for special purposes. Temperatures, at present, are taken at a latticed shed in the shade. Plants do not grow there; they grow in the sun. Shade temperatures are largely a question of humidity, the disparity being very great in the arid West. We want to know the temperature at the growing parts of plants, and the actual conditions under which the plants grow, which are the sun temperatures there. We want to know the soil temperatures under all conditions of sun temperature and humidities. We want to know the humidity at the growing parts of the plants, and the effects of variable humidity on their growth and character. We want to know the humidity of the soil best suited for special plants. Now, we drown them out, or starve them by our methods of irrigation, because we do not have the data to get at the condition of the soil scientifically, and much water is wasted and crops are often short in quantity and weight for this reason. We know that a crop needs water badly when it begins to wilt to the eye, but that is long after it should have been irrigated. Now we irrigate so many times a month, and our crops grow much as the Irishman fatted his pigs to get a streak of fat and a streak of lean. This rule of thumb method is crude, but it is the best we have. When we get these data, then we can figure the rate of evaporation in a general way, and by this means the crops can be kept at top notch of growth during the entire season, and thus we can increase our output with the same labor from 25 to 100 per cent. and at the same time save our water so that it can be used elsewhere for more crops.

In the matter of sun temperatures a great deal of experimenting must be done to determine what fairly represents the conditions under which plants grow, for reflection and radiation from the ground is very important and varies with conditions. For example: Last summer during a long series of observations, I put three standard thermometers out at the same time: one in the shade, one in a hygrometer box which was laid on the asphalt pavement, and another by its side uninclosed. The first read 94°, the second 140°, and the third 120°. Thermometers hung against the side of a house will read higher than those close by, hanging freely. It may be said that the conditions are so varied that no definite results can be obtained, but plants are grown under these conditions, and the planter must know what are the effects of these conditions before he can control the growth and nourishment of the plants as it should be done. It may also be said that the present records amount to almost nothing in this regard and can never be of much service. Within our section the conditions of plant growth are very diverse. On the mountains they do not vary greatly from the East, but in the low and hot valleys it is far different, for example: In the Panamint Valley, where I was studying conditions, the gravelly soil became so hot in the sun during April that my feet began to burn while walking over it. The hob nails in my shoes dropped out, and left the leather looking as if it had been scorched, and yet plants grew in that gravel, some shrubs, but mostly some short-lived annuals. Under such conditions, when there is water for irrigation, six crops of alfalfa are raised a year, and other vegetation grows like weeds; but without water all is parched in a few days.

The botanist and student of plant life in general wants still more data, but if he could get even these, it would be a great step in advance.

When the Bureau made its present change into drainage areas from political divisions, it was an important improvement, there is, however, ground for further advance. In such a complex area as the Great Basin there are two very distinct regions which should be kept apart in making up all averages. All that area having an annual temperature of 58°, or higher, is as distinct from the rest as though it belonged to a separate planet. To average the records of these regions with the rest would vitiate both.

Note.—It is necessary for the Weather Bureau to have its instruments on the top of buildings as nearly all its stations are situated in the midst of large business centers in order to best subserve the interests there. The exposure of thermometers in a city will give higher mean temperatures than an exposure outside of a city.

A series of observations of sun temperatures would, no doubt, prove very valuable to the botanist, and could be accomplished by using a black bulb in vacuo properly standardized. But whether the work of obtaining the observations as required by the botanist could be carried on as economically by the Weather Bureau officials as by him is doubtful.

The question raised, when to irrigate, is a very important one, and when rightly understood would be the means of saving much money. This could be done by using some form of soil humidity apparatus.

The question of the effect of temperature, intensity of radiation, humidity, and other climatic factors on plant life is so involved with biological considerations that it appears to be more a study for the botanist and horticulturist than for students of the weather and climate.—*A. H. T.*

THE EFFECT OF EXPOSURE AND ALTITUDE ON THE DISTRIBUTION OF FOREST TYPES IN THE MANTI NATIONAL FOREST.

By LINCOLN CROWELL, Forest Assistant.

During the past season the writer has been at work on a timber estimate of the Manti National Forest and has had an excellent opportunity to note the effect of exposure and altitude upon the distribution of forest types.

Topographically speaking, the Manti National Forest is located on a deeply eroded plateau some 75 miles long, north and south, and from 5 to 35 miles wide, east and west. The altitude ranges from 5,000 feet at the base of the foot hills to about 11,000 feet for the tops of flat ridges and divides, although some points rise somewhat higher. The headwaters of the creeks that originate in the forest flow in an east or west direction, thus giving the sides of the canyons through which they flow northerly and southerly exposures.

Change in altitude corresponds to a certain change in latitude and as temperature and precipitation vary with a difference in latitude so do they vary with a difference in altitude. Personal observation leads me to believe that the higher parts of the forest receive a heavier precipitation than do the lower parts. With increase in altitude the daily and seasonal mean temperatures are lower.

The effect of this variation in precipitation and temperature is that tree growth at a lower elevation has a longer growing season but less moisture than does that at a higher elevation.

The different tree species found in the forest are grouped into more or less distinct belts or zones, depending upon their adaptability to withstand the lower temperatures of the higher altitudes, or the drought and high daily temperatures of the lower altitudes.

In the foothills up to 6,000 feet the cedar and pinyon are the principal trees met with; above these occur a belt of oak brush at 6,000 to 7,000 feet, then a broad belt 7,000 to 9,500 feet in which the quaking asp covers a large area, although mixed with it are coniferous trees such as blue spruce, Douglas fir, white fir, and yellow pine. At 9,500 to 10,800 feet occurs the Engelmann spruce zone. It is this zone that supports the heaviest stands of timber and from which the sawmills obtain most of their logs.

These zones are not, however, as distinctly marked as one might be led to suppose, nor are the species characteristic of one zone by any means lacking in the neighboring zone. The boundaries are very irregular and intermingled, and at the same elevation the types characteristic of two distinct zones are often present. This is brought about by difference in exposure. The southern and western exposures get more direct sunlight

than do the eastern and northern exposures. Snow melts there earlier in the spring and growth starts earlier. The daily range of temperature is greater, the soil drys out quicker, and in fact conditions resemble those at lower elevations; so that in the upper or Engelmann zone, while the northerly exposure may have a fine stand of timber, directly facing it, the southerly exposure will be covered with aspen, or be entirely bare of tree growth.

This holds true for the other zones as well, the lower zone always reaching a higher elevation on sites exposed to the sun.

CORRIGENDUM.

On page 372, MONTHLY WEATHER REVIEW for July, 1909, substitute the name of Prof. A. G. McAdie for that of Alfred H. Thiessen as District Editor for that month.