fact that the position of the Sierra Divide was much farther to the westward than at present. Waning glaciation over this lofty region was certainly competent to appreciably augment the basal lake supplies. It is thus quite possible that Whitney's explanation of melting ice is partly correct.

The disappearance of the great Lake Lahontan, as well as the dimunition in size or vanishing of many of the other bodies of water once much larger than now, is readily explained by postulating greatly diminished inflow occasioned not so much by a change from moister climatic conditions as by the rapid eastward migration of the Sierra Nevada watershed and by the capture of its chief catchment basin by the Columbia River. The east base of the great snowy range is 4,000 feet higher than the west foot. Headwater erosion thus goes on so much more speedily on the sunset flank than on the other side that the divide has already nearly reached the eastern margin of the orographic block. Some of these west-flowing streams are now actually crowding down the east slope of the ridge. The headwaters of Feather River in California reach even now quite to the brow of the high escarpment overlooking the Great Basin. Pitt River in the same State has already broken through the range and drains lakes that not so very long ago were strictly Great Basin features. The time can not be long until the canyon of the American River, along the brink of which the Southern Pacific railway runs 3,000 feet above the bottom, shall have been cut back completely through the Sierra, capturing the Truckee River on the eastern side. At a little later date the waters of Humboldt River may be flowing uninterruptedly to the Golden Gate.

Bearing directly on the question of an independent genesis of the two largest lakes of the Great Basin is the attitudes of the minor lakes of the region. Admittedly of a half score distinct origins, these several classes of desert waters retain their characteristics far beyond the confines of the Great Basin. Their congruous relations to normal desert environment continue southward quite to the Tropics; so they are the same in regions far beyond supposed influences of Glacial climate. In climatic discussions of the Great Basin the significance of this fact is little considered. It is one of the strongest arguments against appreciable change in climate since the time when these lakes began to form. The continental glacier front is far too remote to influence the climate of Nevada. All lacustral testimony seems to support conclusively the postulate that during late geologic times the climatic fluctuation in the region has been no more rapid than the larger orographic change. It is doubtful whether during the Glacial Epoch there was any appreciable modification in the climatological features of the arid lands.

CROP CENTERS OF THE UNITED STATES.

By J. WARREN SMITH, Meteorologist.

[Dated: Weather Bureau, Washington, D. C. June 28, 1918.]

Dr. Adolph E. Waller, Associate at the Botanical Laboratory of the Ohio State University, Columbus, Ohio, contributes an article under the above head in the Journal of the American Society of Agronomy for February, 1918, vol. **10**, pages 49–83, that is of more than passing interest to students of agricultural meteorology. The author writes from the point of view of the ecologist, and relates farm practice, as shown in the development of commercial field crops, with natural vegetation as influenced by climate and soil.

The article opens with a discussion of the climate of the United States, particularly in the inter-relation of temperature, rainfall, and evaporation, and the effect upon certain marked types of vegetation. Unfortunately, in explaining the influence of high and low pressure areas upon rainfall, the author makes the serious error of saying that "the eastern side of a high and the western side of a low are regions of ascending, converging, cooling air," and is thus "the region of increasing moisture," while "the western side of a high and the eastern side of a low are regions of descending, diverging, warming, drying air." He indicates in the next paragraph that the wind blows away from areas of low pressure, which is contrary to the well-known fact that the wind blows *away* from high and *toward* low pressure areas. While these errors are regrettable, they do not vitiate the general excellence of the paper as a whole.

In his discussion of climatic and edaphic factors, the author states that:

> In every stage of their development plants respond to the moisture and temperature changes of the habitat. The nature of the soil has such a far-reaching influence upon plant life that it must be considered second in importance to but one factor, the climate. Those plant-growth factors related to the soil have been named by Schimper (1903) the edaphic factors.
>
> Warming (1909), impressed with the fundamental relation between plant growth and available water supply of the habitat, grouped vegetation into three principal classes, hydrophytes, mesophytes, and xerophytes. The water-content of soils was made the basis of his work, but when he recently reclassified the three types in order to accommodate them more closely to plant distribution, the new system was too involved to receive general recognition from plant geographers. Schimper made practically the same grouping that Warming made of water-content associations. He also pointed out that the terms forest, grassland, and desert are a subconscious classification of the principal climatic formations and are only another way of expressing the water-content of soils.
>
> The effect of the edaphic factors is to modify the climatic influences. The physical and chemical properties of soils tend to diminish or intensify the effect of climatic factors upon plant growth. * * *
>
> The physical nature of soil structure is more important to plant life than the chemical composition of the soils due to the relation between soil texture and water-content.

In discussing the relation between the crop centers and centers of natural vegetation, the author says:

> The corn and wheat belts agree with the deciduous forest and the prairie centers in the United States. * * *
>
> Three sets of factors are operating in combination to establish this region as the center for the production of our great cereals. These factors may be grouped as climatic, edaphic, and economic.
>
> By reason of the hot, almost tropical summers with the relative humidity rather high and the annual rainfall sufficient for the growth of the plant, the entire area from Ohio to central Nebraska on the north and southward to the Gulf of Mexico is suited to corn production. * * *
>
> The climatic factor in Indiana and Ohio is suited to the profitable production of corn, but production centers in Illinois for edaphic reasons. * * *
>
> In the United States wheat production centers on the 60 per cent rainfall-evaporation ratio line. This means that the center of wheat production lies west of the best corn lands, although on many farms throughout the prairie and deciduous forest climaxes both wheat and corn are usually grown, if rotations are practiced. In the matter of growing wheat in regions too dry for corn, the United States is not an exception to the rule. The great wheat-producing regions all over the world are level plains with a cool, rather dry climate. It is known that wheat, particularly winter wheat, yields larger crops in the more humid sections, yet in normal times other crops can be grown in the humid parts of the United States with greater profit than wheat. It is competition with these crops that drives wheat to the plains. * * *.

[To face p. 281.]

FIG. 1.—Special instrument shelter at the Pomona Cooperative Weather Bureau station.

An inspection of the spring wheat chart shows production to center on the northern extension of the 60 per cent line where all the evaporation lines are rather close together and nearly parallel. Ecologically, spring wheat could as well be grouped with the crops of the northeastern center, but geographically it belongs with the prairie climax. Edaphic considerations, then, rather than climatic, locate the area of spring wheat production. * * *

Oats center slightly north of the corn belt. Climatically, the center of production would be expected much farther northward. Edaphic reasons, and the convenience of a spring-sown crop rather than a fall-sown one to follow corn in the rotation now largely in practice in the corn belt, push the center somewhat to the south. * * *

The region south and east of the 100 per cent rainfall-evaporation ratio line is ecologically known as the southeastern evergreen center. While the rainfall throughout this part of the country is greater than it is northward, higher temperatures cause much more rapid evaporation. The physiological water requirement is higher. * * *

Cotton is the principal crop plant of this region. Eastward the extension of the southern Appalachians makes too rough a topography for the production of a cultivated crop. Temperature is the limiting factor of production northward; moisture is the limiting factor westward beyond central Texas.

Other comparisons of interest are that the fodder crops are important in New York and New England because "the lower temperatures make cereal production less profitable;" "the center of the white potato production in the Northeast bears a fairly close relation to the northeastern evergreen center;" "the cultivated plants of the plains climax must be grown under the best known methods for saving and utilizing all the water that can be captured by the soil and under irrigation;" and "the establishment of alfalfa as an important crop at about the one hundredth meridian, where the rainfall is only six-tenths of the evaporation."

In his discussion of animal centers the writer points out that "back of the interrelations between plants and animals is the relation of both to the physical factors of their environment." "Beef cattle and swine are found centering in and slightly west of the corn belt;" "the greatest production of horses is in the region just north of the corn belt," which is also the present center of oats production.

The summary is quoted below in full:

The crop centers of the United States agree with the biotic centers. In detail this means that the corn and winter wheat belts correspond to the deciduous central forest and the prairie climaxes, the tame hay and pasture region to the northeastern evergreen forest, the cotton belt to the southeastern evergreen forest, and so on. The rainfall-evaporation ratio map is useful for the demarcation of these centers because in it are included four factors of climate, namely, relative humidity, temperature of the evaporating surface, and wind velocity as the divisor and precipitation as the dividend. These four factors are of profound importance to plant growth.

Edaphic factors frequently determine the distribution of the cultivated plants. Edaphic and climatic factors, although they may be independent of one another in their operation, sometimes cause the same agricultural practices to be employed. Economic factors modify the influence of climate and soils.

A fundamental difference between crop plants and the natural vegetation is seen when plants are found beyond their usual centers. The crops are found on the best soils only, since that is their sole chance to compete with other crops for profit. Plant invaders of the indigenous vegetation migration from their centers can offer competition in the poorest habitats only. In the better habitats the plants belonging to the center are little influenced by invaders.

In addition to the exotic crops being given the best fields, further soil modifications are usually introduced. In the extreme cases, climatic as well as soil modifications are practiced. Field plants are then grown on a comparatively large scale under glass or cloth shelter.

The domesticated animals are grouped about the centers of production of those crops upon which they are most dependent.

The methods used in studying plant succession have been used here. It is in this field of research that an accurate interpretation of conditions as consequences of the operation of physical forces of the past and present has been made. Migration, including invasion and competition, the latter implying dominance, are the direct results of interaction of climate and soils upon vegetation.

75052—18——2

LAWN SPRINKLER AND THERMOGRAPH.

By WILLIAM G. REED, Meteorologist.

[Dated: Pomona, Cal., December 5, 1917.]

In connection with the possible effect of irrigation on the local climate the traces from the one-day thermograph

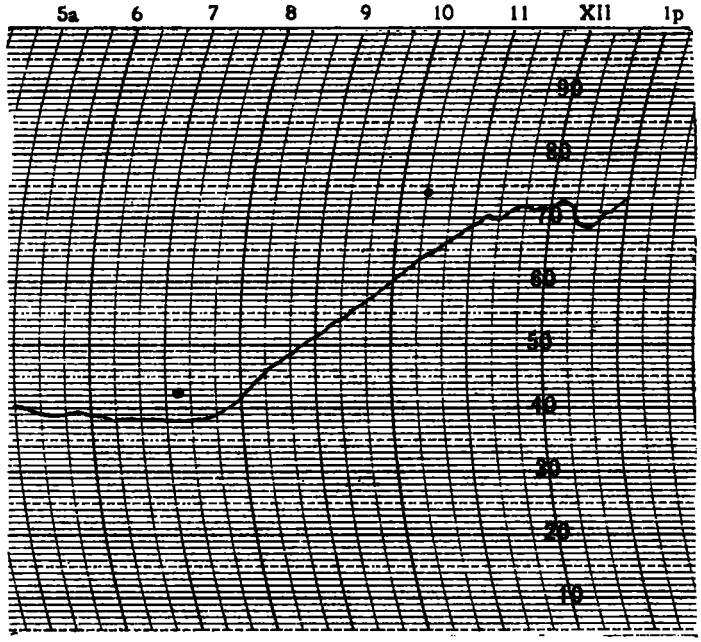

FIG. 2.—Thermogram for the City Hall lawn, Pomona, Cal., Dec. 5, 1917. Lawn sprinkler near shelter about 12:10 p. m.

and hygrograph exposed in a 1917-pattern shelter (fig. 1) on the lawn of the City Hall at Pomona, Cal., may be of interest (see figs. 2 and 3). The curves show nothing

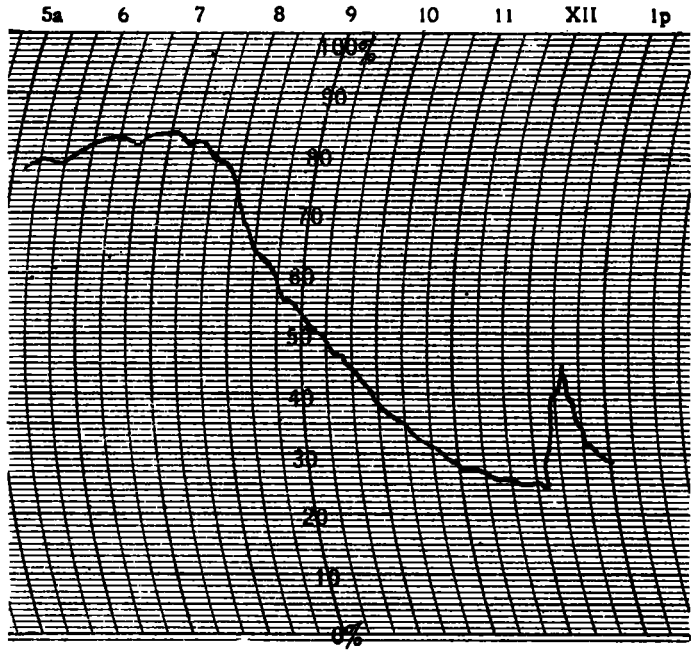

FIG. 3.—Hygrogram for the City Hall lawn, Pomona, Cal., Dec. 5, 1917. Lawn sprinkler near shelter about 12:10 p. m.

unusual until about 12:10 p. m., when the temperature fell sharply about 4 degrees in 15 minutes and the relative humidity rose 20 per cent in the same time or a