EXPERIMENT OF MR. ERNEST A. MEACHAM, RIVERSIDE, CAL.

"On the morning of February 9, 1900, at the Meacham Ranch, a test was made of the Meacham warm water method of protecting citrus fruits against frost. The experiment began at 3:45 a. m. and was conducted in the presence of a number of gentlemen belonging to the Riverside Horticultural Club, nearly all of whom were orange growers.

"At 6:30 a. m. the temperature of the ground 100 feet or more away from the boiler was 32°. The temperatures given herewith are those obtained by Mr. McAdie of the Weather Bureau with sling psychrometer No. 70; the number of the dry thermometer was 4487 and of the wet 4486. The plant consists of a 12-horsepower tubular horizontal boiler, laid in a brick furnace and arranged to deliver water with or without pressure. Cold water enters the bottom of the boiler and is delivered from the top orifice directly into the flume. The fuel used was crude petroleum, of which about 50 gallons were used in three and one-half hours. At the rate of 14 gallons an hour and an estimated cost of a little over 4 cents per gallon, the actual expense of fuel for the experiment was about 60 cents per hour. The oil is burned with a steam jet under pressure. A secondary 6-horsepower boiler, carrying 70 pounds of steam, was used. The oil is thus entirely consumed and makes but little smoke. The whole arrangement is such that not more than two men would be required to attend to all the details.

"Fifty minutes from the time of beginning, the water which had an initial temperature of 55.4° was raised 30°. Two sets of temperature records were made, one by Mr. Priestley Hall and the other by Mr. McAdie. In Mr. Hall's test 8 inches of water was run in 50 furrows, which barely ran the water past the ends of the furrows. In the second case 8 miners' inches of water was delivered into 25 furrows, thus carrying the heat farther down the furrows than in the first experiment. According to the present laws of California, a miners' inch is $\frac{1}{50}$ cubic foot per second; the "second-foot" is the quantity represented by a stream 1 foot wide and 1 foot deep, flowing at the average rate of 1 foot per second. A cubic foot of water, maximum density, weighs 62.4 pounds; a gallon contains 10 pounds of distilled water at 62°. The data obtained by Mr. Hall were as follows: 5:30 a. m., normal temperature, 34°; normal temperature of water, 60°; temperature of heated water, 92°; at the flume, 92°; 20 rods from the flume, 58°; 40 rods, 52°; temperature of unheated water 40 rods from the flume, 41.5°; vapor condensed on trees early in the morning and more condensed on the trees in the heated plat.

"Mr. McAdie's records are as follows: Time, 6:30 a. m., air temperature varying from 34° to 36°; temperature on the ground, 32°; frost was observed on grass blades; initial temperature of water, 55.4; heated water delivered to flume at 85.2; in a straight line down a furrow 200 feet from the boiler in the direction of the wind (motion of the air was very gentle) there was a fall in temperature of 14.2°; water vapor was observed rising to a height of about 4 feet; 200 feet from flume, as stated. the temperature of the water was 71°; the temperature of the surface soil 4 inches right and left of the water was 43°; temperature of the soil 16 inches from the water or in the middle of the ridge, 42.2°. It is presumed that the temperature of the ground, had no water been flowing, would have been 33°, and it would seem as if the soil itself was warmer by nearly 10°. At the end of a furrow, 600 feet, the temperature of the water was 54°, or there had been a fall of 31° in 40 rods; the temperature of the ground 4 inches from the water, 38°; 16 inches from the water, 36°; temperature of unheated water 50 rods from the flume, 40°.

"The approximate value of the plant was $200, and it is estimated that for a plant all equipped sufficient for a 10-acre grove $600 would cover all expenses. See fig. 7, Plate IV."

SPRAYING.

After frost, or rather just before a frost has ended, a spraying device can be used to advantage. Its chief function is to prevent a too rapid warming of the chilled fruit. It is said by horticulturists that even the light coating of ice formed in this way does not seriously damage the fruit. It is very likely that the latent heat of solidification set free by the change from water to ice may play a helpful part; but the chief effect is to prevent a too rapid thawing. In other words, both heat and water should be supplied to the chilled plant slowly, and according to the plant's ability to make good use of the same. At the A. J. Everest Ranch at Riverside, Cal., a portion of the grove is protected by sprinklers at the top of fifty-foot masts.

PROTECTIVE METHODS BASED UPON SCREENING OR COVERING.

All screening or covering devices are in effect modified hothouses, and there is no question but that a thorough protection can be accomplished. The expense is the one objection. Screens are made of light materials, namely, canvas, muslin, or light wood work, and have been used with considerable success. At the A. J. Everest Ranch an elaborate structure of lath screens is in use, illustrations of which are given herewith (see figs. 8 and 9, Plates IV and V). There is no question as to the value of the protection, but the expense is considerable, averaging perhaps $400 to the acre. This lath covering may be considered as forming a well ventilated hothouse.

NOTES BY THE EDITOR.

MR. HOWARD SHRIVER.

Mr. Howard Shriver, the well-known meteorological observer, was born at Sandy Mount, near Baltimore, Md., November 8, 1824, and died February 5, 1901, in Cumberland, Md., where he had spent most of his life, and of which city his father, Thomas Shriver, was formerly mayor. His interest in weather observations began at an early period. He began observations while living in Virginia in 1866, and the Editor well remembers his visit to the Central Office in Washington in 1873. He had a genuine love for the study of natural science and took the greatest pleasure in communicating his results to others. He was particularly interested in the study of the climate and flora of the neighborhood of Cumberland. His elder brother, Edwin Thomas Shriver, had begun a meteorological record in January, 1859, and the combined record of the two brothers, therefore, extends forty-two years, or to January, 1901. A summary of the principal results of these observations is published in the report on the geology of Allegheny County recently issued by the Maryland Geological Survey. Mr. Shriver's instrumental equipment was unusually complete for a voluntary observer. He was one of the best known citizens of Cumberland, a favorite with the children and the school officials, and a great gathering attended the commemorative public exercises held on February 24 in the Academy of Music. A fuller account of Mr. Shriver's work is given in Dr. Fassig's notice, published in the February report of the Maryland and Delaware Climate and Crop Section.

DR. EARL FLINT.

Dr. Earl Flint, M. D., for many years voluntary observer of the Weather Bureau at Rivas, Nicaragua, died January 21, 1901. He will be remembered by students of Central American climatology as the one meteorological reporter in all that great region, stretching from Mexico on the north to the Isthmus of Panama on the south, who made a continuous record of the weather for upward of twenty years. Dr. Flint's meteorological work began in 1881 and continued without interruption until his last illness.

Dr. Flint was a student of archæology and ethnology as well as of meteorology. Before locating in Rivas he had traveled extensively, not only in Mexico and Central America, but throughout the more northern countries of South America. During his travels he found opportunity to make a number of interesting and important archæological collections, some of which were later in his life deposited in the National Museum in Washington, D. C. He was always a student of material things, an intelligent observer, a zealous collector, and an honored citizen of his adopted country.—*A. J. Henry.*

HERBERTSON'S DISTRIBUTION OF RAINFALL OVER THE LAND.

In the important and elegant Atlas of Meteorology edited by Buchan and Bartholomew and recently published by Archibald, Constable & Company, of London, there are reproduced, among other charts, the rainfall of the world in four seasons by Dr. A. Supan, and also twelve monthly charts by Dr. A. J. Herbertson. Both of these sets of charts are, however, on the Mercator projection and on too small a scale to be easily consulted. Subsequently, Dr. Herbertson has been able to slightly amend his original charts, which seem to have belonged to his dissertation for the attainment of the degree of Ph. D., at the University of Freiburg in Breisgau, in 1898. This dissertation is entitled The Monthly Rainfall over the Land Surface of the Globe, and has been printed in English. A new edition of this dissertation to accompany a new set of charts, twelve monthly and one annual, on a much larger scale, is entitled The Distribution of Rainfall over the Land, London, 1901, and is published, apparently, as a separate pamphlet, by the Royal Geographical Society. In the text Dr. Herbertson gives numerical data when it is not easily accessible elsewhere, but does not reprint that given in his lists of data and bibliography or in Dr. Supan's Distribution of Precipitation, published in 1898 as one of the Ergänzungshefte of Petermann's Mittheilungen. The text of the two pamphlets differs principally in that the second pamphlet contains, on pages 53–56, certain remarks on the annual and seasonal distribution that do not occur in the original dissertation.

In general this memoir gives thirteen maps of the globe on Lambert's equal area azimuthal projection for each month and for the year the distribution of rainfall over all the land surfaces where observations have been made. Nothing is said about rainfall on the ocean except to refer to the new edition of the memoir by Mr. W. G. Black, published by the Geographical Society of Manchester, Edinburgh, 1899.

In his general remarks Dr. Herbertson says:

There are seven well-marked bands of high and low rainfall girdling the earth, viz: (1) The subequatorial wet belt; (2), (3) the subtropical dry belts; (4), (5) the temperate wet belts; (6), (7) the polar dry belts. These hyetal belts move north and south during the year with the sun. In equatorial regions there are two wet and two dry seasons every year; most rain falls when the sun is highest, at noon, except on the west coasts of temperate lands. Rain can fall steadily and in considerable quantities only when there is a steady cooling of the atmosphere, as when (1) the air steadily moves from warmer to cooler regions, or (2) when it has an ascending convectional movement, as in equatorial regions when the sun is overhead at noon, or (3) when the convectional movement is in connection with the complicated atmospheric disturbances called cyclones, or (4) when a range of mountains deflects the surface winds into higher regions. The ascending convectional movements, 2, 3, and 4, are the most important sources of rains, and occur when the sun is highest in the heavens. In general, the maximum rainfall occurs when the sun is nearest the zenith at noon, viz, (1) in summer, for places beyond the Tropics; (2) about the time of the equinoxes, for places at the equator; and (3) at intermediate times, at other intertropical stations. The winter cyclones of the temperate belt can not penetrate far into the interior of the continents, where a great high-pressure system exists; hence the rains may be heavy on the coasts, but do not spread far inland. On the other hand, in the summer the low-pressure areas over the continents are the goal of steady winds, slowly inflowing from all sides. The summer rains are in part the outcome of the greater capacity of the atmosphere for vapor, since this capacity increases more rapidly than the temperature, so that the same amount of cooling yields a greater rainfall from air that is saturated at high temperatures than at low temperatures. Much summer rain has its origin in local evaporation. The water must be replaced if the rainfall is to continue. It can only come from the oceans. Hence a slow current of vapor must steadily flow into the region of summer rains. The normal trade winds are usually dry and are passing from regions of low temperature to those of high temperature. The trades do not cause any rain as long as they are not forced upward. Thus the flat llanos of South America are dry while the northeast trades rule over them, and in winter these trade winds affect only a narrow strip of mountainous coast land; but in summer, when the trade winds are sucked in toward a well-developed low pressure, they become the source of the heavy convectional rains, as in the case of the Asiatic monsoon rain. The influence of ocean currents on rainfall is indirect, through the temperature of the air. The most interesting example of this is the low rainfall on the tropical west coasts of the continent.

The effects of mountain barriers are seen in the Monthly Rainfall Maps. The line of maximum elevation is not necessarily the line of heaviest rain; the latter may lie on the leeward slope of the mountains or at some distance from the edge of a plateau. The air may continue to rise for some distance as it moves beyond the ridge, and the maximum precipitation may occur even beyond this line, and not on the windward slope.

Herbertson's monthly and annual charts supply a long felt want and will be made the foundation of many studies. They came in very opportunely in connection with the Editor's recent exposition of the physical basis of long-range seasonal forecasts of rainfall.

THE STORMS OF THE HAWAIIAN ISLANDS.

Under date of March 8, Mr. Curtis J. Lyons writes that an examination of the United States daily weather maps shows that—

The connection between our November storms and the lows that appeared on the Oregon and Washington coast is, I think, very apparent.

The storm that prevailed here from February 5 to 14 very evidently came up from south-southwest, as we had a southeast to south-southeast gale for two or three days, previous to the southwest winds—this is unusual. The barometer fell to 29.48, the lowest for twenty years.

THE RAINFALL AND EVAPORATION OF GREAT SALT LAKE.

On a previous page we publish a paper by Mr. Simon F. Mackie dealing with the changes of level and the total rainfall. This question is one that has been discussed in previous numbers of the MONTHLY WEATHER REVIEW, but will always interest meteorologists and geologists. Any solution of the question of rainfall, evaporation, inflow, and outflow that applies to Great Salt Lake, will doubtless also apply to many other lakes throughout the world. In general it must be remembered that the rainfall records for one or two stations in the neighborhood of the lake, or within its watershed, may not be perfectly representative of the whole watershed. The following table is furnished to the Editor by Prof. A. J. Henry as containing all the data in the archives of the Weather Bureau from stations in the watershed of the Great Salt Lake.

Rainfall in inches in Salt Lake watershed.

Year.	Salt Lake City.	Ogden.	Coalville.	Provo.	Logan.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1874	14.67				
1875	23.64	20.69	21.02		
1876	21.28	14.80	14.20*		
1777	16.35	18.95	11.75		
1878	19.75	15.11	10.71		
1879	13.11	12.35			
1880	10.94	10.24			
1881	16.93	10.13*			
1882	15.98	9.07			
1883	14.24	10.98			
1884	17.52	19.49			
1885	19.69	19.40			
1886	18.89	12.60			
1887	11.66	9.14			
1888	13.62	12.03			
1889	18.46	16.91			
1890	10.83	18.61			
1891	15.82	23.11			
1892	14.08	14.20			
1893	17.35	16.97			14.51
1894	15.27	16.04		10.21	14.36
1895	11.95			10.57	13.51
1896	18.42	13.95			16.15
1897	16.74				17.45
1898	16.09			13.95	13.18
1899		13.53			12.60
1900					15.06

* Somewhat doubtful.

By plotting the stations it will be seen, as Professor Henry states:

That the rainfall record at Salt Lake City may be taken to represent the average rainfall over a belt of country 20 to 30 miles wide, but not