwind on land may become a waterspout at sea—at least I suppose so, as I have myself seen one lift water out of the river in the act of crossing it, which afterwards sped across a meadow, lifted a couple of sheep over a fence of hurdles, and deluged everything in its course. This was a very local affair and was quickly over. The whirl was formed in a gully between two hills by cross currents of air; it lifted the water 80 or 100 feet, and then, as its force was soon spent, the lateral translation of the water ceased and it fell almost all together. The whole force was purely mechanical, and as I know well every foot of ground where the whirlwinds occurred which are described in the August number (p. 107), I should, without hesitation, explain them in the same way. I could therefore allow very easily that rain might be saline, but not hail, and the evidence for this does not seem to be well authenticated.

Arriving once at Freshwater Bay in the Isle of Wight, on my first view of the sea, I saw a waterspout in the act of drawing up to the cloud; the cloud to which it was attached was carried by a westerly wind across the island, and, as informed by a local paper, it formed again, letting itself down to the sea on the eastern side of the island. How is this to be explained? I should say the formation of the high land forbade the continuance of the whirl in the lower half, making it for the time mechanically impossible; and when the obstruction ceased, being continued above all the time, the motion was again prolonged downwards to the sea.—Yours truly,

JOHN SLATTER.

Whitchurch Rectory, Oxon, 18th September, 1889.

EARTHQUAKE IN CORNWALL, OCT. 7TH.

A shock of earthquake, extending from Doublebois to Boscastle, occurred yesterday, Oct. 7th, at about a quarter to two o'clock, and whilst some observers describe it as a slight shock, others speak of it as smart. At Doublebois station (between Liskeard and Bodmin Road) and in the neighbourhood, the phenomenon was noted by several persons. In the farmhouse of North Folly, about a mile from the railway station, the shock seems to have been more severely felt than elsewhere in that neighbourhood. The house itself seemed to vibrate, and the small articles rattled, some pieces of china being thrown down and broken. Further down the valley at Lewarne, the shock was spoken of as smart. It was very momentary, but attracted the attention of everyone in the house, and it appeared to come from the west. In Camelford a distinct vibration of the ground was felt by a large number of persons. Earthenware and other goods in the shop shook, and in some cases fell. The vibration was accompanied by a rumbling noise like thunder, which was heard for some seconds, and seemed to proceed from beneath the surface of the earth. Observers at Boscastle speak of two distinct shocks.—*Western Morning News.*

[The places named are somewhat far apart, Boscastle being about 17 miles N. of Doublebois; the centre of disturbance seems to have been near Bodmin Moor, one of the highest and wildest parts of Cornwall.—ED. *M. M.*]

CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE FOR 1888.

STATIONS.	ABSOLUTE.				AVERAGE.					ABSOLUTE.		TOTAL RAIN.		AVERAGE
Those in Italics are South of the Equator.	Maximum.		Minimum.											
	Temp.	Date.	Temp.	Date.	Max.	Min.	Mean.	Dew Point.	Humidity	Max. in Sun.	Min. on grass.	Depth.	Days.	Cloud.
	°		°		°	°	°	°		°	°	in.		0—10
England, London ...	84·7	June 25	19·1	February 2	55·5	41·9	48·7	42·3	82	127·6	17·7	27·74	173	6·7
Malta	102·8	July 10	40·4	February 29	73·5	59·4	66·5	55·7	74	154·7	34·0	13·75	59	3·5
Cape of Good Hope	99·2	January 28	35·5	July 19	70·5	54·1	62·3	...	...	...	...	36·06	101	5·2
Mauritius	85·4	February 3	56·7	July 18	78·9	68·6	73·8	64·9	76	139·6	47·3	52·81	208	5·8
Calcutta	106·6	June 14	48·3	January 31	86·4	70·5	78·5	68·4	67	165·4	15·7	69·71	103	4·4
Ceylon, Colombo ...	93·4	February 1	66·0	February 8	86·9	74·8	80·9	71·4	77	154·0	57·4	101·06	174	5·4
Melbourne	104·0	January 15	28·3	July 27	66·8	48·8	57·8	47·6	71	155·8	20·9	19·42	123	5·5
Adelaide	107·5	December 25	33·7	August 7	73·7	54·0	63·8	47·6	57	160·6	23·5	14·57	131	4·6
Wellington	73·3	January 4	35·0	July 5, 21	60·7	48·1	54·4	47·5	77	151·0	27·0	41·00	186	4·2
Jamaica, Kingston..	94·6	July 28	59·6	January 5	89·0	70·1	79·5	70·7	74	...	...	40·81	...	...
Toronto	92·0	June 22	—16·1	February 9	51·0	34·4	42·7	36·0	75	...	—23·0	26·26	191	6·2
New Brunswick, Fredericton ...	87·7	June 23	—22·0	January 28	48·6	29·4	39·0	33·1	72	...	...	47·56	187	6·1
Manitoba, Winnipeg	97·0	August 23	—46·4	February	43·6	21·1	32·3	28·1	80	...	...	16·89	139	5·1
British Columbia, Victoria	85·0	July 17	8·0	January 13	57·1	41·1	49·1	...	...	...	...	24·77	125	...

SUMMARY.

Highest Temperature in Shade	107°·5 at Adelaide on December 25th.
Lowest Temperature in Shade	−46°·4 at Winnipeg in February.
Greatest Range in Year	143°·4 at Winnipeg.
Least Range in Year...	27°·4 at Colombo, Ceylon.
Greatest Mean Daily Range.....	22°·5 at Winnipeg.
Least Mean Daily Range	10°·3 at Mauritius.
Highest Mean Temperature	80°·9 at Colombo, Ceylon.
Lowest Mean Temperature	32°·3 at Winnipeg.
Driest Station	Adelaide, mean humidity 57.
Dampest Station.....................	England, London, mean humidity 82.
Highest Temperature in Sun	165°·4 at Calcutta.
Lowest Temperature on Grass............	−23°·0 at Toronto.*
Greatest Rainfall	101·06 inches at Colombo, Ceylon.
Least Rainfall	13·75 inches at Malta.
Most Cloudy Station	England, London, average amount 6·7.
Least Cloudy Station.........................	Malta, average amount 3·5.

* There being no grass min. thermometer at any other Canadian station.

TORRENTIAL RAINS IN BAVARIA.

To the Editor of the Meteorological Magazine.

SIR,—I see that in *British Rainfall*, 1888, you have dealt specially with intense falls of rain; I have gone through my records of the last four years, and find that there have been eight falls which you would have classed as exceptional, and of these, three are equal to those of such an intense character as to be set out on page 33 of the above-mentioned volume.

Grouping them in the order of their noteworthiness, they are as follows:—

Date,	Amount. in.	Duration. h. m.	Rate per hour. in.
1889, July 9th	·85	0 8	6·37
1886	·48	0 8½	3·38
1886, July 14th	·80	0 17½	2·74
1886	·82	0 37½	1·31
1886	·71	0 27½	1·56
1885	1·10	1 49	·60
1884	·52	0 26½	1·17
1884	·14	0 3½	2·40

I see that you regard the table on page 33 as the epitome of about 20,000 yearly records, and yet you have only 43 entries, or about 1 in 500. As I have three cases in 5 years, one of two facts is obvious—(*a*) torrential rains are much more frequent here than in the British Isles; or (*b*) your observers do not look out sharp enough.

Yours very truly,

MICHAEL FOSTER WARD.

Partenkirchen, Bavaria.

[We think that both causes are in operation. Col. Ward was always a very careful observer, and would rarely miss any phenomenon, and we believe that the storms in Bavaria are exceptionally severe. —ED.]

CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE, MARCH, 1889.

STATIONS. (*Those in italics are outh 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		0–10
England, London	59·6	24	19·2	4	48·2	33·8	34·8	80	98·8	16·4	1·36	13	7·0
Malta	78·2	21	40·8	17	61·7	50·1	47·0	77	129·3	37·2	2·71	12	5·4
Cape of Good Hope ..	89·0	5	50·8	22	76·8	57·9	...	...	...	...	1·49	5	4·8
Mauritius	83·7	5, 27	72·0	7	81·4	74·8	72·3	84	137·3	64·1	17·09	26	7·7
Calcutta	98·3	27	60·8	6	91·6	69·7	68·0	62	154·5	51·0	·92	3	2·2
Bombay	94·3	6	70·0	3, 4	86·1	73·8	70·1	72	147·7	59·9	·00	0	2·3
Ceylon, Colombo	93 0	29	72·6	6	90·6	75·1	73·0	77	147·5	68·5	1 67	14	3·4
Melbourne	96·0	16	43·0	1	75·8	53·6	50·9	63	147·2	29·0	·24	5	5·0
Adelaide	102·0	16	49·6	20	81·6	60·2	51·3	50	151·0	40·9	·81	8	4·4
Wellington	73·0	3	43·2	26	65·5	52·9	50·7	73	131·0	35·0	3 97	12	4·3
Auckland	...	...	...	...	...	...	...	...	...	...	...	...	..
Jamaica, Kingston	92·5	29	60·0	2	88·6	68·7	69·3	73	...	...	5·43	...	...
Trinidad	95·5	12	62·0	27	90·6	70·1	70·5	72	158·5	54·0	4·16	...	...
Toronto	54·8	23	13·1	11	39·3	26·5	25·3	73	...	5·0	·99	9	6·1
New Brunswick, Fredericton	51·8	23	— 7·7	1	39·7	20·4	23·3	70	...	...	3·68	10	5·5
Manitoba, Winnipeg ...	61·8	23	—14·1	13	38·2	15·4	22·6	78	...	...	·35	9	3·9
British Columbia, Victoria	64·0	26*a*	30·0	3	56·9	39·5	...	...	...	...	1·50	14	...

a And 29.

REMARKS, MARCH, 1889.

MALTA.—Mean temp. 54°·8 ; mean hourly velocity of wind 14·3 miles. Sea temp. ranged from 58°·5 to 60°·6. TS on 23rd, H on 6th and 17th. R nearly four times the average ; wind 40 per cent. above average. J. SCOLES.

Mauritius.—Mean temp. of air 0°·1 below, mean dew point 2°·6 above, and R 9·32 in. above their respective averages. Mean hourly velocity of wind 12·4 miles, or 2·1 above average ; extremes 31·1 on 11th and 1·7 on 3rd. Prevailing direction, E.S.E. to E. L on 4 days ; T on 5 days. Local inundations from 9th to 11th and on 17th. C. MELDRUM, F.R.S.

COLOMBO.—Thunderstorms on 7 days and L on 7 other days. J. C. H. CLARKE, LT.-COL. R.A.

Melbourne.—Mean temp. of air 0°·7 above average ; temp. of dew point 1°·2, humidity 5, amount of cloud 0·6, and R 1·87 in. below averages. Prevailing winds S.E., S.W., and S. ; strong on 5 days. Heavy dew on 10 days and distant T on the 18th. R. L. J. ELLERY, F.R.S.

Adelaide.—Pressure ·043 in. and temp. slightly above the average of 32 years. R a quarter of an inch less than the average. C. TODD, F.R.S.

Wellington.—Generally showery during the month, with intervals of fine weather Prevailing wind N.W., strong on 8 days ; gales on 8th and 22nd. Mean temp. 2°·9 below, R 1·15 in. above average. R B. GORE.

SUPPLEMENTARY TABLE OF RAINFALL, SEPTEMBER, 1889.

[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.	...	XI.	Castle Malgwyn	2·77
,,	Margate, Birchington...	1·06	,,	Rhayader, Nantgwillt..	3·17
,,	Littlehampton	·77	,,	Carno, Tybrith	2·60
,,	Hailsham	·74	,,	Corwen, Rhug	1·63
,,	Ryde, Thornbrough	...	,,	Port Madoc	2·97
,,	Alton, Ashdell	1·05	,,	I. of Man, Douglas	2·78
III.	Oxford, Magdalen Col...	1·49	XII.	Stoneykirk, Ardwell Ho.	2·86
,,	Banbury, Bloxham	2·05	,,	New Galloway, Glenlee	2·13
,,	Northampton	2·19	,,	Melrose, Abbey Gate...	1·17
,,	Cambridge, Beech Ho...	2·76	XIII.	N. Esk Res. [Penicuick]	1·50
,,	Wisbech, Bank House..	2·38	XIV.	Ballantrae, Glendrishaig	2·99
IV.	Southend	2·36	,,	Glasgow, Queen's Park.	1·22
,,	Harlow, Sheering	2·85	XV.	Islay, Gruinart School..	3·51
,,	Rendlesham Hall	1·83	XVI.	Dollar	1·00
,,	Diss	3·00	,,	St. Andrews, Pilmour Cot	·79
,,	Swaffham	2·76	,,	Balquhidder, Stronvar..	1·57
V.	Salisbury, Alderbury...	1·16	,,	Dunkeld, Inver Braan..	·77
,,	Warminster	1·44	,,	Dalnaspidal H.R.S.	1·93
,,	Bishop's Cannings	1·35	XVII.	Keith H.R.S.	1·93
,,	Ashburton, Holne Vic...	2·50	,,	Forres H.R.S.	·98
,,	Hatherleigh, Winsford.	1·09	XVIII.	Strome Ferry H.R.S....	4·31
,,	Lynmouth, Glenthorne.	1·54	,,	Fearn, Lower Pitkerrie.	·94
,,	Probus, Lamellyn	1·72	,,	Loch Shiel, Glenaladale	5·73
,,	Launceston, S. Petherwin	1·95	,,	N. Uist. Loch Maddy...	4·07
,,	Wincanton, Stowell Rec.	1·87	,,	Invergarry	2·59
,,	Taunton, Lydeard Ho...	1·53	,,	Loch Ness, Drumnadrochit	1·19
,,	Wells, Westbury	1·31	XIX.	Lairg H.R.S.	1·20
VI.	Bristol, Clifton	2·27	,,	Forsinard H.R.S.	...
,,	Ross	2·06	,,	Watten H.R.S.	2·50
,,	Wem, Clive Vicarage...	2·12	XX.	Dunmanway, Coolkelure	3·34
,,	Cheadle, The Heath Ho.	3·43	,,	Fermoy, Gas Works...	1·39
,,	Worcester, Diglis Lock	1·49	,,	Tipperary, Henry Street	1·38
,,	Coventry, Coundon	3·01	,,	Limerick, Kilcornan...	1·10
VII.	Ketton Hall [Stamford]	2·28	,,	Miltown Malbay	3·22
,,	Grantham, Stainby	2·39	XXI.	Gorey, Courtown House	1·60
,,	Horncastle, Bucknall...	2·01	,,	Navan, Balrath	1·33
,,	Mansfield, St. John's St.	2·24	,,	Mullingar, Belvedere...	2·03
VIII.	Neston, Hinderton	2·96	,,	Athlone, Twyford	1·45
,,	Knutsford, Heathside...	3·36	,,	Longford, Currygrane...	2·39
,,	Lancaster, South Road.	2·95	XXII.	Galway, Queen's Coll...	2·59
,,	Broughton-in-Furness..	4·96	,,	Clifden, Kylemore	4·40
IX.	Wakefield Prison	1·07	,,	Crossmolina, Enniscoe..	2·19
,,	Ripon, Mickley	·79	,,	Collooney, Markree Obs.	3·18
,,	Scarborough, West Bank	1·00	,,	Ballinamore, Lawderdale	...
,,	East Layton [Darlington]	·66	XXIII.	Warrenpoint	1·29
,,	Middleton, Mickleton..	1·28	,,	Seaforde	2·03
X.	Haltwhistle, Unthank..	1·82	,,	Belfast, New Barnsley..	3·31
,,	Shap, Copy Hill	1·12	,,	Bushmills, Dundarave...	3·72
XI.	Llanfrechfa Grange	2·98	,,	Stewartstown	2·13
,,	Llandovery	2·82	,,	Buncrana	3·24

SEPTEMBER, 1889.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average. 1870–9	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)	1·77	— ·74	·73	24	10	80·3	11	35·1	23	0	4
II.		Maidstone (Hunton Court)	1·27	— 1·04	·57	3	8	...	...	...	...	...	...
,,		Strathfield Turgiss	1·39	— ·91	·83	24	11	80·0	12	30·8	18	3	6
III.		Hitchin	1·69	— ·79	·61	24	13	74·0	11	38·0	17	0	...
,,		Winslow (Addington)	2·40	— ·08	1·03	24	11	80·0	11	31·0	23	1	5
IV.		Bury St. Edmunds (Westley)	3·48	+ ·79	1·05	24	10	...	...	...	...	...	...
,,		Norwich (Cossey)	3·29	+ ·21	·91	24	10	70·0	1*a*	32·0	17 *e*	3	...
V.		Weymouth(LangtonHerring)	·88	...	·42	23	7	72·0	4	40·0	25	0	...
,,		Barnstaple	1·64	— 2·64	·56	23	7	83·0	13	37·0	23	0	...
,,		Bodmin (Fore Street)	1·89	— 3·30	·86	23	12	...	...	...	...	...	...
VI.		Stroud (Upfield)	1·69	— 1·56	·70	23	10	80·0	12	38·0	20*f*	0	...
,,		ChurchStretton(Woolstaston)	1·63	— 1·84	·78	23	14	77·0	12	38·0	25	0	1
,,		Tenbury (Orleton)	1·49	— 1·86	·86	23	10	81·6	12	29·5	18	2	4
VII.		Leicester (Barkby)	2·29	— ·41	1·06	23	13	80·0	11	30·0	17	4	5
,,		Boston	1·87	— ·74	·58	23	10	78·0	11	28·0	22	...	...
,,		Hesley Hall [Tickhill]	1·24	...	·62	23	10	75·0	10*b*	32·0	22*g*	2	...
VIII.		Manchester(PlymouthGrove)	2·65	— 1·22	·54	26	13	76·0	10	35·0	25	0	2
IX.		Wetherby (Ribston Hall)	1·15	— 1·93	·36	2	6	...	...	...	...	...	..
,,		Skipton (Arncliffe)	2·69	— 2·89	·57	18	15	72·0	7	33·0	22	0	...
,,		Hull (People's Park)	1·38	— 1·61	·35	23	13	...	...	...	...	...	...
X.		North Shields	1·51	— ·81	·30	11	12	70·5	10	32·0	22	1	4
,,		Borrowdale (Seathwaite)	8·31	— 4·91	2·43	26	14	...	...	...	...	...	...
XI.	WALES.	Cardiff (Ely)	2·11	— 2·69	1·20	23	9	...	...	...	...	...	...
,,		Haverfordwest	3·05	— 2·00	2·07	23	13	71·2	12	32·5	22	0	4
,,		Plinlimmon (Cwmsymlog)	4·18	...	1·56	19	13	..	...	...	...	...	...
,,		Llandudno	2·22	— 1·53	·45	18	13	72·2	12	42·2	18	0	...
XII.	SCOTLAND.	Cargen [Dumfries]	1·80	— 2·61	·66	18	11	73·4	6	30·0	22	1	...
,,		Jedburgh (Sunnyside)	1·39	— 1·20	·41	27	8	66·0	5 *c*	32·0	22	1	...
XIV.		Old Cumnock	3·50	— ·99	·80	18	15	74·0	1	22·0?	21	6	...
XV.		Lochgilphead (Kilmory)	3·59	— 2·17	·87	18	14	...	...	..	...	...	...
,,		Oban (Craigvarren)	2·37	...	·71	18	17	70·0	6	33·3	24	0	2
,,		Mull (Quinish)	3·85	...	·84	17	21	...	...	...	...	...	...
XVI.		Loch Leven Sluices	·80	— 2·43	·40	19	5	...	...	...	...	...	...
,,		Dundee (Eastern Necropolis)	·60	— 2·34	·25	18	7	69·8	10	34·0	24	0	...
XVII.		Braemar	1·03	— 2·91	·27	18	13	70·0	6	30·0	24	1	11
,,		Aberdeen (Cranford)	·99	...	·38	18	15	70·0	9*d*	34·0	25	0	...
XVIII.		Lochbroom	3·98	...	·76	19	15	...	...	...	...	...	...
,,		Culloden	1·15	— 1·75	...	...	...	68·0	7, 10	33·0	25	0	7
XIX.		Dunrobin	1·87	...	·46	10	10	66·5	9	34·0	26	0	...
,,		S. Ronaldsay (Roeberry)	2·07	— 1·16	·66	10	16	63·0	4	38·0	24	0	...
XX.	IRELAND.	Cork (Blackrock)	·99	— 3·16	·48	23	12	70·0	8, 14	39·0	24	0	..
,,		Dromore Castle	2·45	...	·63	23	14	75·0	12	41·0	29	0	...
,,		Waterford (Brook Lodge)	·85	...	·35	23	10	69·5	3	39·0	18*h*	0	..
,,		O'Briensbridge (Ross)	1·23	...	·18	23	13	71·0	1	40·0	30	0	...
XXI.		Carlow (Browne's Hill)	·81	— 2·45	·21	18	11	...	...	...	..	...	...
,,		Dublin (FitzWilliam Square)	1·04	— 1·37	·35	23	13	69·7	11	38·9	25	0	1
XXII.		Ballinasloe	1·44	— 2·52	·38	10	16	69·0	12	35·0	25	0	...
XXIII		Waringstown	2·17	— 1·18	·53	11	15	74·0	5	35·0	22*i*	0	4
,,		Londonderry (Creggan Res.)	3·81	...	1·15	26	20	...	...	...	...	...	...
,,		Omagh (Edenfel)	2·51	— 1·53	·50	26	18	69·0	12	38·0	22	0	...

a And 11, 14. *b* And 11. *c* And 9, 14. *d* And 10, 11. *e* And 18, 22. *f* And 25. *g* And 23. *h* And 23, 25, 26. *i* And 24.

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

METEOROLOGICAL NOTES ON SEPTEMBER, 1889.

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.—We have seldom experienced a finer September. Coming after a showery August, unsuitable for harvesting, it gave full recompense for the shortcomings of that month. A sharp touch of frost occurred on the 17th, 18th and 19th, and rough weather prevailed from the 24th to the 27th.

ADDINGTON.—Taken altogether, it was a fine month, and very warm from the 9th to the 13th. Little R fell until the 23rd, when there was a good steady downpour from about 10 p.m. on the 23rd, to the afternoon of the 24th, 1·96 in. falling in the two days. Frost occurred rather early, tender plants being injured on the 18th, and some quite destroyed on the 23rd.

BURY ST. EDMUND'S, WESTLEY.—The month was remarkable for the severe TS on the night of the 2nd, when an inch of R fell in a very short time; also for the 1·76 in., which all fell on the 24th, though measured in two days.

LANGTON HERRING.—The first half of the month was very warm, the mean temp. exceeding that of August. In the latter half, the temp. was low, and there were several nights on which there was white frost. The mean temp. at 9 a.m. was 0°·5 above the average. Solar halo on the 8th; fogs on the 9th and 13th; heavy dews on 11th, 13th and 15th.

WOOLSTASTON.—A perfect harvest month. The second week was very hot, the max. temp. on the 12th being the highest recorded during the year. Mean temp. 54°·5.

ORLETON.—The first half of the month was very fine and dry, with a temp. above the average. The remainder of the month, excepting the 26th and 27th, was much cooler than the average, with rough, cold and variable winds, the mean for the whole month being about 0°·4 below the average of 28 years. Frosts occurred on the mornings of the 18th and 23rd, and fogs on the mornings of the 2nd, 8th and 13th. The R nearly all fell after the 18th, and no T or L was recorded. The weather was favourable for gathering the hops, and securing the late harvest.

MANCHESTER, PLYMOUTH GROVE.—During the first 12 days summer weather prevailed, the 16th, 17th, 18th, 22nd, 25th, and 29th were fine autumn days, and the rest of the month was wet and cold. T, L and H on 20th.

HULL.—The weather was at times showery, but there were good long periods of fine bright autumnal weather.

WALES.

HAVERFORDWEST.—The month commenced with high temp., southerly wind, cloud, and some fog. After the 5th, the air cleared, and fine bright summer-like weather prevailed to the 17th; cold nights occurred about the 15th, with a decided fall of temp., which continued to the end of the month, a sharp frost occurring on the 22nd, followed by an unusually heavy R, 2·00 in. in less than 10 hours. Crops of all kinds splendid, and harvest got in in fine order; such a season has not been remembered for many a long year. Temp. at or above 70° on 4 days; much bright sunshine during the first 3 weeks.

SCOTLAND.

CARGEN.—The difference in the temp. of the first and second halves of the month was remarkable. For the first 14 days the mean temp. was 58°·8, being 2°·2 above the average for June, and 0°·4 above that of August. The latter half of the month was unusually cold, bringing down the mean temp. of the month nearly 1° below the average. Cold nights occurred on the 21st, 22nd, and 23rd, frosting down vegetation ; a warm wave followed on the 27th and 28th. E. winds prevalent ; sunshine below the average.

JEDBURGH.—The weather during the month was seasonable and favourable for ingathering corn, which, except in high districts, was nearly completed at the close. The turnip and potato crops look well, and grass is abundant.

CRAIGVARREN, OBAN.—On the whole a fair month, with liberal showers of much benefit to stock and growth. Temp. high during the first half, and low during the second. Very early S on hills on 21st, with a cold wave full a week earlier than before noted.

LOCHBROOM.—The first half of the month was beautiful, enabling the farmer and the crofter to secure their crops in splendid condition ; but from the 16th to the end it was stormy and cold in the extreme, H rattling about our ears on many occasions, and S on the hills nearly down to our houses. Seldom have we seen so sudden a change as took place about the 17th.

INVERNESS, CULLODEN.—The month generally was fine, with a dry period from the 1st to the 20th.

ROEBERRY.—The first half of the month was fine, the second half cold and unsettled.

IRELAND.

CORK.—On the whole, a fine but frequently not a bright month. Mean temp. (57°·6) 4°·0 below the average.

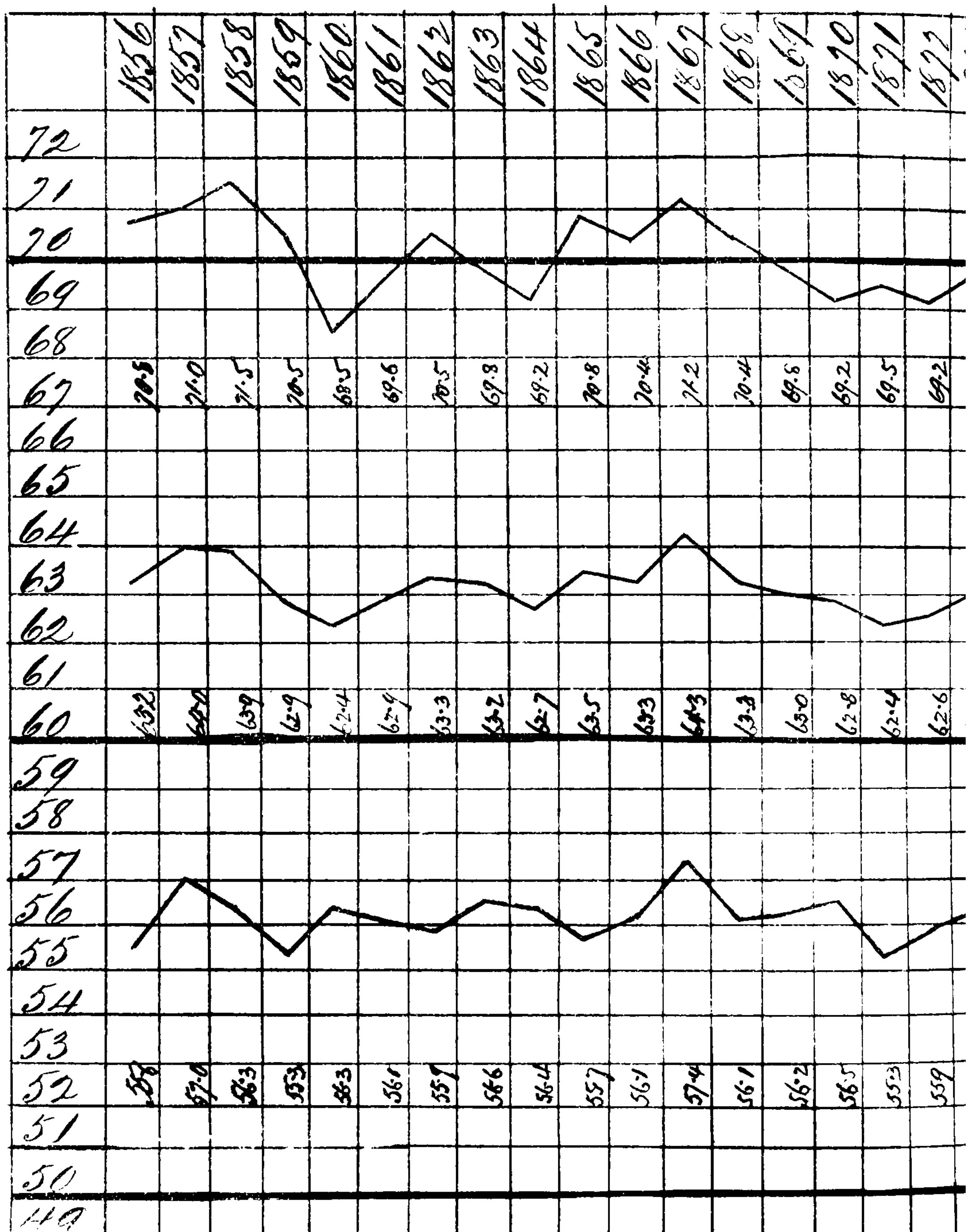
WATERFORD.—R 2·68 in. below the average. Mean temp. 56°·1. Fog on 5th, 10th, 11th and 12th.

DUBLIN.—A fine month, with high mean pressure, winds from polar quarters —chiefly N.W.—a moderate R, and a normal temp. At the beginning, fogs were prevalent along the coast, and towards the close, strong and squally winds occurred on several days. High winds on 7 days ; gale on 18th. Mean humidity 87 ; mean amount of cloud 6·2.

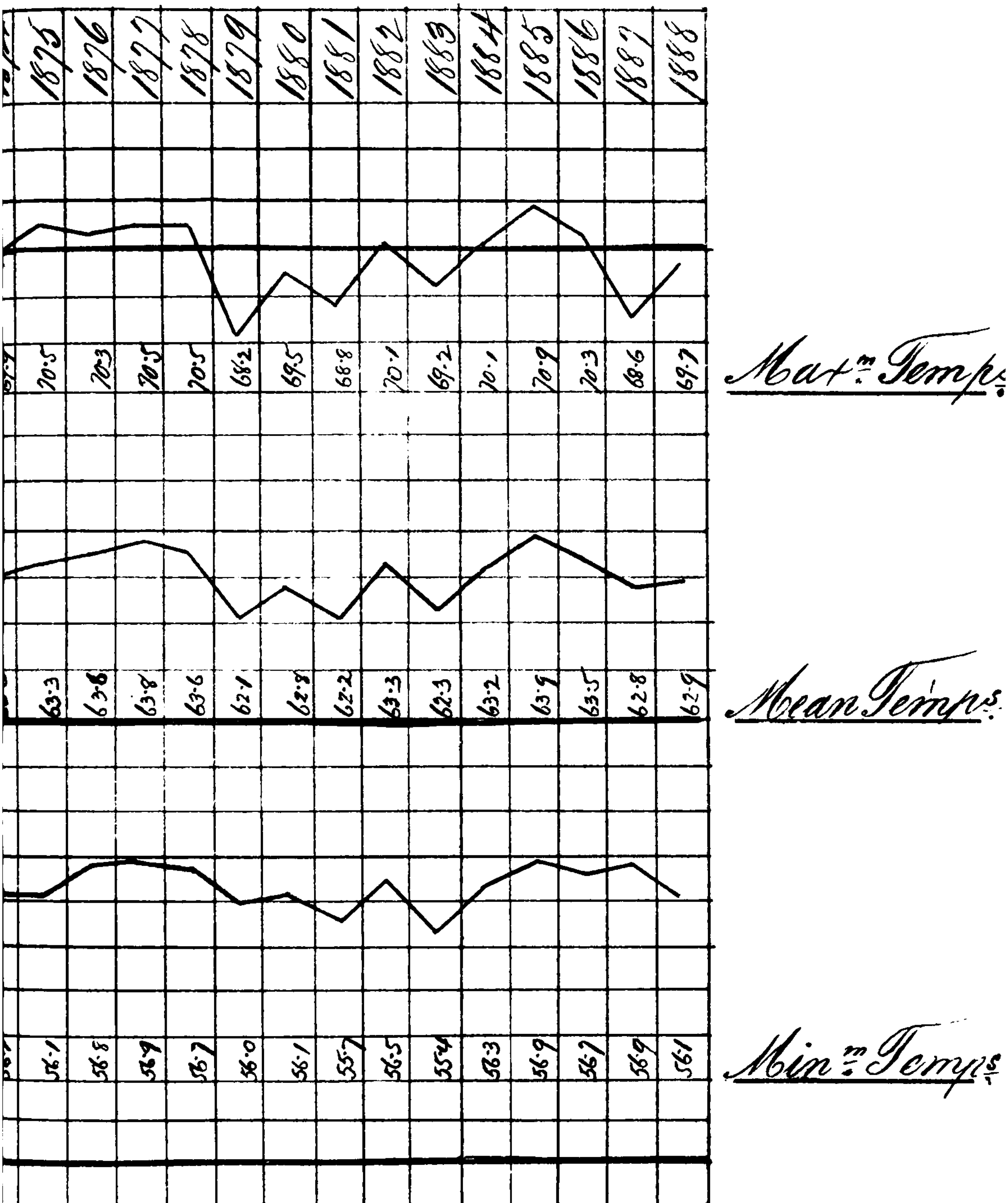
WARINGSTOWN.—Strong drying northerly winds prevailed during the last fortnight of the month, which prevented the R from materially retarding harvest operations.

EDENFEL, OMAGH.—With the exception of the 8th, 10th, and 11th, the first half of the month was fine, warm and favourable, and enabled the greater part of an excellent harvest to be secured in good condition. The remainder of the month was squally, wet and unsettled, with more or less heavy R on every day but the last. Swallows last seen on 27th.

Diagram shewing Temperature 1856 to



…urves at Sydney N.S.W.
…188



H C Russell
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