551·578 11

Size distribution of Raindrops - Part I

V. N. KELKAR

Department of Physics, Nowrosjee Wadia College, Poona

(*Received 17 September 1958*)

ABSTRACT. Results of measurements of the size distribution of raindrops made at Poona during the months of August, September and October 1956, are reported in the form of a table showing the number of drops received at the ground level per m^2 per sec for various ranges of diameter at 0·25 mm interval, for different intensities of precipitation ranging from 0 to 40 mm hr^{-1}. Average values have been calculated and presented in the form of a similar table. Histograms showing the number, volume of liquid water, momentum and kinetic energy of raindrops per m^2 per sec, against the raindrop diameters are given for six typical intensities of precipitation. The variation of the total number N, momentum M and kinetic energy E (in joules) of raindrops per m^2 per sec with intensity of precipitation is shown graphically. By the method of least squares the following relations are obtained.

$N=710\, I^{0\cdot47}$, $M=165\, I$, and $E=2\cdot8\times10^{-3}\, I^{1\cdot18}$, where I is the intensity of precipitation in mm hr^{-1}. The results are presented in a form suitable for soil erosion problems. The data are confined to general rains.

1. Introduction

In a previous publication (Kelkar 1945) the author had reported some measurements of the size distribution of raindrops at Poona by the method of splashes for different kinds of showers such as drizzle, light shower, moderate shower, etc. The intensities of precipitation were not measured and the classification into different kinds of showers was more or less arbitrary. Fresh and more extensive measurements have now been made from records of dropsizes obtained during the months of August, September and October 1956, at Poona. The rates of precipitation have been measured by giving a timed exposure and a correlation of the dropsize distribution with rate of precipitation has become possible. In the present paper, only general rains have been considered. Thunderstorm rains will be treated separately.

The results can be presented in two ways, either as number of drops grouped according to diameter received on the ground per m^2 per sec or as the number of drops of different diameters per m^3 of air. The former method adopted in this paper is suitable for problems of soil erosion while the latter is suitable for correlation with radar observations and is of interest also as a matter of pure meteorology.

2. Measurement

The method used is substantially the same as reported earlier (Kelkar 1945). However, instead of coating smooth white paper with ink and drying, it was found to be easier to give a light coating of a soluble dye with a pad of cotton wool, following the usual practice in the filter paper method. Coloured circular spots are obtained on a practically white background.

The details of the calibration have been already described in the earlier paper (Kelkar 1945). The calibration curve was, however, then extrapolated towards smaller diameters. This was due to the difficulty of obtaining water drops of small diameters. No tip, however small, flat or tapering, would give drops less than about 2 mm in diameter. This difficulty has now been overcome by using a natural phenomenon in which such small drops are produced. It is well known that when a hanging drop breaks away from the tip of a tube, it is followed by a smaller droplet called the Plateau's spherule. The diameter of the Plateau's spherule has been found to depend upon three factors, *viz.*, (*a*) the time of formation of the main drop, (*b*) the external diameter of the tip and (*c*) the internal diameter of the tip. A narrow vertical rectangular portion of a sheet of ground glass was strongly and uniformly illuminated. In front of the ground glass sheet was mounted a rotating circular disc with four narrow slots in it. The glass tube was arranged to be in front of the rotating disc. Water was allowed to trickle slowly under a constant pressure head to ensure uniformity. A series of pictures at an interval of 1/50 sec of the falling droplet were taken by means of a Cossor oscillograph recording camera on a 35 mm film run at a speed of 5 inches per second. The narrow slots in the rotating disc served the double purpose of scanning the picture and providing intermittent views. Fig. 1 shows sample photographs of the falling Plateau's spherule together with the main drop. Even this small droplet is seen to oscillate in shape under the control of surface tension forces. However it was possible to pick out a phase in which the droplet was either spherical or very nearly so. In any case the mean of the vertical and horizontal diameters measured with a travelling microscope was taken to be the diameter of the droplet after multiplying by a suitable factor which depends upon the reduction produced by the camera. The droplet was photographed at a height of 189 cm from the floor. A series of splashes produced by the droplets were obtained on the coated paper placed nearly at the ground level, just before and just after the photographs were taken, to ensure uniformity of the droplet diameter. The splash of the Plateau's spherule was separated from that of the main drop either by using a gentle horizontal crosswind by means of a small electric fan or more simply by moving the paper horizontally. The height of fall of 189 cm was sufficient for the droplets to attain their terminal velocity before the splash was produced. The diameters of the splashes were measured with a travelling microscope and the mean values were calculated. Fig. 2 shows sample records of the splashes of Plateau's spherule together with those of the main drop for three different rates of trickle for the same tip. At larger rates of trickle two droplets were obtained. But the series of pictures obtained on the film shows that in this phase of two droplets, the reproducibility of the phenomenon is poor. The ratio of the diameters of the two droplets undergoes erratic fluctuations and sometimes only a larger single droplet is produced. For good reproducibility it was therefore necessary to use a slow rate of trickle. Droplets of various diameters were produced by using tubes of different external diameters. The smaller the diameter of the tube the smaller was the droplet at slow rates of trickle. It was possible to extend the calibration curve to 0·6 mm diameter beyond which it is extrapolated for still smaller diameters. Fig. 3 shows the calibration curve in which the ratio of splash diameter to drop diameter is plotted against the drop diameter. The ratio rather rapidly increases upto drops of 1·5 mm diameter and more slowly afterwards. Table 1 shows the values of the splash diameter and the corresponding drop diameter based on the calibration curve. It was found that the extrapolation of the former calibration curve is justified as the new data fit the original curve.

Sheets of paper 21 cm × 33 cm were used. A suitable exposure was given by uncovering and covering the paper. The exposure was measured with a stop watch reading to 1/10 of a second. A series of papers were exposed to rain at as rapid an interval as it was possible to do with the help of an assistant, as the exposed papers had to be removed and put away for drying and a fresh paper brought for exposure. The data are therefore, also useful for studying the dropsize variation with time. Eight rain periods have been recorded, 3 in August, 3 in September and 2 in October. In all 104 papers were exposed and the total number of drops actually measured is 49,208. The diameters of raindrops have been determined within an interval of 0·25 mm. The number of drops within each diameter group received on the ground per m^2 per second have been calculated by taking into account the area of the paper and the time of exposure. The rate of precipitation has been determined from the volume of liquid water received, the area of the paper and the time of exposure. As the time of exposure varied from 1 sec to about a minute,

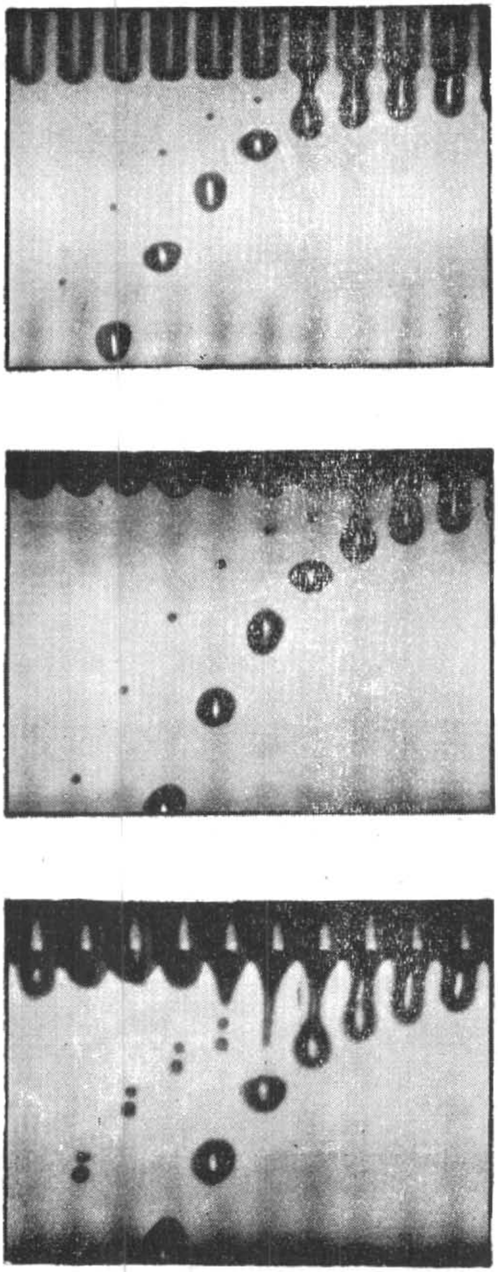


Fig. 1. Photographs of falling Plateau's spherules

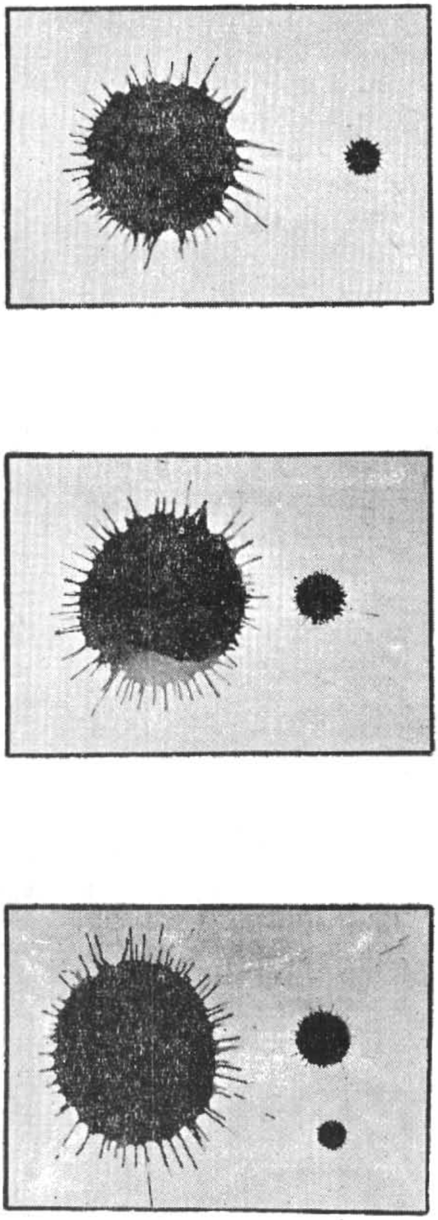


Fig. 2. Splashes of Plateau's spherules

TABLE 1

Splash diameter (mm)	Raindrop diameter (mm)	Splash diameter (mm)	Raindrop diameter (mm)
0·3	0·25	18·8	3·25
1·2	0·50	20·5	3·50
2·5	0·75	22·0	3·75
4·5	1·00	23·7	4·00
6·3	1·25	25·5	4·25
7·9	1·50	27·5	4·50
9·5	1·75	29·5	4·75
11·0	2·00	31·5	5·00
12·6	2·25	33·6	5·25
14·0	2·50	36·0	5·50
15·7	2·75	38·5	5·75
17·2	3·00	41·0	6·00

TABLE 3

Rate of precipitation (mm hr^{-1})	Most probable drop diameter (mm)
0·00 — 0·20	0·25 — 0·50
0·20 — 0·80	0·50 — 0·75
0·80 — 4·0	0·75 — 1·00
4·0 — 9·0	1·00 — 1·25
9·0 — 40·0	1·25 — 1·50

TABLE 2

Average intensity of precipitation (mm hr^{-1})	0·00 to 0·25	0·25 to 0·50	0·50 to 0·75	0·75 to 1·00	1·00 to 1·25	1·25 to 1·50	1·50 to 1·75	1·75 to 2·00	2·00 to 2·25	2·25 to 2·50	2·50 to 2·75	2·75 to 3·00	3·00 to 3·25	3·25 to 3·50	3·50 to 3·75	3·75 to 4·00	Average No. of raindrops per m^2 per sec
0·20	40	**188**	62	28	12	7·6	0·2	..	..	..	..	..	..	..	..	..	338
0·33	11	101	**209**	66	18	7·1	1·1	1·2	1·3	..	..	..	..	..	..	..	416
0·46	..	74	**275**	118	15	7·1	4·5	1·9	1·3	..	..	..	..	..	..	..	496
0·57	17	103	**202**	142	35	14	6·8	1·9	0·7	..	..	..	..	..	..	..	522
0·64	22	121	**305**	162	36	10	3·4	3·1	1·3	..	..	..	..	..	..	..	664
0·76	33	83	**245**	118	35	15	10	7·4	3·3	0·7	0·4	..	..	..	..	..	551
0·87	20	62	220	**242**	57	20	8·5	3·8	0·5	0·3	0·3	..	..	..	..	..	634
1·1	8·5	77	204	**208**	74	31	14	7·6	1·3	0·7	0·3	..	..	..	..	..	626
1·5	..	69	310	**316**	122	35	13	11	5·9	0·7	..	..	..	..	..	..	883
1·9	..	89	**336**	263	135	71	21	9·3	5·9	5	3	..	..	..	..	..	938
2·3	..	81	271	**625**	345	150	31	12	2·6	0·6	..	..	..	..	..	..	1518
3·5	..	75	209	320	**436**	212	53	13	3·3	1·4	..	..	..	..	..	..	1323
4·1	..	44	177	**582**	383	192	50	42	9·3	1·4	..	..	..	..	..	..	1471
4·6	9·5	90	320	372	**440**	364	48	17	1·3	0·7	..	..	..	..	..	..	1662
5·4	..	23	235	294	**380**	298	124	87	34	2·8	0·6	..	..	..	..	..	1478
6·2	..	99	348	430	**472**	364	170	50	6·6	3·5	0·7	..	1·6	..	..	..	1945
8·6	..	..	92	162	**540**	495	265	118	11	6·3	..	0·7	..	..	..	..	1690
9·9	2·5	90	300	286	330	**405**	295	130	46	32	7·4	2·3	..	..	0·8	0·9	1928
13	..	27	256	256	370	**608**	390	167	80	41	7·4	..	0·8	..	..	..	2193
18	..	48	231	190	382	**650**	395	321	112	50	33	13	0·8	7·4	..	..	2433
34	296	842	**960**	410	460	**790**	665	620	336	161	74	11	3·2	..	..	..	5628

the values of the intensities of precipitation are more accurate for smaller intensities than for larger ones.

3. Results

The intensities of precipitation in mm hr^{-1} have been arranged in order of increasing magnitude and the corresponding dropsize distribution is given in Appendix I. The total number of drops of all sizes per m^2 per sec have also been calculated. These together with the number of drops actually measured are given in two separate columns. The most probable drop diameter which corresponds to the maximum or the mode of the frequency curve is seen gradually to shift from small value to larger values as the intensity of precipitation increases. The individual records show statistical fluctuation of about 0·25 mm up or down in the position of the maximum. As the intensity increases, there are very frequently more than one maximum.

To smoothen out the variation of individual records the observations have been grouped into sets of five (except the last four observations grouped together) and average values of the intensity of precipitation and the number of drops of different diameter groups have been calculated and are shown in Table 2. The positions of the maxima (given in bold types) clearly show a gradual shifting towards larger diameters. Upto intensity of precipitation of 13 mm hr^{-1} the frequency curve has only one maximum and for larger intensities there are two maxima, *i.e.*, the distribution becomes bimodal. One of the two maxima lies in the region of smaller diameter (0·50–0·75 mm) showing the presence of a considerable number of smaller drops along with the larger ones. Table 3 shows approximate ranges of the rate of precipitation and the corresponding most probable drop diameter, *i.e.*, the mode of the frequency curve.

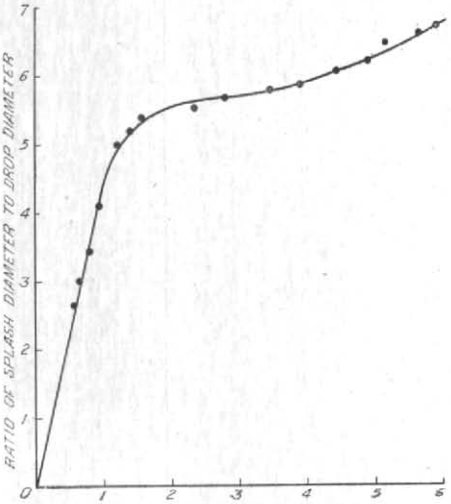


Fig. 3. Calibration curve

Apart from the frequency of drops, the volume of liquid water, momentum and kinetic energy of drops of different diameters are also of importance for soil erosion problems. Calculations of these quantities have been made and for six typical intensities of precipitation, *viz.*, 0·20, 0·57, 1·5, 5·4, 13 and 34 mm hr^{-1} the results are plotted semi-logarithmically in Fig. 4 in the form of histograms. The position of the maximum of the frequency curve or the mode may be taken as a criterion to distinguish between different types of dropsize distributions. The first five of the above mentioned intensities of precipitation have their maxima in different diameter groups. The last has been chosen for its high rate of precipitation and its bimodal distribution curve. The histograms for the volume of liquid water, momentum and kinetic energy for a particular intensity of precipitation are very similar in general character. The position of the maximum has in all cases shifted towards a larger diameter group.

The variation of the total number, momentum and kinetic energy of raindrops per m^2 per sec with intensity of precipitation is also of interest. Fig. 5 is a semilogarithmic plot of the total number of raindrops N against the intensity of precipitation I (in mm hr^{-1}). Inspite of the large scatter of points the total number of drops on the whole increases with intensity of precipitation. On account of the logarithmic plotting

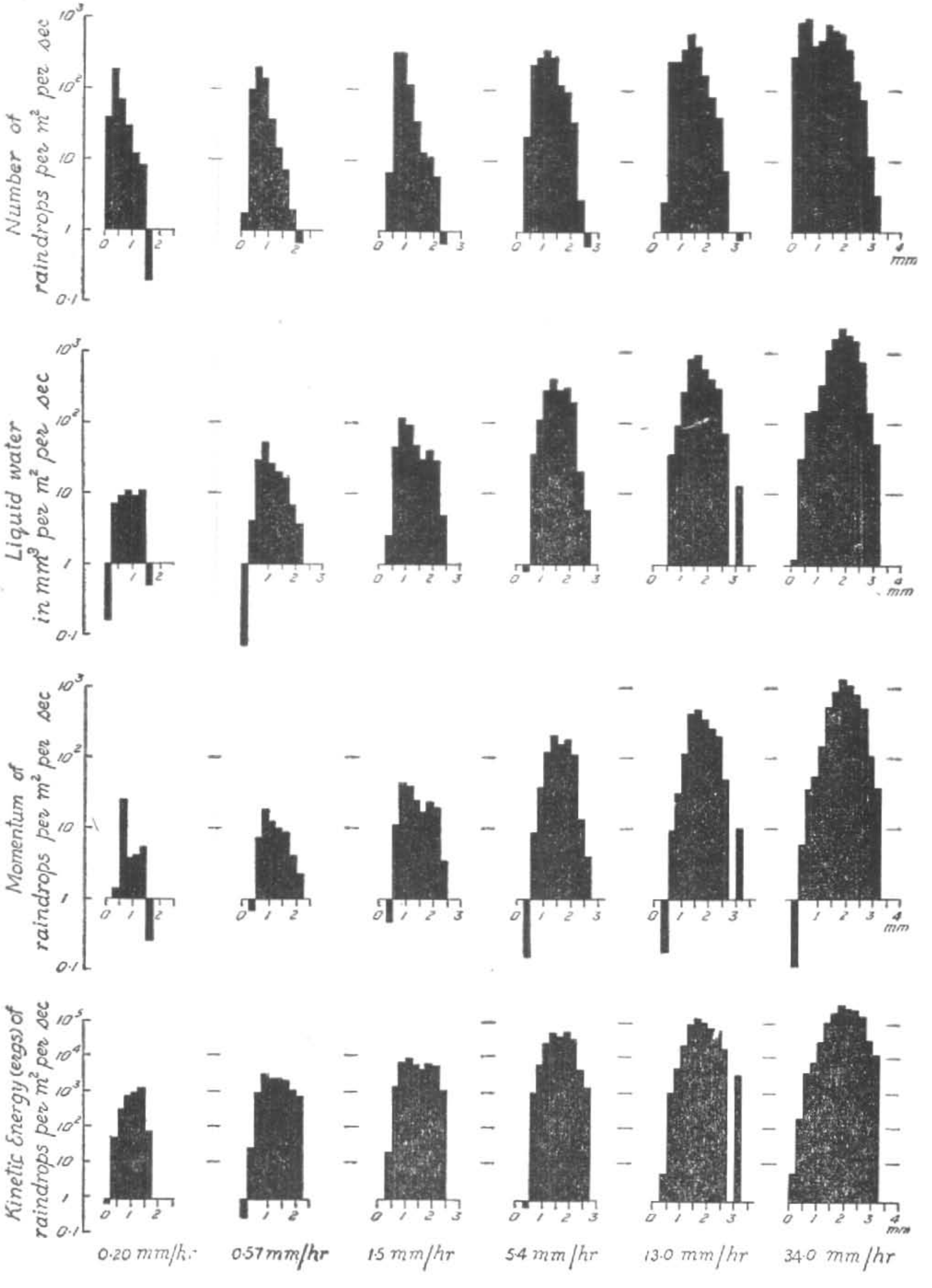


Fig. 4. Distribution of the number, liquid water, momentum and kinetic energy of raindrops, in different diameter groups, for six different intensities of precipitation

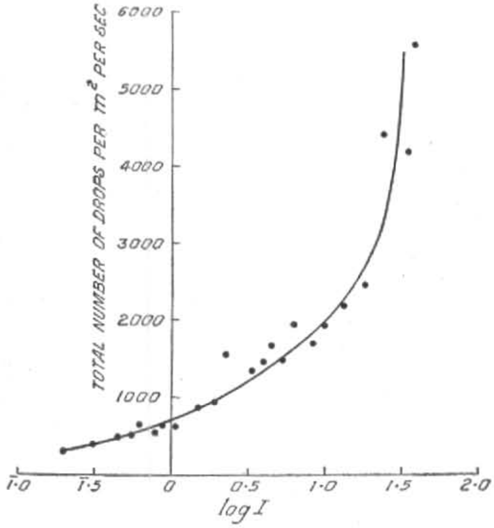


Fig. 5. Variation of the total number of raindrops per m² per sec with intensity of precipitation

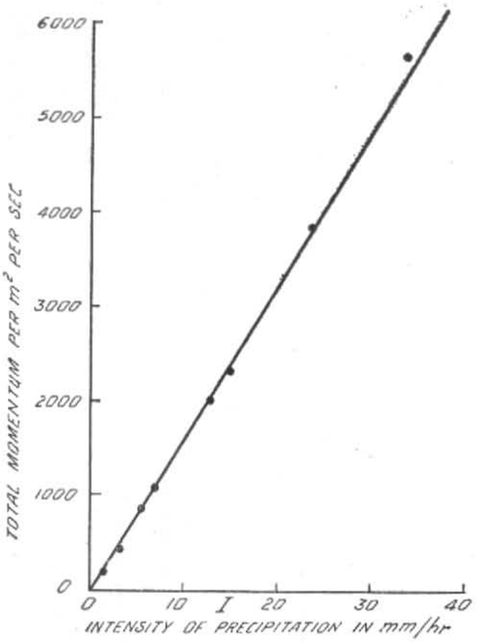


Fig. 6. Variation of the total momentum of raindrops per m² per sec with intensity of precipitation

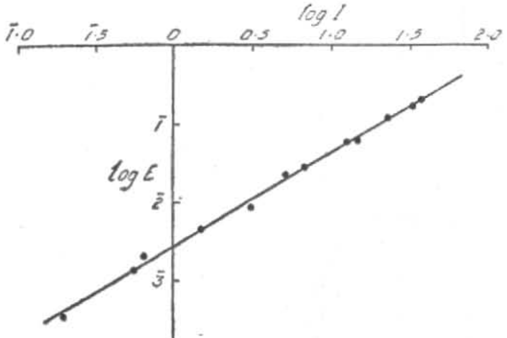
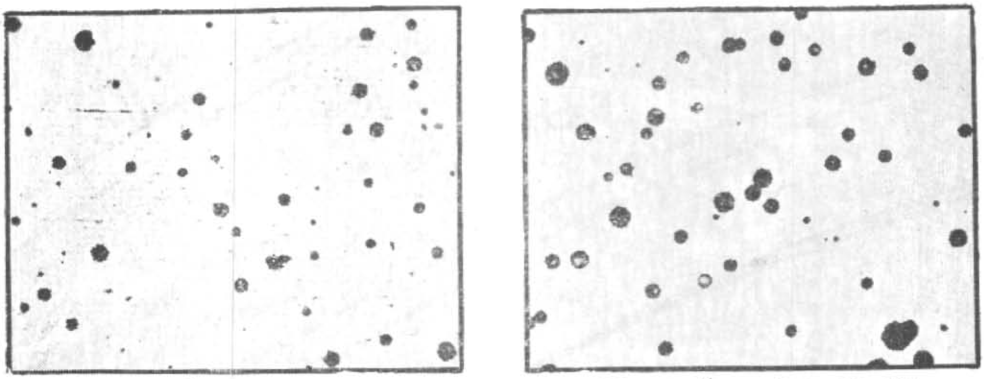
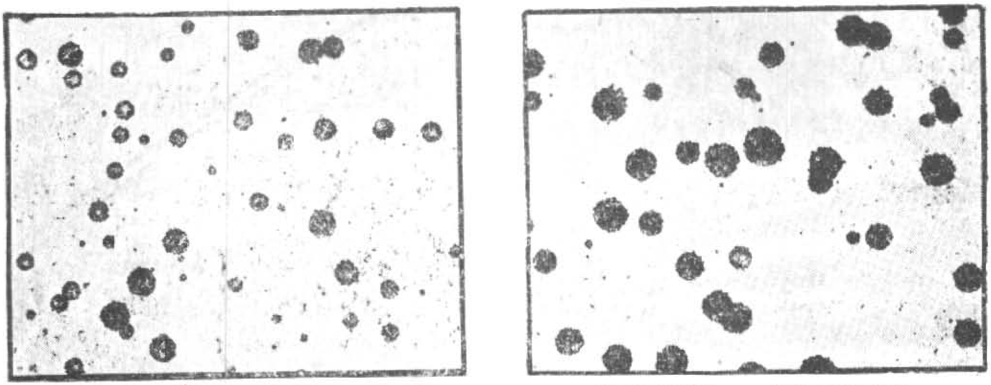


Fig. 7. Variation of the total kinetic energy of raindrops per m² per sec with intensity of precipitation



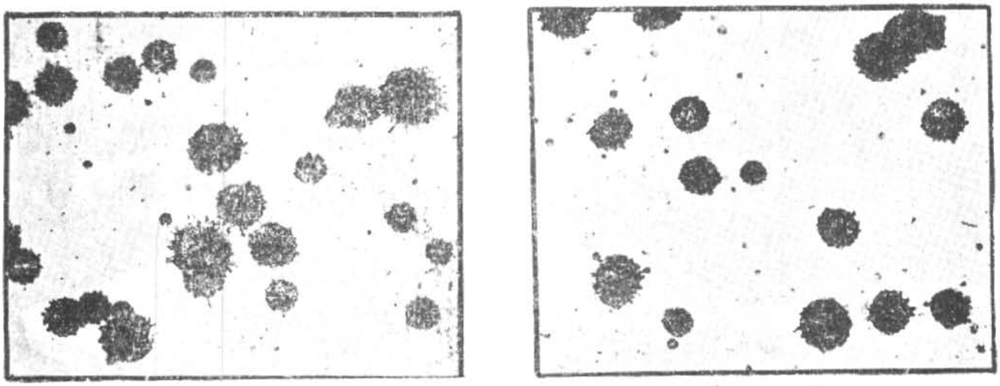
0·53 mm/hr; exp=14·7 sec

3·3 mm/hr; exp=5·2 sec



7·8 mm/hr; exp=3·6 sec

14 mm/hr; exp=1·9 sec



25 mm/hr; exp=1·5 sec

35 mm/hr; exp=1·0 sec

Fig. 8. Sample records of raindrop splashes for different intensities of precipitation

of the intensities, the rate of increase of the number of drops towards higher intensities has been exaggerated. By the method of least squares the relation between these quantities is found to be

$$N=710\ I^{0.47}$$

Fig. 6 (p. 131) shows that the momentum-intensity plot is linear. If M represents the momentum (in c.g.s. units) of raindrops per m^2 per sec the relation

$$M=165\ I$$

is obtained. Fig. 7 (p. 131) shows that the logarithmic plot of kinetic energy E in joules against intensity of precipitation I is linear. The method of least squares gives the relation

$$E=2\cdot8\times10^{-3}\ I^{1.18}$$

Fig. 8 shows sample records of splashes of raindrops for six different intensities of precipitation. The time of exposure is also given for each record. These photographs were obtained by contact printing through the paper record and a paper negative was made. By again printing through the paper negative, positive prints were obtained without using any camera and film/plate. In some photographs the texture of the original paper is seen. The magnification is obviously unity.

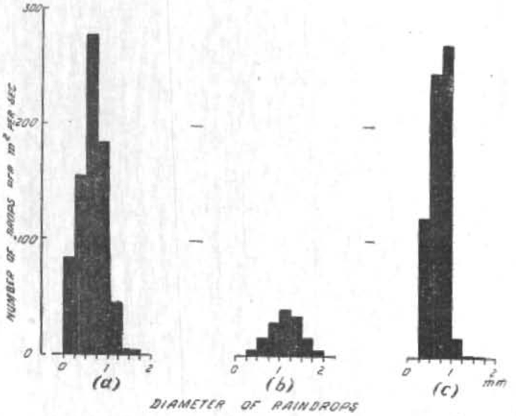


Fig. 9. Different dropsize distributions for identical intensity of precipitation

Though the average dropsize distribution for a particular intensity of precipitation has a definite significance there are occasional wide fluctuations from the average. Fig. 9 shows three dropsize distributions for identical intensity of precipitation of 0·6 mm hr^{-1}. Fig. 9(a) has its mode in the region 0·50 to 0·75 mm and represents the normal distribution curve. Fig. 9(b) shows that the mode has shifted to 1·00—1·25 mm. The total number of drops is very small. But a small number of large drops produce the same intensity of precipitation as a large number of small drops. Fig. 9(c) is an intermediate case where the mode is in the region 0·75—1·00 mm.

4. Acknowledgement

The author is thankful to Shri H. V. Modak of the Physics Department for lending his oscillograph recording camera, purchased out of a State Government grant, his initial help in setting up the photographic technique and the benefit of discussion from time to time.

REFERENCES

Best, A. C. 1950 *Quart. J.R. met. Soc.*, **76**, p. 16.
Defant, A. 1905 *Wien. S.B., Math. Naturwiss Kl. Wien*, 114, p. 585.
Kelkar, V. N. 1945 *Proc. Indian Acad. Sci.*, **22**, p. 394.

APPENDIX I

Date	Intensity of precipitation (mm/hr)	0·00 to 0·25	0·25 to 0·50	0·50 to 0·75	0·75 to 1·00	1·00 to 1·25	1·25 to 1·50	1·50 to 1·75	1·75 to 2·00	2·00 to 2·25	2·25 to 2·50	2·50 to 2·75	No. of drops per m³ per sec	Total No. of drops actually measured
8-10-56	0·10	56	**328**	93	—	—	—	—	—	—	—	—	477	731
19-9-56	0·11	5	22	**68**	29	4	0·6	—	—	—	—	—	128	455
8-10-56	0·24	**79**	62	30	5	9	7	0·7	—	—	—	—	201	310
19-9-56	0·25	—	10	**47**	46	18	21	0·8	—	—	—	—	143	377
,,	0·28	60	**430**	64	57	28	7·5	—	—	—	—	—	646	1112
17-9-56	0·28	—	63	**287**	95	—	—	—	—	—	—	—	445	445
,,	0·28	—	123	**300**	83	0·9	—	—	—	—	—	—	07	574
23-9-56	0·34	—	48	**77**	67	28	15	7	—	—	—	—	242	386
19-9-56	0·37	54	**119**	42	15	24	20	10	5	0·5	—	—	288	589
,,	0·39	—	147	**345**	74	36	—	—	—	—	—	—	602	636
17-9-56	0·42	—	186	**525**	69	9	1·5	—	—	—	—	—	791	527
19-9-56	0·46	—	20	33	**35**	29	29	15	3·4	0·5	—	—	162	292
23-9-56	0·47	—	69	**120**	112	26	5	8	7	—	—	—	347	485
8-10-56	0·47	—	31	**260**	216	6	—	—	—	—	—	—	513	649
,,	0·49	—	59	**433**	146	7	—	—	—	—	—	—	644	773
19-9-56	0·53	—	186	**422**	172	14	3	—	—	—	—	—	797	811
23-9-56	0·55	—	57	54	55	**60**	27	11	3	1·5	—	—	268	353
19-9-56	0·59	84	153	**276**	182	44	4·3	4·3	—	—	—	—	747	704
,,	0·59	—	4	15	29	**41**	36	18	5	2	—	—	150	214
6-10-56	0·59	—	121	245	**271**	17	1·6	1·6	—	—	—	—	657	434
19-9-56	0·61	75	115	**304**	139	52	21	—	—	—	—	—	706	706
8-10-56	0·61	—	72	**423**	192	32	—	—	—	—	—	—	719	798
19-9-56	0·63	—	258	**366**	260	22	—	—	—	—	—	—	906	717
,,	0·67	34	134	**400**	194	56	7	—	—	—	—	—	775	628
,,	0·69	83	138	**340**	48	8	2·3	2·3	6	10	1·5	2·3	641	832
,,	0·69	—	25	**29**	29	19	**24**	16	16	6·3	—	—	166	229
,,	0·71	49	109	**146**	12	1·5	7	23	**24**	5·3	—	—	376	496
,,	0·73	12	113	**431**	207	46	18	—	—	—	—	—	827	613
23-9-56	0·82	—	26	**126**	71	29	**40**	21	7	2·6	2·6	—	325	370
30-10-56	0·83	—	184	212	**257**	77	18	5	0·8	—	—	—	754	901
8-10-56	0·84	—	56	203	**459**	17	—	—	—	—	—	—	735	707
23-9-56	0·85	—	31	**130**	81	57	40	9·3	11	2·3	1·2	1·2	363	313
19-9-56	0·86	36	97	**361**	276	61	7·2	11	—	—	—	—	849	473
23-9-56	0·90	—	28	**186**	122	53	32	20	6·8	—	—	—	448	398
19-9-56	0·90	63	94	213	**274**	106	19	1	—	—	—	—	770	686
,,	0·94	36	89	**315**	250	69	30	5·6	4·2	—	—	—	798	565

APPENDIX I (*contd*)

Date	Intensity of precipitation (mm/hr)	0·00 to 0·25	0·25 to 0·50	0·50 to 0·75	0·75 to 1·00	1·00 to 1·25	1·25 to 1·50	1·50 to 1·75	1·75 to 2·00	2·00 to 2·25	2·25 to 2·50	2·50 to 2·75	2·75 to 3·00	No. of drops per m² per sec	Total No. of drops actually measured
17-9-56	1·04	—	168	222	**445**	118	—	—	—	—	—	—	—	953	487
23-9-56	1·07	—	43	**114**	85	65	40	23	20	3·2	1·1	—	—	394	363
8-10-56	1·07	7	53	**294**	204	87	46	9	2	—	—	—	—	700	385
23-9 56	1·08	—	31	**72**	58	40	42	30	12	4·9	3·7	—	1·2	294	238
,,	1·21	—	10	96	**122**	96	28	16	19	10	1·5	—	—	391	271
19-9-56	1·25	—	58	**293**	192	139	86	4·8	—	—	—	—	—	692	326
17-9-56	1·53	—	75	436	**624**	170	2·2	—	—	—	—	—	—	1307	597
30-8-56	1·55	—	12	121	**490**	38	12	**33**	27	3·3	—	—	—	735	444
23-9-56	1·69	—	189	**610**	165	161	46	8·4	6·3	**15**	2·1	—	—	1203	573
,,	1·76	—	298	**323**	178	121	48	2·3	9·2	9·2	**12**	4·6	—	1005	439
,,	1·79	—	—	79	**118**	69	**76**	26	7	8·8	**11**	8·8	—	403	229
,,	1·87	—	37	**275**	124	119	95	34	20	6·8	1·7	1·7	—	715	421
8-10-56	2·13	—	42	**762**	687	195	12	6	—	—	—	—	—	1704	568
23-9-56	2·13	—	67	**232**	212	178	129	39	10	5·2	2·6	—	—	875	339
6-10-56	2·40	—	162	**390**	352	274	155	14	7·2	—	—	—	—	1355	376
30-8-56	2·83	—	14	120	**753**	502	100	20	2·9	—	—	—	—	1512	527
17-9-56	3·06	—	80	**590**	385	380	226	12	—	—	—	—	—	1673	451
30-8-56	3·12	—	—	106	**622**	371	120	41	23	—	—	—	—	1284	436
,,	3·16	—	150	150	**1000**	194	12	**68**	24	12	2·9	—	—	1612	548
,,	3·30	—	175	186	**670**	465	183	11	2·8	—	—	—	—	1693	607
,,	3·34	—	—	82	**424**	406	130	77	20	4·7	—	—	—	1143	492
8-10-56	3·52	—	110	**478**	137	**309**	239	51	23	4	—	—	—	1341	335
30-8-56	3·66	—	3·1	45	159	**520**	260	77	3·1	3·1	—	—	—	1067	348
3-8-56	3·85	—	77	252	225	**490**	261	46	13	3·1	6·1	—	—	1374	447
,,	3·92	—	65	350	368	**495**	188	34	24	17	3·4	—	—	1545	450
30-8-56	3·96	—	14	74	**895**	518	210	28	8·5	—	—	—	—	1748	613
,,	3·97	—	—	83	**460**	178	83	46	**138**	15	—	—	—	1003	327
8-10-56	4·25	—	87	**212**	208	169	**383**	133	4	4	—	—	—	1200	285
30-8-56	4·29	—	52	168	**990**	554	84	30	**37**	10	3·4	—	—	1929	527
,,	4·32	—	13	56	200	305	**340**	45	5·4	—	—	—	—	964	534
,,	4·51	—	6	260	**508**	495	422	32	—	—	—	—	—	1729	553
3-8-56	4·53	—	15	188	423	**646**	340	**37**	11	—	—	—	—	1660	448
8-10-56	4·56	48	408	**946**	404	190	**361**	57	24	5	—	—	—	2443	514
3-8-56	5·09	—	6·4	166	330	**564**	358	74	45	—	3·2	—	—	1546	483
30-8-56	5·23	—	48	226	552	**650**	332	188	63	4·8	—	—	—	2063	428
3-8-56	5·25	—	—	210	**280**	245	222	132	121	16	3·9	—	—	1230	316

APPENDIX I (*contd*)

Date	Intensity of precipitation (mm/hr)	0·00 to 0·25	0·25 to 0·50	0·50 to 0·75	0·75 to 1·00	1·00 to 1·25	1·25 to 1·50	1·50 to 1·75	1·75 to 2·00	2·00 to 2·25	2·25 to 2·50	2·50 to 2·75	2·75 to 3·00	3·00 to 3·25	3·25 to 3·50	3·50 to 3·75	3.75 to 4·00	No. of drops per m² per sec	Total No. of drops actually measured
3-8-56	5·33	—	50	325	135	490	212	93	89	38	—	—	—	—	—	—	—	1433	339
30-8-56	5·58	—	—	234	355	406	512	90	20	3·9	—	—	—	—	—	—	—	1620	415
3-8-56	5·63	—	16	198	154	109	205	131	150	38	9·6	3·2	—	—	—	—	—	1014	317
8-10-56	5·79	—	298	991	1086	287	224	160	11	—	—	—	—	—	—	—	—	2587	574
3-8-56	5·95	—	47	182	326	565	368	123	60	4·2	8·5	—	—	—	—	—	—	1683	397
,,	5·95	—	—	202	265	258	192	168	103	21	10	3·4	—	6·9	—	—	—	1229	358
,,	6·12	—	144	342	216	606	490	106	48	4·8	—	—	—	—	—	—	—	1957	407
30-8-56	7·32	—	3·9	24	254	655	545	285	16	3·9	—	—	—	—	—	—	—	1986	456
,,	7·75	—	—	47	132	294	561	357	110	9·5	—	—	—	—	—	—	—	1512	355
,,	7·82	—	—	32	126	330	284	347	126	27	9	—	4·5	—	—	—	—	1285	285
,,	7·83	—	—	48	248	932	612	192	8	—	—	—	—	—	—	—	—	2040	510
,,	8·00	—	—	39	71	184	229	251	286	14	14	—	—	—	—	—	—	1087	308
3-8-56	8·99	—	—	288	240	850	785	173	63	—	4·8	—	—	—	—	—	—	2403	500
,,	9·38	—	—	204	250	566	552	250	144	33	4·7	—	—	—	—	—	—	2003	432
30-8-56	9·38	—	29	192	658	512	312	265	173	53	4·8	—	—	—	—	—	—	2198	458
2-8-56	9·55	—	104	213	126	87	183	188	152	35	74	31	4·4	—	—	4·4	4·4	1206	277
8-10-56	9·57	13	317	596	177	120	447	603	70	13	—	—	—	—	—	—	—	2356	372
3-8-56	10·8	—	—	283	232	375	530	164	103	98	72	5·2	5·2	—	—	—	—	1867	363
30-8-56	11·0	—	—	125	322	437	467	385	222	9·6	34	—	—	—	—	—	—	2001	416
2-8-56	11·3	—	22	222	188	453	802	360	83	67	17	—	—	—	—	—	—	2213	400
2-8-56	12·9	—	30	208	244	528	1080	372	124	40	5	5	—	—	—	—	—	2626	531
8-10-56	14·3	—	56	518	378	259	497	651	217	63	—	—	—	—	—	—	—	2739	377
2-8-56	15·6	—	25	209	144	169	184	184	204	208	149	35	—	5	—	—	—	1516	305
,,	16·0	—	79	260	287	583	892	552	194	86	22	7·2	—	—	—	—	—	2962	412
,,	16·0	—	101	354	274	490	1140	483	282	50	—	—	—	—	—	—	—	3174	441
30-8-56	17·5	—	44	193	88	150	225	274	375	256	88	44	6·3	—	—	—	—	1742	279
,,	18·6	—	—	68	142	562	765	463	600	99	—	—	—	—	—	—	—	2699	355
,,	20·1	—	17	277	166	136	222	212	141	83	139	111	61	5·5	33	—	—	1603	302
2-8-56	25·5	—	202	578	337	596	932	617	432	202	87	48	9·7	—	—	—	—	4040	420
8-10-56	35·1	1183	2184	1918	413	319	573	679	999	386	120	13	—	—	—	—	—	8787	660
2-8-56	35·5	—	144	453	319	382	800	782	577	330	247	82	21	—	—	—	—	4137	402
8-10-56	40·8	—	852	825	573	546	865	573	479	439	200	160	13	13	—	—	—	5538	416
																Total			49,208