The other important question that arises is the relation between the north-east portion and the winter high over America and the Indian weather. This portion would give rise to westerly winds. It is well known that this region is the starting point of the Atlantic depressions that affect the temperate latitudes, or the extra-tropical depressions one of whose successive secondaries affect India in the winter. A high pressure area over the north-east portion of the high over N. America in winter should help in the formation of extra-tropical depressions and hence in the formation of secondaries that affect India. Other things being equal more secondaries would mean more rain in N.W. India. Hence the rain in N.W. India should be positively correlated with the pressure in the north-east portion of the winter high over N. America. As the speed of the westerlies in temperate latitudes is much greater than the easterlies in the equatorial latitudes. the time lag between N. America and N.W. India would be about 15-20 days only. Hence the contemporary correlation coefficient would have to be tried if a period of about three months is taken for rain. The stations that were chosen to represent pressure were Chicago, Albany (N.Y.) and Washington.

C.C. of North America (N.E. Portion) Jan. to March pressure to contemporary rain in N.W. India was 0.194 for the same number of years (1876-1930). This is significant to 80% level.

(The correlation coefficients were calculated by Mr. K. S. Ramamurthy for me.)

It is interesting to notice the behaviour of different portions of the North American winter high towards rain in N.W. India. If the North American high pressure area remained abnormally high throughout the southern winter, it follows that due to the souhern and western portions of it, the winter rain in N.W. India should be defective and due to the influence of the north-east portion of the high pressure the rain in N.W. India should be abundant. Different portions of the same high pressure area exercise opposing influences. In other words, the high pressre area acts as a sort of balancing factor to N.W. India rain. The passage of western disturbances from west to east would pull the 'pulses' or low pressure areas travelling in lower latitudes and may occasionally prevent their crossing of the equator and may create a "break" in the monsoon in the southern hemisphere. Or the high pressure area may also act to a certain extent as a balancing factor for the southern monsoon also.

It appears probable that even for the Indian monsoon, one portion of the southern high near S. America may give rise to 'pulses' moving westwards and ultimately producing the S.W. monsoon in India. A more southerly portion of the high may give rise to extra-tropical depressions, which travel in the southern hemisphere from west to east, may pull down the monsoon pulses and create a "break" in the Indian monsoon.

The high pressure belts away from the equator on either side of it seem to act as stabilising factors on the weather on the two sides of the equator, one being more prominent in northern summer and the other in southern summer.

1. *Forecasting Weather in and Near India.* S. L. Malurkar. Printed limited number in May 1941, pp. 34. 2. *Ibid.*, 119. 3. *Ibid.*, p. 87. 4. *Ibid.*, p. 120, *et seq.* 5. *Ibid.*, p. 101. 6. *Ibid.*, p. 105.

RAINIEST SPOT IN THE WORLD

By H. L. Chhibber

(Department of Geography, Benares Hindu University)

It was surprising to observe that even the standard books on climatology gave varying data about the rainiest place in the world. H. F. Blanford in his book on *The Climates and Weather of India, Ceylon and Burma*[1] (p. 73), has given the average monthly and total annual rainfall of Cherrapunji as follows:—

W. G. Kendrew in his book on *The Climate of the Continents*[2] (p. 55), has stated that "the west side of Kamerun Peak has 412 inches *per annum* near sea-level, the second highest record in the world, surpassed only at Cherrapunji (India) which has 458 inches", while on p. 131 of the same book 428 inches is given as the annual mean rainfall for Cherrapunji.

Elevation in feet	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov	Dec.	Total
4,455	0·6	2·6	9·0	29·6	50·0	110·0	120·5	78·9	57·1	13·6	1·8	0·3	474·0

The monthly average of rainy days on p. 74 is given below:—

Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total
2	4	10	20	25	26	29	28	24	12	3	1	184

Referring to p. 222 of the same treatise the following figures are given for the mean rainfall of Cherrapunji.

Cherrapunji	Altitude in feet	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
	4.309	0·7	2·1	11·7	30·8	46·2	96·8	98·2	76·5	46·1	16·7	1·9	0·2	427·9

The same author in his book on *Climate*[3] (p. 141), has stated: "The very high mean of 412 inches is recorded near sea-level on the south-west side of Kamerun Peak, where a south-west wind blows on-shore for the greater part of the year, and there is certainly much more on the higher slopes; the heaviest rains are from June to October, the months when the monsoonal *indraft* is *strongest.* Kamerun is situated about 5° N. lat. and this too tends to give it its wettest season in the northern summer. There are stations outside the equatorial belt which have a large rainfall." On pp. 39-40 of *Climatology*,[4] by Austen Miller, it is recorded: "the heaviest rainfalls in the world are recorded under such conditions, Kauai[1] *in the Hawaiian Island, has an* average rainfall of 476 inches and *Cherrapunji, in Assam, has* 450 *inches.*

In the same connection, W. G. Kendrew in his book on *Climate*, has recorded on p. 145[2]: "the north-east trades of the Pacific Ocean meet such a barrier in the Sandwich Islands, while the volcanic mountains rise steeply from the Ocean to 13,000 feet; on Mount Waialeale *(5,080 feet) in* the Island of Kauai a high cliff facing north-east forces the Trade winds to rise almost vertically, and the rainfall is both heavy and continuous. The records are *slightly uncertain* owing to the difficulties involved in reaching this remote and elevated spot in order to reach the rain-gauges, but it seems that the mean daily rainfall is over 1 inch and the annual mean over 400 inches. This is among the highest figures recorded on the earth."

Finding such great discrepancies in standard works on climatology, it was deemed advisable to refer the matter to the India Meteorological Department since relevant references were not available at Benares. The Dy. Director-General of Observatories, Poona, informed me that there are at present three rain-gauges at Cherrapunji with annual total rainfall as tabulated below:—

CHERRAPUNJI RAINFALL
(Average Annual Total)

I. *Provincial rain-gauge, located in the Police Station* (started in 1871):
   (1) From Blanford's. This average is based on data before 1899—474".
   (2) From 'Rainfall of India', *Memoirs*, Vol. No. XIV. Average based on data from 1872 to 1900. (This publication appeared in 1902)—457"·8.
   (3) 1920 normal. Based on data upto 1920 (49 years)—427"·8.
   (4) 1940 normal (70 years)—425"·5.

II. *Rain-gauge at Cherrapunji Welsh Mission House* (opened in 1903):
   Average 1903-1920 (18 years)—441"·7.
   1940 normal (38 years)—459"·6.

III. *Rain-gauge at Cherrapunji Observatory* (opened in 1906):
   1940 normal (35 years)—425"·2.

Monthly and Annual Rainfall (in Inches)

Station	Lat °N	Long.	Height	Length of record yrs.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1. Cherrapunji (Police Station) Provincial rain-gauge	25°16′	91°44′E	4,309	70	0·73	1·91	9·92	28·80	49·82	100·35	95·85	73·11	45·95	16·74	2·06	0·22	425·46
2. Cherrapunji (Welsh Mission House)	25°16′	91°44′E	4,309 Approx	38	0·86	2·28	7·58	28·61	52·67	114·71	106·04	76·61	44·39	21·66	3·59	0·59	459·50
3. Cherrapunji (Observatory)	25°16′	91°44′E	4,309	35	0·75	2·11	7·27	26·23	50·44	106·05	96·74	70·08	43·35	19·42	2·70	0·49	425·23
4. Waialeale (Kauai Is.)	22°4′	159°30′ W	5,075	20	*	*	*	*	*	*	*	*	*	*	*	*	460 20
5. Debundja (Nigeria)	4°5′	8°59′E	16	14	7·91	11·26	16·06	18·11	25·43	58·35	63 03	54·21	61·42	46·34	24·06	13·39	399·57

Note.—Not available. Data of 4 and 5 taken from *Climate and Man*, published by the United States Department of Agriculture.

In the above table are given the monthly and annual rainfall figures for the three rain-guages in Cherrapunji along with its co-ordinates, height above sea-level and the length of record. The same figures for Waialeale in Kauai Island (as far as available) and Debundja in Nigeria are also tabulated.

Waialeale, Kauai Island, Hawaii territory, according to data in *Climate and Man*, a publication of the United States Department of Agriculture, has an average annual total rainfall of 460 inches. No monthly figures are available and the average is based on data of 20 years only. This average, however, is not supported by the data of annual rainfall for the years 1912 to 1930, given in *Heavy Rainfall Records*, by Jhon R. Theman. The figures for Waialeale are reproduced in the table in the previous column.

MT. WAIALEALE (Hawaii Territory)

Year	Rainfall in inches
1912 ..	414·00
1913 ..	451·00
1914 ..	—
1915 ..	—
1916 ..	521·00
1917 ..	—
1918 ..	—
1919 ..	204·00
1920 ..	549·00
1921 ..	367·00
1922 ..	452·00
1923 ..	360·00
1924† ..	228·00
1924–25* ..	362·40
1925–26* ..	219·60
1926–27* ..	403·24
1927–28* ..	—
1928–29* ..	354·22
1929–30* ..	301·95

* From July 1 to July 1.
† Records of six months.

In view of the foregoing and also the much longer period of 38 years on which the average of the rainfall at the Welsh Mission House, Cherrapunji, is based, it may be taken that the rainfall of Cherrapunji is higher than that of Waialeale.

With regard to other places having high rainfall it may be noted that Mawsynram, a station near Cherrapunji, has records of a few years which show that it has a rainfall of well over 400 inches. No average is given as the period of data is short.

The only other station known, which has an annual rainfall of 400 inches or over is Debundja in Nigeria. Its average annual rainfall based on data of fourteen years only is 400 inches.

From the above it appears that Cherrapunji receives the heaviest rainfall in the world. *Next to Cherrapunji and Mawsynram*, the places of heaviest rainfall seem to be Waialeale and Debundja.

I wish to express my great indebtedness to the Deputy Director-General of Observatories, India Meteorological Department, for kindly helping in elucidating this important matter.

1. Blanford, H. F., *A Practical Guide to the Climates and Weather of India, Ceylon and Burma* (MacMillan), 1889. 2. Kendrew, W. G., *The Climates of the Continents* (Oxford University Press), Third Edition, 1941. 3. Kendrew, W. G., *Climate* (Oxford University Press), 1942. 4. Miller, A. Austen, *Climatology* (Metheun), Fourth Edition, 1946.

NEW METHODS OF PRODUCING HIGH ENERGY PARTICLES

By G. SURYAN and C. K. SUNDARACHAR
(*Department of Physics, Central College, Bangalore*)

THE extension of our knowledge in respect of the meson and the short-range forces inside the atomic nucleus awaits the development of laboratory techniques accelerating charged particles to cosmic-ray energies. The relativistic increase in mass leading to a change in frequency sets an upper limit to the energy of a well-defined beam of ions in the cyclotron. Devices which give promise of attaining energies in excess of 200 Mev. are the (1) betatron, (2) synchrotron, (3) relativistic cyclotron, (4) microtron, (5) linear resonance accelerator and (6) linear wave guide accelerator. The first four bring about resonance acceleration in a steady or varying magnetic field and the last two make use of micro-waves.

The induction electron accelerator called the *betatron* was perfected by Kerst.[1] A stream of electrons shot tangentially into a toroidal vacuum chamber placed between the pole-pieces of an A.C.-fed electromagnet gets accelerated in the electric field induced by the changing magnetic field. Decrease of the field with the radius gives rise to magnetic focussing, resulting in a fine output beam. The magnet of the 100 Mev. betatron built by the G.E. Co. at Schenectady weighs 130 tons, has a pole-face of 16 inch diam., and is fed by a 60 cycle A.C. at a full load of 200 KW. Although it may be possible to raise the energy to 500 Mev. by proper adjustment of the time dependance of the field, the loss of energy by radiation will be considerable at the higher energies.

The *synchrotron* due to Veksler[2] and McMillan[3] uses a time-varying magnetic field as in the betatron and a split thin-walled dee system connected to a high voltage generator as in the cyclotron. The inherent phase stability of the orbits brings about automatic synchronisation and makes up for moderate energy losses. When accelerating heavy particles, the damping of the phase oscillation set up by the radial displacement of the orbit may be compensated by motor-driven tuning devices. If the radiation loss per turn can be reduced in respect of the amplitude of the dee voltage,