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SUMMER FOG PRECIPITATION ON THE SAN FRANCISCO PENINSULA

The San Francisco Peninsula, like most of the central California coast, is dry in the summertime. Fields and hills turn yellow before May and even a trace of rainfall is rare in the summer months and often until November in the autumn. In spite of the dry summer aspect of the vegetation, fog almost daily shrouds the immediate coast line where the redwoods grow. However, only where trees are tall and exposed to blasting, fog-laden wind is there evidence of significant condensation.

The vegetation of the San Francisco watershed is relatively undisturbed and well represents this coastal fog belt. Here a trail or road may be dusty dry through grassland and chaparral then suddenly bog down in mud and pools of water beneath tall trees. On the crests of ridges where there is no high ground above for seepage, this summer fog precipitation is most striking. The wind blows fog against the branches of the tall trees of the ridge-top where it condenses and drops like rain on the ground below. The dripping is most evident under trees that are exposed and unprotected by any hills to interrupt the wind from the Pacific Ocean.

The first line trees to the seaward exposure receive the greatest amount of moisture and the trees to the east and down the slopes exhibit a gradual decline in this type of precipitation. An attempt was made to measure this source of water which appeared to contribute significantly to the ground water of this ridge.

Five totalizer gauges were made with a capacity of five gallons each and with straight sided funnels to collect the drippings. A one inch oil seal was placed in the cans to prevent evaporation. These gauges were placed under appropriate trees along a 3 mile stretch of Cahill Ridge. The gauges remained in place from July 20 until August 28, 1951. There was little chance of interference since the gauges were in a remote part of the enclosed watershed which is well guarded. Data concerning the relative positions of the gauges and the resulting precipitation are summarized below in Table I.

The gauges were placed at random beneath the trees, and there may have been some variation within the cover of any one tree. However, five gallon cans were used with at least 16 square inch exposure surface to minimize measuring errors. The 58.8 inch accumulation as found beneath the boughs of the tan oak represents a higher precipitation in little more than a month than found for the area in the entire rainy season. These trees must certainly play a prominent part in maintaining the ground water levels and the lower seepages noted on Cahill Ridge.

It is further evident that the position of a tree with respect to the interception of the fog-laden wind was perhaps more important, within limits, than the height of the trees in determining the amount of condensation. Adjacent grassland and chaparral had dry soil on the same days when this enormous precipitation was accumulating in the forests. Kittredge, (1947) in his summary of forest experiment station data, concludes that fog

TABLE I. Precipitation under fog-exposed trees

Species of tree	Approximate height	Exposure position to fog	Inches of precipitation
<i>Sequoia sempervirens</i>	200 ft.	Forest, no front line exposure	1.8
<i>Lithocarpus densiflorus</i> ...	20 ft.	Direct exposure no interception of wind	58.8
<i>Pseudotsuga taxifolia</i>	125 ft.	Partly protected by Montara Mt. front line exposure	7.2
<i>Pseudotsuga taxifolia</i>	125 ft.	Little protected by Montara Mt. front line exposure	8.9
<i>Pseudotsuga taxifolia</i>	125 ft.	No protection by Montara Mt. front line exposure	17.1

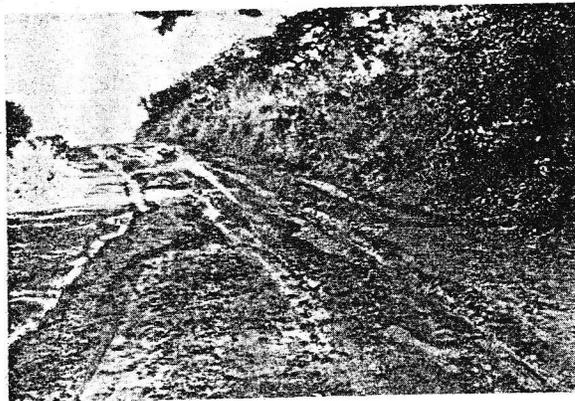


FIG. 1. Crest of Cahill Ridge in mid-July. Fog condensation from the Douglas fir in the background.

drip may increase the precipitation by 2 or 3 times that in the open. These data also show increased precipitation with the height and vertical expanse of the trees with maximum accumulation at the windward edge of the forest. Mearns (1927) sampled ground moisture under Monterey pine and eucalyptus and found an equivalent of 2 to more than 3 inches of precipitation from fog

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condensation under trees from 15 to 20 feet in height. He found that as the trees grow larger their collecting area shows a corresponding increase. Brush and grass, on the other hand, were found to collect relatively little.

Within these moist zones many early spring species continued blooming until late summer. The condensation appeared to provide the conditions for the orchids *Epipactis gigantea* and *Eburophyton austinae*, since these plants were found exclusively in these moist ridge tops. Although this fog drip is considered too spotty to be a limiting factor in coast redwood distribution (Byers 1953), it is evident that these hilltop pools add measurably to the floral variety. Seedlings of douglas fir,

Monterey cypress, and eucalyptus appear to be encouraged beneath parent trees which collect moisture.

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COMPARATIVE YIELDS OF HERBAGE FROM OAK SCRUB AND INTERSPERSED GRASSLAND IN COLORADO

In much of southern Colorado and adjoining states, the lower foothills zone is covered with oak scrub and, since this is a cattle country often with short range, many have suggested that the oaks be cleared to increase the forage yields. Actually, relatively little clearing has been done, and there are few yield records where it has been done. It has also been pointed out that the forage under the oak scrub, which is largely blue grass, is very valuable forage late in the season and therefore it would be unnecessary to remove the oaks. The principal object of this study was to compare the yield of herbage from the oak clumps with the yield from grass parks outside the oaks. There was also opportunity to study the herbage yield from grazed land and from land ungrazed for the past 60 years. The ungrazed area enclosed a reservoir and a domestic water supply and stock had been fenced out.

SITE FACTORS

The study was made during the summers of 1944 and 1949 on Ft. Lewis range lands near Durango, Colorado, where the elevation is 7,700 feet. Figure 1 shows typical range land in the scrub oak community. The temperatures are mild and the precipitation averages 18.5 inches. The soils are light brown and classified as clay loam. Maximum noon light intensities from light meter readings in oak clumps varied from 40-200 foot candles while in the open they varied between 9,000 and 10,000 foot candles. The oak is Gambel's oak, *Quercus gambeli* and the dominant grass between the oaks over most of the area is western wheat grass, *Agropyron smithii*.

Soil samples for moisture were taken adjacent to typical herbage plots at one foot depths down to 6 feet and on the dates indicated in Figure 2. The parks tended to be lower in surface soil moisture early in June as compared with the oak clumps and about the same in moisture later in the summer. In contrast, the deeper horizons of the soil under the oaks lost more of their moisture during the summer than did the parks. The surface soil was near the wilting percentage of 6.8 per cent for both the oak and the park plots in September and early October. Soil sampling was not very satisfactory during the second season because of very dry conditions and difficulty in holding samples on the auger.

METHODS

Samples of herbage were clipped from 25 square foot areas marked off in random fashion by throwing a wire ring into the area. Samples were from separate oak clumps and adjacent grass parks. The samples of herbage

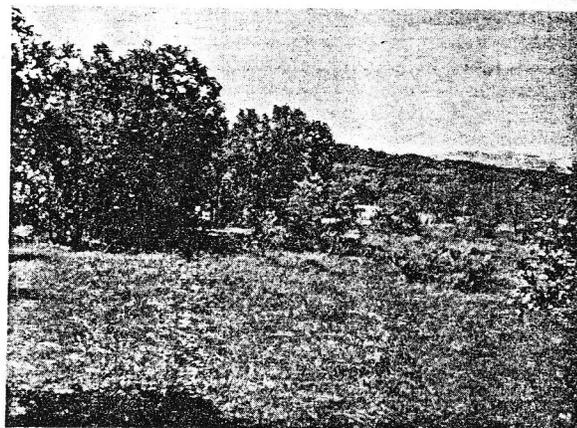


FIG. 1. Typical grazed oak scrub and grass-weed park range.

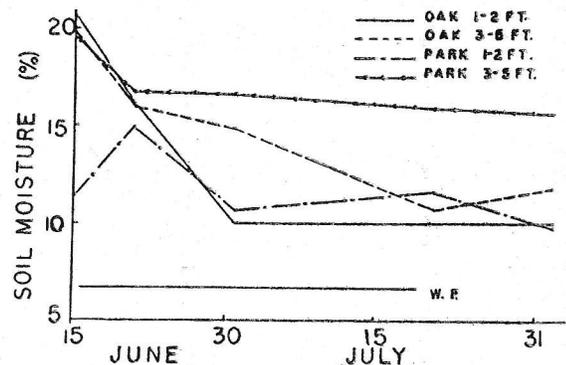


FIG. 2. Average soil moisture at the 1-2 foot and 3-5 foot levels for oak clump and the grass-weed park communities.

were placed in paper bags and taken immediately to the laboratory for dry weight determinations. Several representative open grasslands or parks and their adjacent oak clumps around a center within an area of 100 yards in diameter in the east half of the 10 square mile holdings were sampled the first season and a similar area one-fourth mile to the west was sampled the second season. Both of these pastures have been grazed for a number

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