ANNUAL REPORT

OF THE

DIRECTOR

KODAIKANAL AND MADRAS

OBSERVATORIES

FOR 1914.

MADRAS:
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1915.

KODAIKANAL AND MADRAS OBSERVATORIES.

REPORT FOR THE YEAR 1914.

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KODAIKANAL AND MADRAS OBSERVATORIES.

I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1914.

Staff.—The staff of the observatory on December 31, 1914, was as follows:—

Director	J. Evershed.
Assistant Director	T. Royds, D.Sc. (on combined privilege and special leave). S. Sitarama Ayyar, acting.
First Assistant (Acting Assistant Director).	S. Sitarama Ayyar, B.A.
Second Assistant (Acting First Assistant).	G. Nagaraja Ayyar.
Third Assistant (Acting Second Assistant).	A. A. Narayana Ayyar, B.A.
Fourth Assistant	S. Balasundaram Ayyar.
Writer	L. N. Krishnaswami Ayyar.
Photographic Assistant	R. Krishna Ayyar.

The Director was away on deputation to New Zealand during January and February, Dr. Royds officiating until his return on March 6.

Early in the year the sanction of Government was obtained for an expedition to Kashmir to test the suitability of the climate for solar research, and on April 21 the Director again left Kodaikanal to take up this work. The very remarkable conditions which had been observed during a holiday tour in Kashmir in August and October 1913 were found to hold also in the months of May, June and July 1914. The definition of the sun was found to be almost invariably good not only on every day that observations were made but also during all hours of the day, and, contrary to all previous experience, the definition was observed to improve during the morning hours reaching the best quality shortly after midday. The detailed report of this expedition in which valuable assistance was given by Mrs. Evershed has been published as Bulletin No. XLII.

The Assistant Director was granted combined leave for six months from November 30, 1914. The Writer was on privilege leave for three months from July 10 and the Second Assistant for one month and eight days from November 16. The Fourth Assistant returned from furlough on August 1, 1914.

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, five peons, a boy peon for the dark room and two lascars.

2. *Distribution of work.*—The Director and the Assistant Director have charge of the two spectroheliographs and the large grating spectrograph. The First, Second and Third Assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (Visual and photographic), and the transit instrument. They have also to do the astronomical computing, the preparation of the observations for the press and the measurement of spectrum plates. The Third Assistant has charge of the seismometer and clock comparisons. The meteorological work is done by the Fourth Assistant and the Writer. The Fourth Assistant also has assisted Mr. C. Michie Smith, C.I.E., retired Director of the Observatory, in the preparation of a memoir on the meteorology of

Periyakulam and Kodaikanal. The Writer is responsible for the accounts, correspondence, and all office records. The Photographic Assistant has charge of most of the photographic developing, printing, etc.

3. *Buildings and grounds.*—The buildings, grounds, and fire lines have been kept in good order.

The roof of the spectroheliograph building has given much trouble during wet weather from leakage, and part of the roof of the main building also is in a very bad condition. Reconstruction with impervious roofing material is urgently required.

4. *Instruments.*—The following are the principal instruments belonging to the observatory, or in use, at the present time :—

Six-inch Cooke equatorial.

Six-inch Lerebour and Secretan equatorial remounted by Grubb, with a five-inch Grubb portrait lens attached. The Lerebour and Secretan object glass has been replaced by a Cooke photo-visual lens of the same aperture and the instrument has been adapted for direct solar photography in addition to visual work.

Spectrograph I.—This with the 11-inch polar siderostat has been dismounted and a new spectrograph fed by the 12-inch Foucault siderostat from Poona is under construction.

Spectrograph II—consisting of a collimator of 7 feet focus and camera of 14 feet focus placed at an angle of 60° with the former. Plane gratings of $3\frac{1}{4}$ inches or 5 inches ruled surface are used, and the slit is provided with various devices for the direct comparison of spectra from different sources, and for rotating the solar image.

Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.

An auxiliary spectroheliograph attached to the above, made in the observatory workshop.

Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.

Theodolite, 6-inch—Cooke.

Sextant.

Evershed spectroscope with three prisms, for prominence and sunspot work, by Hilger.

Mean time clock, Kullburg 6326.

Do. Shelton.

Mean time chronometer, Kullberg 6299.

Sidereal chronometer, Kullberg 6134.

Tape chronograph, Fuess.

Two micrometers for measuring spectrum photographs, Hilger.

Hartmann Photometer.

Dividing engine, Cambridge Scientific Instrument Company, Limited.

Milne horizontal pendulum seismograph.

Induction coil with necessary adjuncts.

Small polar siderostat.

Universal instrument.

Complete set of meteorological instruments, including a Richard thermograph and barograph and a nephoscope.

A high class screw cutting turning lathe by Messrs. Cooke & Sons.

Angström Pyrheliometer.

An 18-inch concave mirror by Henry of Paris belonging to the Director is mounted in the spectroheliograph room for general spectrum work.

The instruments received from the Takhtasinghji Observatory at Poona include the following :—

Twenty-inch reflecting telescope, by Common.

Six-inch Cooke photo-visual telescope with equatorial mounting.

Two prisms of 6 inches aperture for use with the above.

Twelve-inch Cooke siderostat.

Eight-inch horizontal telescope.

Large grating spectroscope by Hilger.

An ultra-violet spectrograph by Grubb.

Sidereal clock, Cooke.

Mean time chronometer, Frodsham No. 3476.

One micrometer for measuring spectrum photographs, Hilger.

The following instruments were received during the year 1914 :—

(1) Positive on negative spectrum comparator. Constructed by A. Hilger, Limited, from designs by the Director.

(2) Diffraction grating ruled by Anderson with ruled surface $9{\cdot}7 \times 12{\cdot}8$ cm. and total number of lines 75,085.

OBSERVATIONS.

(*a*) Solar Physics:

5. The following table gives the number of observations made during each month of the year :—

—	January.	February.	March	April.	May.	June	July.	August.	September.	October.	November.	December.	Total.
A	31	28	31	30	31	29	25	29	30	28	26	25	343
B	..	...	...	9	...	2	...	5	1	...	1	1	19
C	28	28	28	30	25	24	11	22	26	11	24	21	278
D	30	28	31	30	30	29	23	29	30	26	26	24	336
E	31	28	31	30	31	28	20	28	30	23	22	22	329

A = disc examined. B = spot spectrum observed. C = prominences observed.
D = photoheliograms taken. E = spectroheliograms taken.

A comparison of this table with those in previous reports shows that about the normal number of routine observations were made and photographs taken. The prominence observations were, however, rather below the average owing to the unusually wet and cloudy period from August to the middle of December.

6. *Photoheliograph.*—Photographs of the sun were obtained on 336 days. A large proportion of the plates are of poor quality owing to unsteadiness of seeing. The 6-inch photovisual telescope and enlarging camera was used throughout and gives excellent definition on the rare occasions when the seeing is good. Eight solar negatives were sent to the Greenwich observatory to complete their series in the period July 1913 to August 1914.

7. *Spectroheliograph.*—Monochromatic photographs of the sun's disc in "K" light were taken on 329 days and prominence plates on 287 days. The autocollimating spectroheliograph was not in use for practically the whole year as the large Michelson grating was required for other work. After installing the new Anderson grating in the spectrograph the Michelson grating was provided with a new mounting and replaced in the spectroheliograph in December. The series of H*a* spectroheliograms will be continued during 1915.

A new instrument has been constructed in the observatory workshop for the accurate measurement of position angles, heights, and areas of the prominences shown on the spectroheliograms and this was brought into use on October 1st. From this date detailed observation at the telescope of the position angles and heights of the prominences was discontinued as all the required data can be much better determined from the photographs.

Duplicates of the disc photographs in "K" light have been sent to the Cambridge Observatory for measurement.

8. *Grating Spectrograph.*—With this instrument Dr. Royds has continued his researches on the displacements of unsymmetrical lines in the electric arc, and he has succeeded in explaining the anomalous shifts of many of the solar lines as due to density conditions in the arc which are not present in the sun. Although the discovery of this density effect in the arc has complicated the whole subject of the shifts of the arc lines under pressure, and the comparison of arc and solar wave lengths, it leads to a distinct gain in our knowledge of solar conditions not only by explaining the apparently anomalous shifts of some of the solar lines when compared with the arc but also by indicating the extreme tenuity of the solar gases, the combined partial pressures of which appear from independent considerations to be less than one atmosphere.

In Bulletin No. XXXIX the displacements of the spectrum lines at the sun's limb are discussed and the reasons given for the conclusion that the line shift is

not due to a pressure difference between the effective regions of absorption at the limb and at the centre of the disc. In continuation of this research the displacements are now being measured not only at the limb but at numerous points between the limb and centre. With a small solar image on the slit plate spectra 28 mm. in width are obtained representing sections of the entire disc from limb to limb. Many of these plates have been measured and the results so far promise very interesting results.

An important addition to the equipment of the observatory is the new grating of 75,085 lines, ruled by Prof. Anderson on Rowland's Engine. This was received in September and no time was lost in mounting it in the large spectrograph. This grating is the most perfect the observatory possesses and it is now used in all researches where high resolving power is required.

9. *6-inch Cooke Equatorial and Spectroscope.*—This has been employed exclusively for spectrum observations, attention being concentrated on phenomena which cannot readily be photographed, such as metallic prominences, temporary eruptions, and displacements of the hydrogen lines both on the sun's disc and at the limb. The position angles of a few definitely marked prominences are also determined for the purpose of checking the correctness of the angles measured on the photographs; these depend on a fundamental angle computed from the hour angle of the sun at the time a photograph is taken, and errors which would otherwise pass unnoticed may arise in the computation or in the entry of the time.

A large increase in the number of metallic prominences and disturbances showing motion in the line of sight has taken place during 1914 as compared with the previous year.

Summary of Sunspot and Prominence Observations.

10. *Sunspots.*—The following table shows the monthly numbers of new groups observed, the mean daily numbers of spots visible and the distribution between the northern and southern hemispheres :—

—	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
New groups	1	2	6	7	7	4	5	5	4	5	11	14	71
Daily number	0·3	0·2	0·4	1·2	0·6	0·8	0·5	0·6	1·3	0·6	1·7	2·5	0·9
North	...	...	3	3	4	1	...	2	2	3	4	6	28
South	1	2	3	4	3	3	5	3	2	2	7	8	43
Equator	...	...	...		...	.	..	...	...	...	...	...	...

The increase of activity compared with the year 1913 is very marked and indicates that the actual minimum of spot activity occurred during 1913.

The steady fall of activity during the years 1910 to 1913 and the sudden rise in 1914 is shown in the table below :—

—	1910.	1911.	1912.	1913.	1914.
Number of new groups	152	56	22	16	71
Mean daily numbers	1·8	0·7	0·3	0·2	0·9
Number of days on which no spot was seen.	56	158	240	288	153

Throughout these years there was a marked preponderance of southern over northern spots; and it may be noted that the minimum activity for the northern hemisphere occurred as early as the year 1912 in which year no northern spots were recorded during the period January to November inclusive with only two in

December. In the southern hemisphere a similar period of complete quiescence occurred during 1913 in the months May to October inclusive. The first appearance of the new cycle of spots in high latitudes occurred in December 1912 after the close of the northern quiescent period and these spots were in the northern hemisphere. With one insignificant exception the southern high latitude spots first appeared in November 1913 immediately following the southern quiescent period.

11. *Prominences.*—The observations indicate a minimum of prominence activity in the year 1913 a notable increase both in numbers and areas having taken place during 1914.

If the two hemispheres of the sun are considered separately the mean areas for the northern hemisphere have their smallest values during the years 1912 and 1913 and remain sensibly constant during those years. In the south there is a steady diminution of prominence area during 1911 and 1912 reaching a minimum value in the second half of 1913.

The mean areas obtained from the photographic and visual records for the years 1913 and 1914 are as follows:—

Mean daily Profile areas of Prominences in square minutes of arc.

—	1913.	1914.
North	1·08	1·50
South	1·11	1·60
Total ...	2·19	3·10

It is of interest to note that the time of minimum prominence area for each hemisphere of the sun coincides approximately with the sunspot minimum for the same hemisphere. The great majority of prominences are however not directly associated with sunspots, the zones of greatest activity being in higher latitudes than the spot zones; and the prominences found in the spot latitudes usually occur in the areas between the spot disturbances.

The class of prominence directly connected with spots is distinct and forms a very small proportion of the whole; these prominences naturally follow the sunspot numbers very closely.

Metallic prominences have been more frequently observed during 1914 than during the previous year, altogether seventeen were recorded as against five only in 1913. The increased activity of the sun during 1914 is also shown by the large number of prominences recorded showing displaced lines due to violent movement, both at the limb and near to spot disturbances on the disc. The greatest displacement observed was 5 A towards red in the hydrogen line α corresponding to a velocity of about 230 kilometers per second away from the observer. This was observed on August 26 in a prominence situated at latitude—82° east.

12. *Solar Radiation.*—Observations with the Angstrom Pyrheliometer were obtained from 9th February to 1st May. Later in the year the meteorological conditions were unfavourable for this work.

(*b*) Other Observations.

13. *Time.*—The error of the standard clock is usually determined by reference to the 16-hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Trichinopoly division. Independent time determinations have been made with the transit instrument using the Sidereal chronometer K. 6134.

14. *Meteorology.*—Eye observations are made at 8^h, 10^h, and 16^h local mean time as in former years. The Richard thermograph (wet and dry bulb) and

barograph, the Beckley anemograph and the sunshine recorder also continue in use. The hourly readings from the barograms, thermograms, and sunshine records are now tabulated at the Calcutta Meteorological Office and the anemograms at the Madras Observatory which also prepares the 8^h register from readings taken here. The preparation of the 10^h and 16^h registers is done in the Calcutta Meteorological Office. The wind velocity is obtained as usual from the Robinson anemometer and a wind vane.

Cloud observations with the nephoscope have been made three times a day since March 1, 1914.

Pressure.—Except in July and November when there was a defect of 0·018 inch and 0·004 inch respectively the mean monthly pressure was higher than the normal throughout the year; the greatest excess was 0·044 inch in January and October. On the other hand the mean daily range was smaller than the normal practically throughout the year, the only exception being the slight excess of 0·001 inch in September.

Temperature.—There was a defect of 1°·6 in the mean maximum for July, but otherwise the temperature was higher than the normal throughout the year whether judged by the mean dry bulb or the mean wet bulb thermometer readings. Excepting July the mean monthly dry bulb maxima were all above normal whilst the mean monthly minima did not show any striking deviations except in December when there was an excess of 2°·0. The mean daily range was consequently higher on the whole than usual.

Humidity.—The relative humidity was not very different from the normal the only noticeable deviations being a defect of 14 cents in January and 13 in February.

Rainfall.—The rainfall in the year was very abnormally high, the excess being 20·11 inches or 34 per cent. over the normal. The increase in the number of rainy days was only 6 per cent. The rainiest months were October with 15·89 inches, September had 13·60 inches, December 11·78 and May 11·27 inches. The distribution was rather uneven since there was an actual defect of 8·16 inches in the six months—January, February, April, June, July and August. The later monsoon months far more than made up for the defect in the earlier part of the south-west monsoon.

Wind.—The wind velocity was in defect by 6 per cent. It was in defect in every month except July, August and December. The highest velocity was 735 miles on the 9th July. The most noticeable deviations in direction were in January, February, and October when they were east, east and east-north-east, whereas normally the directions in those months are north-east, north by east and north by west.

There is some doubt as to whether the anemograph was recording correctly on some days during the months of May and September as the velocity on those days is not consistent with the readings of the Robinson anemometer.

Transparency of the atmosphere.—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was practically the same as in 1913.

Cloud and Sunshine.—The mean clear sky was 38 per cent. which was 6 less than the normal, but the percentage of excess of cloud was less than the percentage of excess of rain. The amount of bright sunshine shows curiously enough an excess of 14 per cent over the normal.

15. *Seismology.*—The milne horizontal pendulum recorded sixty earthquakes against sixty-one in 1913.

16. *Library.*—One hundred and sixty volumes were bound during the year.

17. *Publications.*—Eleven Bulletins, Nos. XXXIV to XLIV were published during the year. Their titles are as follows:—

No. XXXIV.—A comparison of the periodicities in prominences and sunspots, by T. Royds, D.Sc.

No. XXXV.—The apparent effect of planets on the distribution of prominences, by T. Royds, D.Sc., and S. Sitarama Ayyar, B.A.

No. XXXVI.—A new interpretation of the general displacement of the lines of the solar spectrum towards the red, by J. Evershed.

No. XXXVII.—Summary of prominence observations for the second half of the year 1913, by J. Evershed.

No. XXXVIII.—A preliminary note on the displacement to the violet of some lines in the solar spectrum, by T. Royds, D.Sc.

No. XXXIX.—On the displacements of the spectrum lines at the sun's limb, by J. Evershed and T. Royds, D.Sc.

No. XL.—An investigation of the displacement of unsymmetrical lines under different conditions of the electric arc, by T. Royds, D.Sc.

No. XLI.—Summary of prominence observations for the first half of the year 1914, by J. Evershed.

No. XLII.—Report on the conditions for astronomical work in Kashmir, by J. Evershed.

No. XLIII.—The different character of spectrum lines belonging to the same series, by T. Royds, D.Sc.

No. XLIV.—On the displacement at the sun's limb of lines sensitive to pressure and density, by A. A. Narayana Ayyar, B.A.

The following contribution was made in addition to the above :—

The displacement of the lines of the solar spectrum towards the red, by J. Evershed, "The Observatory" March 1914.

No. XLIII had not been distributed at the close of the year.

18. *General.*—The Director-General of Observatories inspected the Kodaikanal Observatory in February.

Professor H. H. Turner, Director of the Oxford University Observatory, paid a visit to the observatory in September on his return from the British Association meeting in Australia.

The staff of the observatory worked well during the year not only in the routine work but also in connection with the measurement and reduction of the spectrum plates required for special researches.

THE OBSERVATORY, KODAIKANAL,
17th February 1915.

J. EVERSHED,
Director, Kodaikanal and Madras Observatories.

II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1914.

Staff.—The staff at the Observatory on December 31, 1914, was as follows :—

Deputy Director	R. Ll. Jones.
Computer	S. Solomon Pillai.
First Assistant	C. Chengalvaraya Mudaliyar.
Second Assistant	E. Ramanujam Pillai.

Mr. S. Solomon Pillai was absent on privilege leave for two months from 10th March 1914.

2. *Time Service.*—No change has been made in the methods of determining time. In the time service the 8 A.M. signals to Colombo were discontinued on the 1st November, arrangements having been made there to determine time locally.

The Fort gun failed on 28 occasions out of 730, giving 96·2 as the percentage of success. From 1st January to 7th August there were no failures. Then there followed a series of failures, the cause of which—a contact on the line—was not discovered until as many as 23 had occurred. None of the failures were due to faults at the Observatory.

The semaphore at the Port office failed on six occasions. On three of these days it was correctly dropped at 2 P.M. It was dropped correctly at 1 P.M. on all other days. None of the failures were due to faults at the Observatory.

3. *Meteorological Observations.*—In addition to the ordinary meteorological observations, extra observations were taken for storm warning purposes and telegrams sent to Simla on two occasions and to Calcutta on 34 occasions. A new solar radiation thermometer was received from Calcutta and brought into use from 12th January 1914.

4. *Buildings.*—Some repairs to the office and quarters were carried out during the year.

With a view to increasing the steadiness of the transit circle, the Chief Engineer came and inspected the Observatory and the compound in February. He finally advised that a subsoil drain should be constructed round the building. Plans and estimates for this construction were accordingly drawn up, the estimates amounting to Rs. 2,880. This has been sanctioned by the Government of India ; the work had not been commenced at the end of the year.

5. *Instruments.*—The following is a list of the instruments at the Observatory on the 31st December 1914 :—

(a) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal clock—Haswall.
Do. Dent, No. 1408.
Do. S. Riefler, No. 61.
Mean Time clock—J. H. Agar Baugh, No. 105.
Do. with galvanometer—Shepherd & Sons
Meridian circle—Troughton & Simms.
Portable transit instrument—Dolland.
Portable telescope with stand.
Tape chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(b) *Meteorological.*

Richard's barograph—No. 10, L. Casella.
Do. Thermograph—No. 29637, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
Do. do. No. 725, L. Casella (spare).
Do. do. No. 1420, L. Casella (spare).

Dry bulb thermometer—No. 94221, L. Casella.
Do. No. 38037, Negretti and Zambra (spare).
Wet do. do. No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry Maximum thermometer—No. 8581, Negretti and Zambra.
Dry Minimum thermometer—No. 69017, L. Casella.
Wet Do. do. No. 91753, Negretti and Zambra.
Sun Maximum thermometer—No. 127618, Negretti and Zambra.
Grass Minimum thermometer—No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter) - No. 1042, Negretti and Zambra.
Measure glass for above.
Raingauge (5″ diameter).
Measure glass for above.

The Haswall and Agar Baugh clocks were cleaned during the year.

A new eyepiece for the Transit Instrument was received from Messrs. T. Cooke & Sons and was brought into use on the 29th July 1914.

The level of the Transit has during the year undergone large changes as usual. With the heavy rain in October and November a very rapid change occurred in the reverse direction to that which had taken place during the previous dry months.

6. *Weather Summary.*—The following is a summary of the meteorological conditions at Madras during 1914:—

Pressure.—Pressure was above normal in January, February, April, May, September and October and below normal during the other months. The greatest excess was 0·081 inch in October and the greatest defect 0·042 inch in July. The highest pressure recorded was 30·216 inches on January 9, and the lowest 29·511 inches on June 25.

Temperature.—The mean temperature of air was above normal in all months except April, September and October. The maximum shade temperature was also above normal in all months except January, February, April, August, September and October. The minimum in the shade was below normal in April, August, September and October and above normal in the remaining months. The highest shade temperature recorded was 110°·3 on June 1, and the lowest 60°·6 on December 24. The highest reading of the black bulb thermometer was 168°·6 on October 5 and the lowest on grass 56°·9 on December 24.

Humidity.—The percentage of humidity was normal in March, nearly normal in January, June and December and above normal in the remaining months.

Wind.—The wind direction was normal or nearly normal in all months except in February when it was two points more southerly, in July and August when it was two points more westerly and in October when it was two points more northerly. The amount of air movement was below normal in all months except January. This is undoubtedly largely due to change in exposure.

Cloud.—The percentage of cloud was above normal in April, May, July and October and below in the remaining months.

Sunshine.—The percentage of bright sunshine was above normal in February, April and September and below in the other months. There were 2207·0 hours of bright sunshine during the year.

Rainfall.—The rainfall was above the average in January, April and from August to November and below for the other months. The greatest excess was 8·22 inches in October and the greatest defect 4·51 inches in December. The total rainfall for the year was 56·63 inches against an average of 49·02 inches. The monsoon rainfall from October 15 to the end of the year was 31·74 inches against an average of 26·00 inches. The greatest fall on any day was 7·46 inches on November 1.

Storm.—A storm formed in the south-west of the bay on the 1st November 1914, moved in a westerly direction and passed inland to the south of Madras.

THE OBSERVATORY, MADRAS,
27th January 1915.

R. LL. JONES,
Deputy Director.

APPENDIX I.

STATION—KODAIKANAL OBSERVATORY.

SEISMIC RECORDS.

ϕ = 10° 13′ 50″ N. λ = 77° 28′ 00″ E. h = 2348 metres. *Subsoil*—Rock.
Apparatus—Milne's Horizontal Pendulum Seismograph.

1914.	T_o	$\frac{r}{T_o^2}$	1914.	T_o	$\frac{r}{T_o^2}$
January	16·0	3·5	July	16·7	2·8
February	16 0	3·2	August	16·8	2·9
March	16·0	3·4	September ...	16·8	3·2
April	16·3	3·0	October	16·1	3·3
May	16,6	3·2	November	15·3	3·4
June	16·4	2·9	December	15·7	3·8

No.	Date.	Phase.	Time G.M.T.	Period. (Sec.)	Amplitude (u).			Distance Δ (Km.)	Remarks.
					An.	Ae.	Az.		
	1914.		H. M. S.						
1	January 12 ...	eP	9 49 18	...	...	...	...	...	
		eL	9 59 30	...	...	..	...	...	
		M	10 5 12		...	50	...	...	
		F	10 23 6	...	...	...	...	...	
2	15 ...	eP	20 3 12	...	...	...	...	...	Widening of line.
		F	20 39 18	...	...	...	...	...	
3	20 ...	eP	12 22 18	...	...	...	...	...	
		iL	12 48 0	...	...	..	...	..	
		M	12 51 42	...	...	40	...	...	
		F	13 9 48	...	...	...	...	...	
4	30 ...	eP	3 56 0	...	...	...	..	...	
		iL	4 49 48	...	..	.	...	...	
		M	5 1 12 / 8 24	...	...	260 / 250	...	...	
		F	?	...	...	...	...	...	
5	February 4 ...	eP	21 02 48	...		...	...	...	
		F	22 16 12	...	.	...	...	...	Widening of line.
6	6 ...	iP	12 50 30	...	...	...	...	...	
		iL	12 53 36	...	..	...	...	...	
		M	12 58 42	...	...	35	..	...	
		F	13 11 54	...	...	...	...	...	
7	13 ...	eP	1 47 24	...	...	...	...	...	Widening of line.
		F	2 10 18	.	...	...	...	...	
8	22 ...	eP	23 20 54	...	...	...	...	...	
		eL	23 31 00	...	...	...	...	...	
		M	23 33 36	...	...	40	...	...	
		F	23 53 48	...	...	...	...	..	
9	March 2 ...	eP	0 41 18	.	..	...	...	...	Widening of line.
		F	1 12 00	..	...	...	...	...	
10	2 ...	eP	1 30 30	...	..	...	...	...	Widening of line.
		F	1 53 36	...	...	...	...	..	
11	6 ...	eP	19 49 0	...	...	...	..	...	Widening of line.
		F	20 23 18	...	..	..	..	...	
12	6 ...	eP	20 49 48		..	...	...	...	
		L	20 51 30	...	...	...	...	...	
		M	20 58 42		...	50	...	...	
		F	20 59 42	.	...	...	...	...	
13	14 ...	eP	20 19 30	...	...	...	...	...	
		eL	20 26 54		.	...		...	
		M	20 44 36	.	...	50	...	...	
		F	21 24 24	.		...	...	...	
14	27 ...	eP	1 40 6	...	...	...	...	...	
		eL	1 43 24	..	...	...	...	...	
		M	1 49 30	...	...	20	...	...	
		F	2 00 6	...	...	...		...	
15	28 ...	iP	10 53 48	...	...	...	...	.	
		eL	10 57 42	...	...	...	..	...	
		M	11 8 24	..	...	60	...	...	
		F	11 36 6	...	...	...	...	..	
16	30 ...	iP	1 2 54	...	...	...	...	...	
		iL	1 12 54	. .	...	..	...	...	
		M	1 25 30	..	...	70	...	...	
		F	...	...	...	...	...	...	

Kodaikanal Observatory Seismic Records—*cont.*

No.	Date.	Phase.	Time G.M.T.	Period. (Sec.)	Amplitude (u).			Distance Δ (Km.)	Remarks.
					An.	Ae.	Az.		
	1914		H. M. S.						
17	March 30 ...	P		...	...	.	...		
		eL	2 1 6	...	...			...	
		M	2 38 0	...	...	60		...	
		F	3 24 24	...	..	.	...	...	
18	April 11 ...	eP	16 41 30	...	...	...		.	
		iL	16 52 00		...		...	...	
		M	17 24 00	...	...	140		.	
		F	19 19 24		...	...	...	...	
19	20 ...	eP	14 55 54	...	...	...	...	...	
		eL	15 00 12	...	...	...	...	...	
		M	15 08 36	...	...	60	.	...	
		F	15 45 6	...	...	...	...	...	
20	May 21 ...	eP	8 35 24	...	...	...	...	...	
		L	8 38 42	...	...	...	...	...	
		M	8 39 12	...		50	..	...	
		F	8 59 12	...	...	...	..	...	
21	26 ...	eP	1 12 00	...	...	...	...	...	Widening of line.
		F	1 38 42	..	...	...	..	...	
22	26 ...	iL	2 52 18	...	...	..	..	...	No. P. Ts.
		M	2 53 18	...	..	70		...	
		F	3 2 48	...	..	.	...	...	
23	26 ...	eP	14 29 6	...	...	...	...	...	
		iL	14 35 0			...	...	..	
		M	14 46 00	...	...	1,070	} ...	...	
			14 59 36	...	...	1,500			
		F	18 19 48	...	...	...	...	...	
24	29 ...	eP	4 46 ?		...	...	...	..	
		L	?	...	...		...	.	
		M	5 1 48	...	...	850	...	...	Instrument examined at 4 *h.* 47*m.*
		F	6 46 12	...	...	...	...		
25	June 20 ...	eP	7 43 36	...	...	...	.	...	
		iL	8 9 6	...	...	...	...	...	
		M	8 23 36	...	..	270	...	...	
		F	9 59 42	...	...	...	...	...	
26	20 ...	eP	11 20 18	...	...	...	...	...	
		eL	11 26 54	...	...	...	...	...	
		M	11 26 54	...	...	50	...	...	
		F	11 54 6	...	...	...	...	...	
27	25 ...	iL	19 12 42	...	...	.	...	...	No. P. Ts.
		M	19 25 12	...	...	900	...	...	
		F	?	...	.	...	...	...	End lost in air tremors.
28	26 ...	eP	5 14 48	...	...	...	...	...	
		eL	5 38 36	...	...	...	...	...	
		M	5 53 48	...	...	150	...	...	
		F	?	...	...	...	...	...	
29	26 ...	P	?	...	...	...	...	...	
		eL	6 52 0	...	...	...	...	..	
		M	6 56 36	..	...	40	...	...	
		F	7 15 24	...	...	...	...	...	
30	July 4 ...	eP	17 00 12	...	...	...	...	...	
		iL	17 01 48	...	...	...	...	...	
		M	17 10 24	...	...	60	...	...	
		F	17 35 36	...	...	...	...	...	
31	4 ...	eP	22 47 24	...	...	...	...	...	Widening of line.
		F	23 39 12	...	...	...	.	...	
32	6 ...	eP	6 52 06	...	..	...	..	..	
		eL	7 05 30	...	...	...	...	...	
		M	7 08 00	...	...	30	...	...	
		F	7 15 36	...	...	...	...	...	
33	14 ...	eP	3 16 54	...	...	...	...	...	
		iL	3 22 42	...	...	...	...	...	
		M	3 30 48	...	...	270	...	...	
		F	4 23 36	...	...	...	...	...	
34	17 ...	eP	7 33 06	...	...	...	...	...	
		eL	7 59 42	...	...	...	...	.	
		M	8 08 42	...	...	30	...	...	
		F	8 38 42	...	...	...	...	...	
35	25 ...	eP	21 46 54	...	...	...	...	..	
		iL	21 51 30	...	...	...	.	...	
		M	21 54 06	...	...	170	...	...	
		F	22 17 42	...	.	..	...	...	
36	August 4 ...	eP	4 28 18	...	...	...	...	...	
		eL	4 30 06	...	...	...	...	...	
		M	4 32 06	...	...	70	...	...	
		F	4 38 18	..	...	...	...	...	
37	4–5 ...	eP	22 58 48	...	...	...	...	...	
		eL	22 54 36	...	..	..	...	...	
		M	23 01 18	...	...	1,300	...	...	
		F	0 58 42	...	...	...	...	...	

Kodaikanal Observatory Seismic Records—*concld.*

No.	Date.	Phase.	Time G.M.T	Period. (Sec.)	Amplitude (u)			Distance △ (Km.)	Remarks.
					An.	Ae.	Az.		
	1914.		H. M. S.						
38	August 5 ...	eP	10 53 48	...	...	...	...	...	
		eL	10 54 36	..	...	...	...	.	
		M	10 56 06	...	...	70	...	...	
		F	11 14 36	...	...	...	..	...	
39	6 ...	eP	4 14 54	..	...	...	...	...	Instrument examined at 4h 16m.
		F	5 04 24	...	...	...	...	...	
40	16–17 ...	eP	23 35 54	...	...	...	...	...	Widening of line.
		F	0 20 12	...	...	...	...	...	
41	28 ...	eP	6 42 00	...	...	...	...	...	
		eL	6 44 42	.	...	...	...	...	
		M	6 53 24	..	...	40	...	...	
		F	7 18 36	..	...	...	...	...	
42	September 28 ...	eP	2 17 42	...	...	...	...	...	Widening of line.
		F	2 29 00	...	...	...	..	...	
43	26 ...	eP	5 17 42	...	...	...	..	..	
		iL	5 18 30	..	...	...	...	...	
		M	5 20 30	..	.	40	...	...	
		F	?	..	..	...	..	...	Instrument examined at 5h 34m.
44	October 3 ...	eP	17 44 06	...	..	...	...	...	
		iL	18 30 00	...	...	...	...	...	
		M	18 40 48	...	...	70	...	...	
			43 48	...	...	70	...	...	
		F	19 34 48	...	..	...	...	...	
45	3 ...	eP	22 18 42		...	...	...	...	
		iL	22 27 18	..	..	...	...	...	
		M	22 40 48	...	...	500	...	...	
		F	23 50 12	...	...	...	...	...	
46	6 ...	eP	20 02 54	...	...	...	.	...	Widening of line.
		F	20 38 42	...	...	.	...	...	
47	9 ...	P		...	...	...	...	...	No. P. Ts.
		iL	2 48 36	...	..	...	...	...	
		M	2 51 42	...	...	1,080	...	...	
		F	3 46 48	...	...	...	...	...	
48	11 ...	eP	16 24 48	...	...	..	...	...	
		eL	16 31 12	...	...	...	...	...	
		M	16 27 54	...	...	50	...	...	
		F	16 35 48	...	...	...	...	...	
49	23 ...	eP	6 28 18	...	...	.	...	...	
		iL	6 34 42	...	...	.	...	...	
		M	6 40 18	...	...	500	...	...	
		F	7 33 18	...	...	...	...	...	
50	November 4 ...	eP	8 30 00?*	.	...	...	...	...	Widening of line.
51	4 ...	eP	9 01 30	...	...	...	...	...	Do.
		F	9 18 06	...	...	...	...	...	
52	4 ...	eP	11 01 00	...	...	..	...	...	
		eL	11 16 54	...	...	...	...	...	
		M	11 22 48	...	..	50	...	...	
		F	11 46 24	.	...	...	...	...	
53	10 ...	eP	6 54 30	...	...	...	...	..	
		eL	7 27 54	...	...	...	...	...	
		M	7 45 00	...	...	30	...	...	
		F	8 01 00	...	...	..	..	...	
54	18 ...	eP	10 41 48	...	...	...	...	...	
		eL	11 08 30	..	...	...	.	...	
		M	11 20 30	...	...	50	...	...	
		F	11 44 54	...	...	...	...	...	
55	24 ...	P		...	...	...	...	...	No P. Ts.
		iL	12 04 12	...	...	...	...	...	
		M	12 32 18	...	...	80	...	...	
		F	13 44 54	...	..	...	..	...	
56	27 ...	eP	15 14 30	..	...	...	..	...	Widening of line.
		F	15 21 12	...	...	...	...	...	
57	28 ...	eP	10 58 12	.	...	...	...	...	
		iL	11 19 18	...	...	...	...	...	
		M	11 28 12	..	...	70	...	...	
		F	11 52 54	...	..	...	.	...	
58	29 ...	P	5 12 24	...	...	...	...	...	Widening of line.
		F	5 30 00 ?	...	...	...	...	...	End lost in hour mark.
59	December 9 ...	eP	6 05 36	...	...	...	...	...	Widening of line.
		F	6 09 42	...	...	...	...	...	
60	20 ...	eP	14 34 24	...	...	...	...	...	
		iL	14 38 00	...	...	...	...	...	
		M	14 38 54	...	...	50	...	...	
		F	16 34 36	...	...	...	...	..	

* Merged in hour mark. Lasted about two minutes.

APPENDIX II.

Latitude 10° 13′ 50″ N.
Longitude 5h 9m 52s E.

Height of Barometer cistern above mean sea level 7,688 feet.

Mean Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1914.

Month.	Barometer.		Dry Bulb Thermometer.				Wet Bulb.		Tension of Vapour.	Relative Humidity.	Sun Max. in Vac.	Min. on Grass.	Wind.			Rain.		Clear Sky.	Bright Sunshine.
	Reduced to 32°.	Daily Range.	Mean.	Max.	Min.	Range.	Mean.	Min.	By Blanford's Tables.				Daily Velocity.	Mean Direction.		Amount.	Days.		
	Inches.	Inches.	°	°	°	°	°	°	Inches.	Cents.	°	°	Miles.	Points.		Inches.	No.	Cents.	Hours.
January ...	22·889	0·060	57·0	67·2	46·8	20·4	46·8	38·7	0·227	50	127·1	36·8	287	8	E.	0·50	2	67	280·4
February ...	·883	·063	58·9	70·2	47·6	22·6	47·7	39·9	·235	48	132·2	36·6	268	8	E.	0·14	1	74	279·5
March	·873	·068	60·5	70·4	50·7	19·7	51 0	43·7	·292	57	138·3	41·3	267	7	E. by N.	3·94	3	60	270·4
April	·861	·063	61·4	70·2	52·7	17·5	54·1	48·0	·360	69	140·6	43·2	221	8	E.	3 46	9	52	241·2
May	·835	·065	62·2	69·8	54·6	15·2	55·8	50·5	·392	73	135·6	47·2	169	2	N.N.E.	11·27	14	35	201·7
June	·777	·055	60 0	66·1	54·0	12·1	54·4	49·9	·383	78	131·7	49·0	349	25	W. by N.	2·49	9	21	149 6
July	·737	·051	56·9	61·3	52·3	9·0	53·5	50·5	·385	86	120·7	50 4	507	25	W. by N.	3·62	13	5	75·2
August	·788	·058	57·8	63·3	52·4	10·9	53·5	49·6	·374	80	128·5	49·9	389	26	W.N.W.	5 50	11	20	158·2
September ...	·811	·073	58·9	65·4	52·5	12·9	55·3	50·9	·411	86	131·6	48·6	213	24	W.	13·60	19	27	174·4
October ...	·853	·075	57·0	62·4	51·6	10·8	54·2	50·3	·404	90	121·4	48·3	243	6	E.N.E.	15·89	22	15	100·5
November ...	·825	·068	56·3	63·2	49·4	13·8	52.5	46·9	·367	82	122·2	44·4	241	1	N. by E.	7·47	8	38	188·9
December ...	847	·065	56·3	63·1	49·5	13·6	50·8	45·5	·328	74	114·9	43·5	306	4	N.E.	11·78	9	45	184·5
Annual ...	22·832	0·064	58·6	66·1	51·2	14·9	52·5	47·0	0·347	73	128·7	44·9	288	2	N.N.E.	79·66	120	38	2304·5

Extreme Monthly Meteorological Records at the Kodaikanal Observatory in 1914.

Month.	Barometer.					Dry Bulb Thermometer.				Wet Bulb.		Humidity.		Sun Th. in Vacuo.		Grass Therm.		Wind.				Rain.	
	Highest.		Lowest.		Range.	Highest.		Lowest.		Lowest.		Lowest.		Highest.		Lowest.		Highest.		Lowest.		Greatest Fall.	
	Inches.	Day.	Inches.	Day.	Inches.	°	Day.	°	Day.	°	Day.	Cents.	Day.	°	Day.	°	Day.	Miles.	Day.	Miles.	Day.	Inches.	Day.
January	22·986	8	22·786	21	0·200	75·8	28	40·7	1	33·2	29	7	28	138·1	6	24.8	29	468	16	146	3	0·25	8
February ...	·966	21	·790	2	·176	76·2	21	41·0	4	30·7	4	11	19	142·0	26	21·5	4	478	3	160	16	0·14	15
March	·962	19	·785	6	·177	75·3	3, 14	47·0	29	32·6	5	7	5	143·6	14	34·3	29	538	29	145	23	3·26	8
April	·940	10	·785	1	·155	75·6	29	49·9	6	41·6	7	33	25	150·8	24	32·3	29	868	21	103	3	0·81	13
May	·938	19	·750	13	·188	74·9	23	51·9	20	45·3	19	36	23	144·2	23	42·3	2	313	10	38*	29	1·75	6
June	·851	1	·692	13	·159	72·4	3	52·5	21	43·7	17	48	17	143 7	5	43·3	17	532	6	125	3,	0·33	13
July	·824	16	·643	27	·181	68·3	1	49·4	25, 26	43·1	23	51	28	143 1	3	47·8	18, 23	735	9	217	30, 31	0·57	15
August	·880	9	·665	17	·215	67·1	22	50·0	6	43·2	21	33	21	143·9	8	45·2	10	594	21	110	31	1·53	12
September ...	·920	20	·694	14	·226	70·1	30	50·4	14	47·5	14	64	22	142·3	27	45 0	16	476	4	86*	8	4·10	20
October	·936	19, 25	·756	6	·180	66·6	1	48 3	18	44·3	3	58	3	140·9	1	44·0	22	548	13	119	5	2·23	1
November ...	·906	27	·732	18	·174	68·5	11	42·9	24	35·3	20	34	20	137·3	20	30·3	20	440	28	110	24	2·64	29
December ...	·942	28	·736	20	·206	70·3	28	42·1	27	31·7	25	11	27	131·9	16	20·4	27	656	19	116	12	3·01	6

* See note under "Wind" in section 14 "Meteorology."

APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1914.

Month.	Hours.																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
January ...	12	12	12	13	13	14	13	13	12	12	14	14	14	13	12	10	9	8	9	10	11	11	12	13
February ...	12	12	12	13	12	12	12	11	11	12	13	13	13	11	11	10	9	9	9	8	8	10	12	12
March ...	11	11	11	11	11	12	13	13	13	14	14	14	12	11	9	9	8	8	9	10	9	9	10	12
April ...	9	11	9	10	10	10	10	11	10	11	10	9	9	9	9	8	6	7	8	9	9	8	8	10
May ...	8	7	6	6	6	6	6	6	6	7	8	8	8	9	8	8	7	7	7	6	7	8	8	8
June ...	17	15	15	16	16	15	15	12	13	12	13	12	12	12	12	12	13	15	16	17	18	18	18	17
July ...	24	21	23	23	23	23	22	21	18	20	18	18	18	18	18	19	19	21	23	23	23	23	24	24
August ...	18	18	18	18	18	17	16	16	15	15	15	13	13	13	13	14	14	15	17	18	18	18	19	19
September ...	8	8	8	8	8	8	9	8	8	9	9	10	10	9	10	10	9	9	10	10	9	9	9	8
October ...	11	10	10	10	10	10	11	10	11	12	11	10	9	9	9	9	9	9	9	9	9	10	11	10
November ...	11	10	11	11	11	11	11	11	10	12	11	11	10	10	9	8	7	8	8	9	9	10	11	11
December ...	14	13	13	13	12	12	12	13	14	14	14	15	14	13	12	12	10	10	11	13	13	13	13	13
Annual ...	13	12	12	13	13	12	13	12	12	12	13	12	12	11	11	11	10	10	11	12	12	12	13.	13

APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1914.

Month.	Hours.											
	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18
January	0·31	0·77	0·82	0·86	0·86	0·86	0·89	0·85	0·86	0·86	0·78	0·33
February	·51	·95	·97	·99	·99	1·00	·94	·93	·84	·75	·73	·39
March	·63	·98	·97	·95	·92	0·83	·75	·69	·56	·53	·50	·42
April	·67	·94	·96	·97	·95	·89	·72	·47	·50	·40	.29	·28
May	·37	·70	·78	·78	·87	·80	·61	·55	·39	·28	·25	·14
June	·23	·50	·58	·65	·68	62	·56	·43	·36	·22	·20	·12
July	·10	·26	·32	·38	·36	·37	·33	·27	·22	·12	·04	...
August	·19	·44	·58	·77	·78	·63	·53	·48	·37	·24	·08	02
September	·21	·56	·74	·79	·77	·80	·58	·42	·39	·34	·15	·04
October	·17	·27	·42	·38	·41	·35	·23	·29	·25	·19	·16	·02
November	·14	·53	·75	·79	·77	·74	·66	·58	·47	·51	·32	·05
December	·08	·54	·66	·67	·64	·62	·59	·60	·63	·51	·39	·04
Mean ..	0·30	0·63	0·71	0·75	0·75	0·71	0·62	0·55	0·49	0·41	0·32	0·17

APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1914.

Month.	Very clear.	Visible.	Just visible.	Tops only visible.	Total.
January	...	15	7	3	25
February	2	5	5	1	13
March	...	3	1	...	4
April	...	...	3	...	3
May	...	...	3	...	3
June	1	4	2	...	7
July	...		1	2	3
August	2	1	...	...	3
September ...	3	6	...	...	9
October	1	2	...	...	3
November ...	3	2	2	1	8
December	1	12	1	...	14
Total ...	13	50	25	7	95

APPENDIX VI.

MADRAS OBSERVATORY—Abnormals from monthly means for the year 1914.

Abnormals of	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Reduced atmospheric pressure	+ 0·072	+ 0·023	− 0·014	+ 0·046	+ 0·008	− 0·011	− 0·042	− 0·003	+ 0·015	+ 0·081	− 0·015	− 0·015	+ 0·015
Temperature of air	+ 0·6	+ 0·7	+ 1·8	− 0·7	+ 1·7	+ 2·0	+ 1·2	+ 0·1	− 0·1	− 0·2	+ 0·9	+ 1·6	+ 0·8
Do. of evaporation	+ 0·4	+ 0·7	+ 1·8	+ 0·8	+ 1·6	+ 0·2	+ 1·1	+ 1·2	+ 2·0	+ 1·1	+ 1·6	+ 1·2	+ 1·2
Percentage of humidity	− 1	+ 1	Same as	+ 5	+ 1	− 1	+ 1	+ 5	+ 9	+ 6	+ 3	− 1	+ 2
Greatest solar heat in *vacuo*	+ 9·9	+ 10·2	+ 12·7	+ 10·6	+ 9·1	+ 9·7	+ 1·0	+ 5·3	+ 8·1	+ 7·5	+ 5·3	+ 11·5	+ 8·4
Maximum in shade	− 1·0	− 0·1	+ 1·2	− 2·1	+ 2·7	+ 3·4	+ 1·0	− 0·5	− 1·4	− 1·5	+ 0·1	+ 1·6	+ 0·3
Minimum in shade	+ 0·4	+ 0·6	+ 1·8	− 0·4	+ 1·2	+ 2·0	+ 1·1	− 0·2	− 0·5	− 0·1	+ 0·7	+ 1·0	+ 0·6
Do. on grass	+ 0·9	+ 1·7	+ 3·0	+ 0·5	+ 2·0	+ 2·6	+ 1·8	+ 0·6	+ 0·1	+ 0·8	+ 1·2	+ 2·0	+ 1·5
Rainfall in inches	+ 0·17	− 0·28	− 0·39	+ 1·43	− 2·11	− 1·47	− 1·27	+ 4·85	+ 2·15	+ 8·22	+ 0·82	− 4·51	...
Do. since January 1st	...	− 0·11	− 0·50	+ 0·93	− 1·18	− 2·65	− 3·92	+ 0·93	+ 3·08	+ 11·30	+ 12·12	+ 7·61	+ 7·61
General direction of wind	1 point N.	2 points S.	Same as	Same as	Same as	1 point S.	2 points W.	2 points W.	1 point S.	2 points N.	1 point E.	1 point E.	Same as
Daily velocity in miles	+ 13	− 10	− 7	− 24	− 30	− 24	− 17	− 34	− 20	− 11	− 21	− 26	− 18
Percentage of cloudy sky	− 8	− 8	− 11	+ 8	+ 1	− 15	+ 11	− 2	− 13	+ 6	− 5	− 10	− 5
Do. of bright sunshine	− 4·6	+ 1·1	− 3·8	+ 3·2	− 10·4	− 1·2	− 12·5	− 4·2	+ 5·7	− 15·3	− 1·3	− 1·5	− 8·4

+ means above normal; — means below normal.

APPENDIX VII.

ABSTRACT of the mean meteorological condition of Madras in the year 1914 compared with the average of past years.

Mean values of	1914.	Difference from	Average.
Reduced atmospheric pressure	29·879	0·015 above.	29·864
Temperature of air	81·9	0·8 ,,	81·1
Do. of evaporation	75·7	1·2 ,,	74·5
Percentage of humidity	74	2 ,,	72
Greatest solar heat in *vacuo*	148·1	8 4 ,,	139·7
Maximum in shade	91·1	0·3 ,,	90·8
Minimum in shade	75·3	0·6 ,,	74·7
Do. on grass	73·4	1·5 ,,	71·9
Rainfall since January 1st on 95 days	56·63	7·61 ,,	49·02
General direction of wind	S.E.	Same as	S.E.
Daily velocity in miles	153	18 below	171
Percentage of cloudy sky	44	5 above.	49
Do. of bright Sunshine	50·0	8·4 ,,	58·4

DURATION and Quantity of the Wind from different Points.

From.	Hours.	Miles.	From	Hours.	Miles.	From	Hours.	Miles.	From	Hours.	Miles.
North ...	160	1,244	East ...	181	806	South ...	180	1,368	West ...	241	1,916
N. by E. ...	299	1,833	E. by S....	186	949	S. by W.	216	1,428	W. by N.	222	1,636
N.N.E. ...	399	2,245	E.S.E. ...	201	970	S.S.W. ..	199	1,402	W.N.W....	120	885
N.E. by N....	819	4,887	S.E. by E.	272	1,514	S.W. by S.	274	1,689	N.W. by W.	74	507
N.E. ...	419	2,814	S.E. ...	495	3,084	S.W. .	242	1,525	N.W. ...	59	302
N.E. by E....	337	2,115	S.E. by S.	885	6,419	S.W. by W.	216	1,399	N.W. by N.	29	104
E.N.E. ...	149	834	S.S.E. ...	497	4,115	W.S.W. ...	181	1,344	N.N.W. ...	7	43
E. by N. ...	303	1,392	S. by E....	314	2,196	W. by S.	309	2,279	N. by W.	117	708

There were 158 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. wind, blowing with a uniform daily velocity of 33 miles.

APPENDIX VIII.

MADRAS OBSERVATORY—Number of hours of wind from each point in the year 1914.

Month.	N.	1	2	3	4	5	6	7	E.	9	10	11	12	13	14	15	S.	17	18	19	20	21	22	23	W.	25	26	27	28	29	30	31	Calm.
January ...	6	21	45	342	156	125	22	21	5	1	...	...	...	...	...	...	...	...	..	..	...	...	...	...	...	...	...	...	...	...	..	...	...
February ...	...	...		2	28	37	35	123	49	69	20	16	78	118	9	49	6	6	2	1	1	1	...	...	...	...	...	...	...	...	...	...	22
March ...	...	...	...	...	...	..	...	30	53	33	60	122	72	229	54	14	8	10	9	8	1	1	1	...	...	...	...	...	...	..	...	...	39
April ...	..	2	...	1	1	1	1	...	1	1	4	58	185	290	85	12	17	19	19	3	...	...	...	...	...	...	1	...	...	...	1	6	12
May	1	4	1	...	...	2	3	...	4	10	44	24	60	76	118	77	41	63	48	48	27	21	20	9	9	10	8	6	2	1	...	1	6
June	5	2	8	1	1	...	...	5	7	17	17	17	28	71	43	57	48	28	8	42	32	32	53	45	36	56	25	21	8	3	2	1	1
July	1	...	...	...	...	...	...	.	...	6	...	...	4	17	23	10	8	32	27	61	77	93	53	118	85	40	37	11	18	9	1	7	6
August ...	...	...	.	1	1	...	1	...	2	14	8	13	14	4	36	22	25	32	37	60	44	32	37	107	83	77	27	27	16	10	1	5	8
September ...	1	1	1	1	...	...	...	1	1	8	9	10	47	63	102	69	26	23	46	50	60	36	14	30	27	35	19	7	11	6	..	..	16
October ...	11	73	60	150	62	47	41	96	41	23	33	5	2	17	27	4	1	3	3	1	...	...	3	...	1	3	2	2	2	...	...	5	26
November ..	113	128	111	107	72	36	44	24	16	3	6	7	5	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	1	36	16
December ...	22	73	173	214	98	89	2	3	2	1	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	1	1	...	2	...	1	56	6
Annual total.	160	299	399	819	419	337	149	303	181	186	201	272	495	885	497	314	180	216	199	274	242	216	181	309	241	222	120	74	59	29	7	117	158

APPENDIX—IX

MADRAS OBSERVATORY—Number of miles of wind from each point in the year 1914.

Month.	N.	1	2	3	4	5	6	7	E	9	10	11	12	13	14	15	S.	17	18	19	20	21	22	23	W	25	26	27	28	29	30	31	Total.
January	62	94	290	2039	1232	806	190	129	28	7	...	...	...	...	...	...	...	...	...	...	...	...	...	.	...	...	..	...	...	...	...	...	4877
February	...	.	...	19	79	203	192	511	197	260	115	37	354	754	92	187	52	54	17	7	4	4	...	...	...	...	...	...	...	...	...	...	3188
March ..	...	..	...	...	..	...	...	150	224	206	290	665	414	1575	496	123	78	99	86	66	9	10	9	...	...	...	.	...	...	...	...	...	4500
April	...	10	...	10	7	16	9	...	13	6	26	219	1131	2110	772	124	155	177	158	28	...	...	...	...	...	...	8	...	...	...	8	41	5028
May	5	18	10	...		16	13	...	29	78	204	186	466	668	1254	687	381	459	328	338	212	160	205	84	84	80	70	43	17	5	...	8	6108
June	27	9	31	5	7	...	...	21	60	115	108	163	252	659	408	408	335	174	60	301	267	210	428	400	373	515	232	201	64	22	14	9	5881
July	2	...	..	...	...	...	...	...	..	23	...	...	42	197	288	100	66	139	161	342	480	546	411	950	775	364	242	74	75	31	5	25	5288
August	...	...	...	9	8	...	3	...	15	80	28	70	71	44	253	173	123	146	243	321	243	188	199	662	546	483	188	135	63	28	2	18	4342
September	7	8	6	3	...	...	...	7	9	56	44	84	258	329	531	370	170	170	333	279	310	281	79	183	134	168	134	42	57	18	..	...	4070
October	109	455	336	620	278	279	209	439	164	84	120	38	12	83	71	24	8	5	16	7	...	...	13	...	4	19	7	12	15	...	...	44	3471
November	960	780	692	582	457	246	190	104	51	27	35	52	34		...	...	...	..	...	...	...	..	...	...	...	...	...	...	...	...	10	201	4321
December	172	459	880	1600	746	549	28	31	16	7	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	4	4	...	11	...	4	362	4873
Annual total ...	1244	1833	2245	4887	2814	2115	834	1392	806	949	970	1514	3034	6419	4115	2196	1368	1423	1402	1689	1525	1399	1344	2279	1916	1636	885	507	302	104	43	708	55897

APPENDIX X.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1914.

Month.	N	1	2	3	4	5	6	7	E	9	10	11	12	13	14	15	S	17	18	19	20	21	22	23	W	25	26	27	28	29	30	31	Calm.
January ...	0·05	...	0·13	...	0·13	0·24	0·20	0·21	0·10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		...	...	...	...	...	...	...	...	...
March ...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...
April ...	...	0·27	...	...	...	...	...	...	...	...	...	...	0·01	0·23	...	...	0·03	...	0·04	0·65	...	...	...	..	...	...	...	..	...	...	0·01	0·81	...
May ...	...	...	...	...	...	...	...	...	..	...	...	...	...	.	..	...	..	...	...	...	...	...	...	...	0·01	...	...	...	...	...	...	...	...
June ...	...	...	...	...	...	...	...	...	...	...	0·10	0·02	0·01	0·03	...		0·04	0·02	...	0·11	...	0·24	...	...	...	...	...	0·03	0·01	0·03	...	...	...	...
July ...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·04	...	...	0·01	...	...	0·20	0·25	0·23	0·21	0·29	0·15	0·07	0·02	0·09	0·43	0·23	0·36	...	...	0·02
August ...	...	...	...	...	...	...	0·06	...	...	...	...	0·13	...	...	0·51	...	0·03	...	0·48	0·13	0·87	0·47	0·02	0·62	0·84	1·77	2·65	0·05	0·04	0·25	...	...	0·48	0·01
September. .	...	...	...	0·38	..	...	...	...	...	...	...	...	0·72	0·92	0·01	...	0·04	0·67	1·14	0·70	0·93	0·64	0·02	0·08	0·02	0·17	0·05	0·15	...	0·20	...	...	...	...
October ...	0·02	1·00	0·46	1·51	2·09	1·79	3·09	2·74	1·56	1·21	1·95	1·09	.	...	0·01	...	...	0·49	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·21
November ...	0·90	1·93	1·46	0·23	1·34	1·07	0·62	0·62	0·50	1·51	0·02	0·08	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	0·24	3·31	0·20
December ...	0·02	...	0·34	0·01	...	0·35	...	...	...	0·05	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...
Annual ...	0·99	3·20	2·39	2·13	3·56	3·45	3·97	3·57	2·16	2·87	2·12	1·90	1·00	0·75	0·01	0·12	0 72	2·11	1·18	2·70	1·58	0·25	0·99	1·02	2·01	2·72	0·32	0·48	0·71	0·36	0·25	4·60	0·44

APPENDIX XI.

MADRAS OBSERVATORY—Wind, cloud and bright sunshine, 1914.

Months.	Wind resultant.		Clouds (0—10).					Bright sunshine.	
	Velocity.	Direction.	8 H.	10 H.	16 H.	20 H.	Mean.	Average per day.	Greatest number of hours in a day.
	MILES.	POINTS.						HOURS.	HOURS.
January	152	N.E.	3·0	3·2	3·4	1·9	2·9	7·2	9·3
February	87	E.S.E.	1·5	2·4	1·3	0·9	1·6	9·1	10·2
March	133	S.E.	1·9	2·1	0·6	0·5	1·3	8·4	10·2
April	153	S.E. by S.	4·4	3·7	1·6	1·5	2·8	9·0	10·9
May	144	S. by E.	3·7	3·3	4·2	4·0	3·9	6·4	9·6
June	102	S.W. by S.	4·6	4·2	5·9	4·3	4·9	4·9	7·9
July	130	W.S.W.	8·0	7·7	8·3	8·6	8·2	2·4	7·6
August	90	S.W. by W.	6·6	6·2	6·9	6·1	6·5	4·3	10·6
September	87	S. by W.	5·1	4·9	5·1	4·2	4·9	5·7	10·7
October	85	N.E.	5·7	6·3	7·8	6·0	6·5	4·1	9·3
November	127	N.N.E.	5·2	5·7	6·1	4·4	5·4	5·3	9·0
December	145	N.E. by N.	4·0	4·8	4·7	3·3	4·2	5·8	8·6
Annual ...	33	S.E.	4·5	4·5	4·7	3·8	4·4	6·1	...

APPENDIX XII.

MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1914.

	Barometer.		Dry Bulb Thermometer.				Wet Bulb.		Tension of Vapour.	Relative Humidity.	Sun Max in Vac.	Min. on Grass.	Wind.			Rain.		Cloudy Sky.	Bright Sunshine.
	Reduced to 32°.	Daily Range.	Mean.	Max.	Min.	Range.	Mean.	Min.	By Blanford's Tables.				Daily Velocity.	Mean Direction.		Amount.	Days.		
	INCHES.	INCHES.	°	°	°	°	°	°	INCHES.	CENTS.	°	°	Miles.	Points.		INCHES.	No.	CENTS.	HOURS.
January	30·069	0·102	75·7	83·6	67·9	15·7	69·6	66·3	0·641	72	148·3	64·0	157	4	N. E.	1·06	2	29	224·3
February	29·987	·124	77·4	86·5	68·6	17·9	71·5	67·6	·693	74	149·9	65·5	112	10	E. S. E.	...	.	16	256·1
March	·913	·133	81·8	90·4	73·9	16·5	75·7	72·8	·805	74	153·2	71·6	145	12	S. E.	...	..	13	261·2
April	·871	·129	83·3	90·8	76·8	14·0	78·7	75 9	·903	79	152·3	75·2	167	13	S. E. by S.	2·05	4	28	270·4
May	·743	·121	88·4	100·5	82·0	18·5	79·9	77·5	·904	68	152 1	80·9	197	15	S. by E.	0·01	1	39	197·1
June	·692	·123	88·4	101·7	82·3	19·4	77·8	74·7	·805	61	150·2	81·2	196	18	S. S. W.	0·64	8	49	148·3
July	·679	·124	85·7	96·6	79·6	17·0	77·0	74·1	·810	66	139·7	78·4	171	22	W. S. W.	2·60	19	82	74·5
August	·746	·114	83·4	93·2	77·2	16·0	77·2	74·2	·854	75	145·3	76·0	140	21	S. W. by W.	9·41	16	65	134·8
September	·792	·132	82·9	91 8	76·6	15·2	78·3	74·8	·902	81	149·4	75·1	136	17	S. by W.	6·84	11	49	173·4
October	·922	·107	80·4	87·5	75·1	12·4	76 7	74·1	·867	84	146·6	73·6	112	5	N. E. by E.	19·22	18	65	126·9
November	·909	·107	78·4	85·2	73·0	12·2	74·5	71·7	·802	82	142·7	70·7	144	3	N. E. by N.	14·03	12	54	159·7
December	962	·108	77·1	85·2	70·8	14·4	71·8	69·1	·711	76	147·3	68·4	157	3	N. E. by N.	0·77	4	42	180·3
Annual ...	29·857	0·119	81·9	91·1	75·3	15·8	75·7	72·7	0·808	74	148·1	73·4	153	12	S. E.	56·63	95	44	2,207·0

EXTREME Monthly Meteorological Records at the Madras Observatory in 1914.

	Barometer.					Dry Bulb Thermometer.				Wet Bulb.		Humidity.		Sun Th. in Vacuo.		Grass Therm.		Wind.				Rain.	
	Highest.		Lowest.		Range.	Highest.		Lowest.		Lowest.		Lowest.		Highest.		Lowest.		Highest.		Lowest.		Greatest Fall.	
	INCHES.	DAY.	INCHES.	DAY.	INCHES.	°	DAY.	°	DAY.	°	DAY.	CENTS.	DAY.	°	DAY.	°	DAY.	MILES.	DAY.	MILES.	DAY.	INCHES.	DAY.
January ...	**30·216**	**9**	9·923	21	0·293	84·8	29	63·4	27	61·9	27	49	27, 29	151·5	30	59·4	27	231	9	113	31	0·57	1
February ...	·113	12	·836	17	277	89·3	6	63·2	25	62·4	25	33	5	154·2	23	59·1	5	192	18	58	2	...	...
March ...	·115	19	·753	31	362	96·1	11	68·3	4	67·7	3, 4	49	29	157·6	22	65·8	4	200	21	81	28	...	...
April ...	·026	10	·682	30	·344	95·8	1	71·6	2	71·6	2	53	19	163·7	14	70·5	25	234	30	87	2	0·95	2
May ...	29·938	3	·556	31	·382	108·9	31	78·2	6	73·3	18	25	31	159·2	7	77·2	2	280	28	102	14	0·01	5
June ...	·819	6	**·511**	**25**	·308	**110·3**	**1**	76·0	14	71·9	3	**22**	**2**	165·6	1	74·2	14	277	2	139	13	0·21	4
July ..	·828	16	·532	10	·296	104·1	1, 6	75·6	15	72·5	25	35	10, 11	157·4	12	73·9	15	245	12	80	23	0·51	17
August ...	·920	9	·547	17	·373	100·0	1	73·8	11	72·1	4	46	3	157·6	26	72·5	11	180	1	92	5	2·89	17
September ...	·995	19	·577	13	·418	98·0	2	72·1	22	71·0	8	47	5	162·4	2	71·1	22	197	27	54	19	2·08	10
October ...	30·068	25	·722	6	·346	97·3	6	72·3	29	71·7	29	53	3, 4, 5	**168·6**	**5**	71·7	17	240	31	62	10	3·49	22
November ...	·054	27	770	1	·284	87·3	9	65·2	28	68·8	23	40	22	155·6	20	61 3	23	289	1	**45**	**7**	**7·46**	**1**
December ...	·133	28	·729	20	**·404**	89·7	21	**60·6**	**24**	**60·2**	**24**	33	22	154·5	14	**56·9**	**24**	**304**	**3**	75	12	0·36	1