and more than 100 times as many as did the North (21 States). None were recorded from the Rocky Mountain States and only one from the Pacific States during these 10 years.[2]

Several factors contribute to the greater frequency of torrential rains in the Southern States. The most important probably is the fact that tropical cyclones are relatively much more frequent there. A large proportion of the rains here studied occurred in tropical cyclones, although only a few in storms of hurricane intensity. An analysis of the maps showing the paths of LOWS published in the MONTHLY WEATHER REVIEW for the decade 1919–28 showed an annual average of 21 tropical disturbances entering the South or passing northward near the Atlantic coast.[3] This average was approximately the same as that for 1892–1912. Tropical cyclones usually lose intensity soon after crossing the coast; and the sharp decline in the number of excessive rains within about 100 miles from the Gulf and Atlantic coast is presumably largely due to this influence.[4]

Another reason for the greater frequency of torrential rainfalls in the South than in the North is the greater number of thunderstorms there. The South has an average of about twice as many thunderstorms as the North; and part of it has more than three times as many as a large part of the North.[5] Although thunderstorms characteristically yield heavy downpours, seldom in the North do they bring to any locality more than 4 to 6 inches in 24 hours; but in the South they frequently yield much heavier rainfalls.

The considerable number of tropical cyclonic disturbances in the South, in addition to the warm-front and cold-front thunderstorms, also makes it more likely that a given locality in the South will have two severe thunderstorms within a 24-hour period than is true for the North. A number of the heaviest rainfall records in the South, and a few of those in the North, resulted from two severe thunderstorms in one day.

Topographic conditions also help to explain the distribution of exceptionally heavy rains. The southern Appalachian mountains comprise a region of heavy rainfall (the greatest in eastern United States) partly because it has orographic as well as other types of rainfall. Several of the rains here discussed occurred in that region.

Orographic rains are also important in the San Gabriel range and other mountains near Los Angeles, where a number of exceptionally heavy rains have occurred, for example those of December 30–31, 1933, and March 2, 1938. Orographic influences are likewise sometimes significant elsewhere in California, and in western Oregon and Washington.

A topographic feature of importance in Texas is the Balcones Escarpment of the plateau region of Texas, especially of the Edwards Plateau. It is just west of several stations which have had exceptionally heavy rains, for example, Taylor, Austin, Smithville, and Montell, each of which has had rains in excess of 19 inches in 24 hours. These rains, however, were not orographic rains, as they occured below, not on or above the slope.[6] This escarpment seems sometimes to interfere with the northward migration of tropical disturbances, thus concentrating their rainfall.

Topographic influences are also sometimes evident near the Ozarks and neighboring elevations, as a number of exceptionally hard rains have occurred on their southern margin. In the Ozarks themselves, and in the adjacent area to the north, there have been relatively few records of 10-inch rains. Similarly, the region to the northwest of the Southern Appalachians, that is eastern Tennessee and Kentucky and northwestern Alabama, has had fewer such recorded rains than the zone nearer the Mississippi River. These areas of fewer hard rains may comprise a sort of "rain-shadow."

Finally, the large areas which lack any records of rainfall in excess of 10 inches in 24 hours merit a few words. In the Great Plains and Rocky Mountain States, the air generally is not humid enough to yield such large rainfalls, partly because of remoteness from effective sources of moisture. Of importance in the Great Plains also is the relatively rapid eastward movement of the rain-producing storms. In the Rocky Mountains, of possible significance is the fact that the records are nearly all from the valleys, not from well up on the mountain sides where the heaviest rains occur.

[2] Southern California had a rainstorm on March 2, 1938 of these proportions, which is described by Daingerfield, L. H., in the MO. WEA. REV., 66:139–143. However, 1938 is not one of the 10 years especially studied.

[3] Visher, S. S.: Frequencies of Tropical Cyclones especially those of minor importance. MO. WEA. REV. 58: 62–64, 1930.

[4] Idem. Effects of Tropical Cyclones on the Weather of Midlatitudes. Geographical Rev. 15: 106–114, 1925. Also, Tropical Cyclones of the Pacific, Bishop. Museum Bull. No. 20, 165 pp., Honolulu, 1925.

[5] Alexander, W. H.: The Distribution of Thunderstorms in the United States, 1904–33. MO. WEA. REV. 63: 157–158, 1935.

[6] The Taylor, TEX., rain was the subject of an article in the MO. WEA. REV. 49: 496–497, 1921, by J. R. McAuliffe, who reported that the 23.1 inches received at Taylor fell in about 15 hours, (10.3 in 3 hours), and that the rainfall a short distance from Taylor was greater, possibly 30 inches. (Numerous tropical weather stations have recorded more than 30 inches in 24 hours; Baguio, Luzon, as much as 46 inches.)

## THE RECORD RAINFALLS OF THE WORLD

The following chart, which is self-explanatory, has been compiled in the Hydrometeorological Section of the U. S. Weather Bureau. The authorities for the data are as follows, where (1) denotes John R. Theaman, *Excessive Rainfall Records*, 1929; and (2) refers to the MONTHLY WEATHER REVIEW, May 1919.

| | | |
|---|---|---|
| Opid's Camp, Calif | Apr. 5, 1926 | (1). |
| Porto Bello, R. P.* | Nov. 29, 1911 | (2). |
| Galveston, Tex | June 4, 1871 | (2). |
| Curtea-de-Arges, Romania. | July 7, 1889 | (2). |
| Guinea, Va | Aug. 24, 1906 | (2). |
| Catskill, N. Y | July 26, 1819 | *American Journal of Science and Arts*, vol. IV, 1822, pp. 124–142. |
| Campo, Calif | Aug. 12, 1891 | (2). |
| Concord, Pa | Aug. 5, 1843 | *Proceedings of the Delaware County Institute of Science*, October 1910. |
| Bassetere, St. Kitts, West Indies. | Jan. 12, 1880 | (2). |
| Cherrapunji, India | June 14, 1876 | (1). |
| Baguio, P. I | June 14–15, 1911 | (1). |
| Cherrapunji, India | June 14–15, 1876 | (2). |
| Funkiko, Formosa | July 18–20, 1913 | (1). |
| Cherrapunji, India | June 12–15, 1876 | (1). |
| Do | Aug. 1841 | (1). |
| Silver Hill Plantation, Jamaica. | Nov. 4–11, 1909 | (1). |
| Cherrapunji, India | Aug. 1841 | (1). |
| Do | July 1861 | (1). |
| Do | 1861 | (1). |

*See also MO. WEA. REV., May 1920, vol. 48, pp. 274–276, Benjamin C. Kadel, "The most intense rainfall on record."

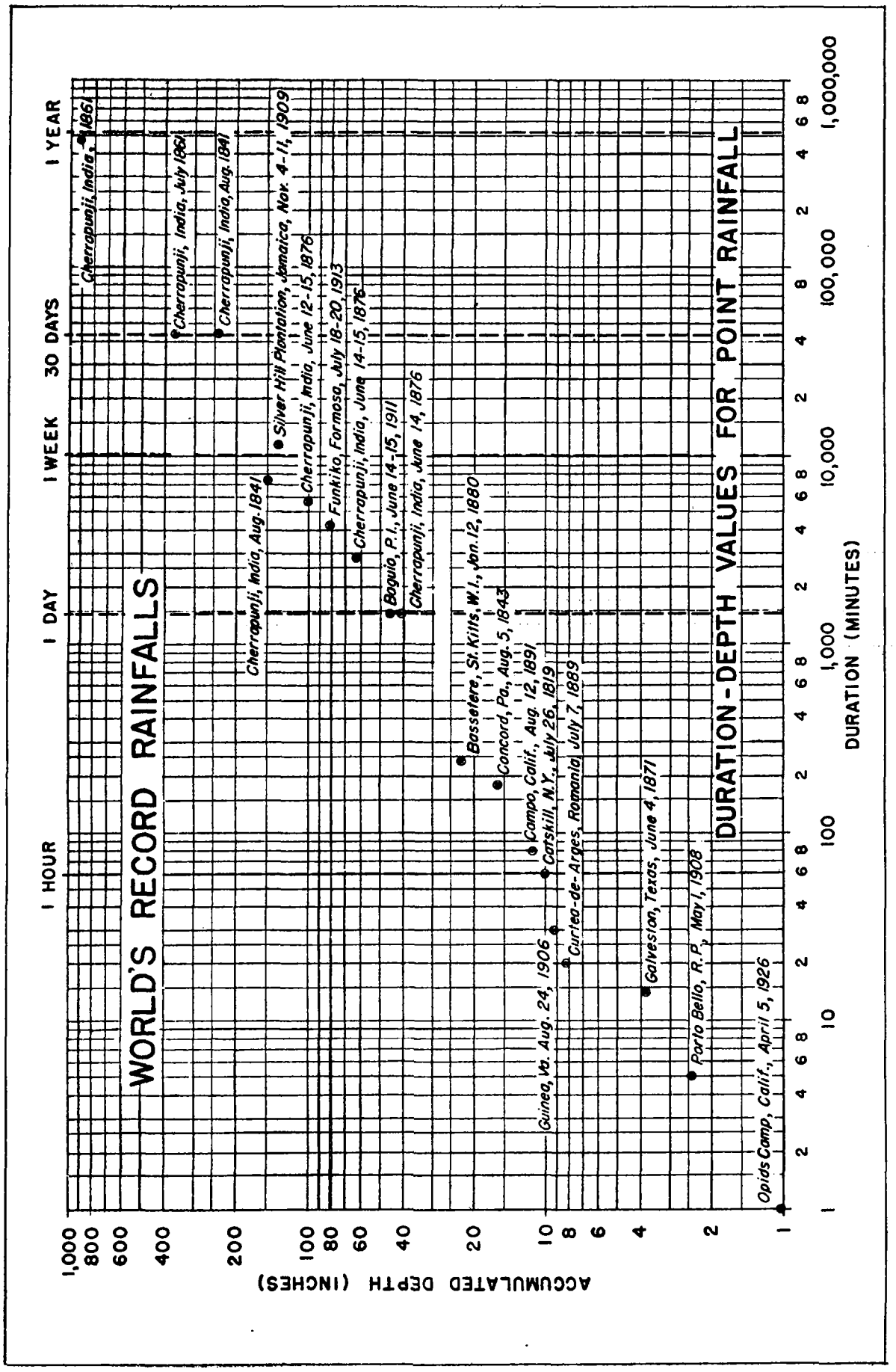


FIGURE 1.—Distribution of 293 torrential 24-hour rains at Weather Bureau stations, from records within the interval 1880-1940, mostly 1920-39.