influence of light upon a given species can not be predicted, and since every plant is "attuned" to a certain range of light intensity, it is evident that the optimum light conditions must be experimentally determined for each species. As soon as this is ascertained, it will then be a very easy matter in view of the comprehensive data constantly accumulating through the observations of the Weather Bureau, to choose a locality, which is known to furnish optimum light conditions. For many years the Weather Bureau has made extensive observations in various regions, not only as to sunshine and cloudiness, but also more recently, as to the thermal effect of solar radiation. The development of research along the lines indicated will make even more apparent the now well recognized public utility of the important facts continually multiplying through the work of the Weather Bureau.

CLIMATOLOGY OF COSTA RICA.

Communicated by H. PITTIER, Director, Physical Geographic Institute.

[For tables see the last page of this REVIEW preceding the charts.]

Notes on the weather.—All over the country, except on the Atlantic coast belt, the weather was unusully dry and close. On the Pacific slope there was a general withering of the vegetation, and owing to the drought and the almost constant wind, the fires, made to burn the fallen trees and trash on newly cleared lands, in many instances spread out, causing serious damage to field and forest. In San José, rain fell on the 23d, 24th, 25th, and 26th, but was scarcely enough to wash away the dust. Pressure and temperature about normal; relative humidity, 66 per cent against 74; sunshine, 255 hours against 205. On the lower hills on the Atlantic watershed, in the San Carlos Valley especially, the scarcity of rain was such that the foliage of the tender plants, growing under the forest shade, was crisp and brittle, and the cacao plantations suffered much damage.

Notes on earthquakes—April 1, 7^h 16^m a. m., slight shock E–W, intensity I, duration 4 seconds. April 2, 10^h 45^m a. m., one shock NW–SE, intensity IV, duration 6 seconds. April 7, 5^h 17^m 45^s, slight shock NNW–SSE, intensity IV, duration 7 seconds. April 20, 3^h 52^m a. m,, slight shock NW–SE, intensity II, duration 4 seconds. April 22, 6^h 47^m p. m., tremors NW–SE, intensity I, duration 4 seconds. April 29, 4^h 40^m p. m., slight shock E–W, intensity II, duration 4 seconds. April 30 5^h 00^m a. m., slight shock E–W, intensity II, duration 3 seconds.

CLIMATOLOGY OF TAMPA, FLA.

By ERIC R. MILLER, Observer, United States Weather Bureau, dated Tampa, May 25, 1903.

Tampa, Fla., latitude 27° 57′ north, longitude 82° 27′ west, is situated midway of the west or Gulf coast of the Peninsula of Florida. It is located at the mouth of Hillsborough River on Hillsborough Bay, the right-hand branch of Tampa Bay, and is about 20 miles from the Gulf of Mexico in a direct line and 35 miles from the bar at the entrance to Tampa Bay.

As regards topography, the city lies on rising ground 10 to 40 feet above sea level. The surrounding region is uniformly low and level or slightly rolling, but is not swampy, as a sandy soil provides natural drainage.

The meteorological history of the station begins in 1825 with the commencement of a record of temperature at Fort Brooke, a military post that formerly occupied the site of the City of Tampa. Measurements of rainfall were begun in 1840 and entries of wind direction and cloudiness were added in 1843. These observations, in a region then the seat of strenuous Indian wars, were made by persons whose duties were mainly military and were frequently interrupted by the more important concerns of the moment. It is to be regretted that such lapses occurred at the time of some very important meteorological events, notably the great freeze of 1835, unquestionably the greatest occurrence of its kind since the occupation of Florida by Europeans; it took place in the midst of a hiatus in the record occasioned by the Seminole war. The Fort Brooke record ceased in 1859, or two years before the opening of the civil war; it was resumed in 1869 for three months, and again during the years 1881–2. W. C. Brown, a civil engineer, acting as voluntary observer for the Smithsonian Institution, kept a record of rainfall for a period covering part of the years 1871, 1872, and 1873. Meteorological observations are also known to have been made for the local newspapers before the establishment of the Weather Bureau office, but no records of these observations have been found. A regular station of the Weather Bureau was established in 1890, and records of all elements have been regularly maintained since April 1 of that year.

The accompanying table exhibits some of the climatological elements. The correlation of these data and the causes of their variation may now be briefly noticed. The weather in winter is more or less modified by passing cyclonic and anticyclonic disturbances, while the weather of summer is mainly controlled by the regular diurnal changes, modified frequently by the occurrence of local thunderstorms and rarely by cyclonic disturbances. The effect of this transfer of the control of the weather from the secondary atmospheric disturbances of winter to the local convectional overturnings of summer upon the temperature is seen only in the character of the disturbances of the diurnal march produced by each, and is not apparent in a climatological table. The rainfall has two maxima, the greater in summer at the time of the greatest frequency of thunderstorms, and the lesser in winter, when the increased frequency of cyclonic disturbances is the source of an increased precipitation. The months of least precipitation, April and November, are those wherein one class of disturbance is gaining and the other losing frequency. Both clouds and wind have winter and summer types, the former being the familiar type of the temperate zones, the latter exhibiting the diurnal changes characteristic of the torrid zone.

Few extreme conditions have occurred since the establishment of the Weather Bureau office that record and tradition do not show to have been exceeded in previous years. The highest temperature recorded since 1890 was 96°, on July 8, 1902, and the lowest 19°, on December 29, 1894. A maximum temperature of 98° was recorded at Fort Brooke in 1848, and it is probable that a temperature as low as 12° or 14° was experienced on February 7–8, 1835, when a minimum temperature of 8° was recorded in the northern part of the State. In the past thirteen years the earliest frost in the fall occurred on October 29, 1892; the first killing frost was on December 6, 1895; the last killing frost March 19, 1892, and the latest frost recorded in spring April 7, 1891. Since the establishment of the Weather Bureau station the greatest rainfall was; for a year, 66.93 inches, in 1894; for a month, 17.83 inches, in August, 1898; for twenty-four hours, 6.56 inches, on September 20–21, 1897; 2.45 inches fell in thirty minutes on June 12, 1900, and of this it is estimated that 1 inch fell in five minutes. In the year 1840 a total of 89.86 inches was recorded; of this 24.52 inches fell in July and 23.40 inches in August, a total of 47.92 inches for the two months. There is a local tradition that the low, flat lands of this portion of the State were under water to the depth of from 1 to 4 feet in 1856, when 22.24 inches occurred in July. There were eighteen successive days with rain in 1894, viz, from August 21 to September 7, inclusive. In 1897 from November 11 to December 4, a period of twenty-four days, there was absolutely no rain, and, if one one-hundredth of an inch be not considered, no rain fell for thirty-two days. April, 1856, is recorded as being wholly without rain. Hail has been recorded at the station only twice in thirteen years, but it has been reported from the surrounding districts a number of times. Snow has fallen three times in the history of the station, and

Climatic data for Tampa, Fla., based on thirteen years Weather Bureau records unless otherwise stated.

[Latitude, 27° 57′ north; longitude, 82° 27′ west. Altitude, 34 feet.]

Months.	Temperature. Mean temperature. All records.	Mean temperature. Number of years.	Mean temperature. 13 years, 1890–1903.	Extremes of monthly and annual means. Maximum.	Extremes of monthly and annual means. Minimum.	Mean of all maxima.	Mean of all minima.	Mean daily range.	Mean of monthly and annual extremes. Maximum.	Mean of monthly and annual extremes. Minimum.	Mean monthly and annual range.	Absolute extremes, 13 years. Maximum.	Absolute extremes, 13 years. Minimum.	Mean daily variability.	Humidity. Vapor pressure, 10 years.	Humidity. Relative humidity. Per cent.
January	60.6	42	59.1	63.6	55.0	68.2	50.1	18.0	80	33	47	82	27	4.5	0.389	81
February	62.8	42	61.6	69.0	54.4	70.3	52.9	17.5	80	33	47	86	22	4.6	0.416	81
March	66.9	42	66.6	71.9	62.0	75.7	57.5	18.3	84	41	43	88	32	3.5	0.488	79
April	71.4	42	70.2	73.3	66.6	79.9	60.5	19.4	88	48	39	90	38	2.4	0.512	74
May	76.3	43	76.2	78.2	73.8	85.5	66.9	18.6	91	58	32	93	53	1:8	0.650	75
June	79.9	44	80.1	81.0	78.9	88.8	71.5	17.2	94	66	28	95	64	1.6	0.770	81
July	81.0	44	81.3	82.7	79.8	89.3	73.3	16.1	94	69	25	96	65	1.4	0.817	82
August	80.9	43	81.5	82.3	80.4	89.4	73.5	16.0	94	69	25	95	66	1.4	0.826	83
September	79.5	43	79.7	81.2	77.6	87.7	71.7	16.0	92	65	27	94	54	1.5	0.786	86
October	74.2	41	73.8	77.2	70.0	81.9	65.6	16.3	88	54	35	92	44	2.4	0.648	81
November	67.5	42	67.3	72.0	61.4	76.2	58.3	17.9	84	43	41	87	34	3.4	0.513	81
December	62.0	41	61.4	65.8	58.7	70.3	52.5	17.8	81	34	47	83	19	4.4	0.417	83
Year	71.9	....	71.6	72.8	70.0	80.3	62.9	17.4	95	27	67	(*) 96	(†) 19	2.7	0.602	81

Months.	Rainfall. Average rainfall. All records.	Average rainfall. Number of years.	Average rainfall. 13 yrs.	Monthly and annual extremes. Maximum.	Monthly and annual extremes. Minimum.	Greatest 24 hour rainfall.	Average number of rainy days.	Greatest successive number of days with— Rain.	Greatest successive number of days with— Drought.	Average thunderstorms.	Cloudiness. Average 0–10.	Average days. Clear 0–3.	Average days. P't cl'dy 4–7.	Average days. Cloudy 8–10.	Average days with fog.	Wind. Prevailing direction.	Average velocity.	Maximum velocity. Velocity.	Maximum velocity. Direction.
January	2.61	33	2.78	6.45	.28	2.75	8	5	23	1	4.9	10	15	6	2	ne.	6.2	36	sw., s.
February	3.13	32	3.48	6.27	.98	4.06	8	5	14	2	4.9	9	12	7	1	ne.	7.2	49	s.
March	3.00	33	2.91	7.36	.08	2.15	7	8	22	2	4.5	12	13	6	1	ne.	7.0	36	s., sw.
April	1.95	33	2.09	5.38	.16	2.70	6	5	24	2	4.3	13	12	5	0	w.	6.9	42	sw.
May	2.73	34	2.56	6.92	.33	3.36	7	12	16	4	4.5	11	15	5	0	w.	6.4	42	sw.
June	7.66	36	9.02	13.42	4.24	• 4.55	17	14	7	10	5.5	7	17	6	0	se.	5.7	37	sw.
July	9.56	37	8.14	15.53	2.11	5.16	18	10	8	11	5.6	6	19	6	0	e.	5.3	43	se.
August	9.36	36	8.65	17.83	4.93	3.98	18	18	10	13	5.8	4	20	7	0	se.	5.0	34	se.
September	6.41	34	8.10	17.28	4.80	6.56	17	16	13	6	5.5	7	15	8	0	ne.	5.7	43	ne.
October	2.57	34	3.14	5.11	.36	2.90	8	7	20	1	4.8	12	13	6	0	ne.	6.5	41	se.
November	1.84	34	1.73	3.96	.24	2.90	5	3	24	0	4.5	12	13	5	1	n.	5.9	36	s.
December	2.30	33	1.80	3.40	.54	1.77	7	4	22	0	4.8	12	11	8	1	n.	6.1	40	s.
Year	53.12	....	54.42	66.93	42.06	....	127	18	24	52	5.0	115	175	75	5	ne.	6.2	....	....

* July 8, 1902. † December 29, 1894.

there is said to have been enough for snowballing in 1886. Thunderstorms occurred on no less than eighty-five days during the year 1900, and there were twenty-four days with thunderstorms in the month of August, 1901. As many as four thunderstorms in one day have been observed at the station. The highest velocity the wind attained in recent years was 49 miles, from the south, on February 28, 1902. Tradition recounts gales in 1848 and in 1859 that caused tides in the river at Tampa at least 12 feet higher than it is known to have reached in recent years.

THE FULTON AUTOMATIC RIVER GAGE AT CHATTANOOGA, TENN.[1]

By Prof. WESTON M. FULTON, Local Forecast Official, Weather Bureau.

This apparatus consists of two parts, the recorder, fig. 2, which is at the Weather Bureau station, and the gage, fig. 1, which is located at the river. The latter part consists of a pulley, A, about 8 inches in diameter, and a small gear wheel, F, both mounted upon a shaft, B, which bears upon the supports C, screwed to the base D. Mounted on the same shaft B, and just to the right (as seen in the drawing) of pulley A, is a small pulley about 1 inch in diameter. The end E of the shaft B, is threaded and screws through the support C. The pulley A and the small pulley have threads around their peripheries cut to the same pitch as the threads on the end of the shaft B. A fine brass spring wire, G, is wound around the pulley A; it passes down through a small hole, H, in the base

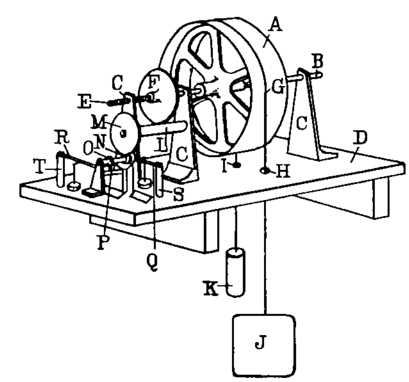

FIG. 1.—The Fulton automatic river gage—the gage.

of the apparatus, and supports the float J. The counterpoise K is in like manner suspended from the small pulley to the right of A, the wire which supports it being so wound upon the pulley that when the float J rises, the counterpoise K will unwind the wire from the small pulley and maintain the wire G taut. The object of the threads on the end E of the shaft B is to give the shaft and pulleys a lateral motion when they revolve, and thus hold the float J and the counterpoise K in the same vertical lines passing through holes in the base B. The gear wheel F, the long pinion L, the gear wheel M, and the pinion N constitute a gear train which so magnifies the motion of the pulley A that when the float, J, moves through a distance of one-tenth of a foot the small shaft O will make one complete revolution. From each end of the shaft O is loosely suspended a bar about 3 inches in length with a crescent-shaped cam attached to its face near the point of suspension. A T-bar, P, attached to shaft O, plays between these pendent

[1] This gage is the invention of Mr. Weston M. Fulton, Official in Charge of the United States Weather Bureau office at Knoxville, Tenn. One of them was installed at Chattanooga, Tenn., during February of the present year, and has been performing very satisfactorily since that time. In response to numerous requests from engineers and others interested, the above description of the gage has been furnished by Mr. Fulton.—ED.