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Rept. No. 20 of Sec.

REPORT

ON THE

CLIMATIC AND AGRICULTURAL FEATURES

AND THE

AGRICULTURAL PRACTICE AND NEEDS

OF THE

ARID REGIONS OF THE PACIFIC SLOPE,

WITH NOTES ON ARIZONA AND NEW MEXICO.

MADE UNDER THE DIRECTION OF

THE COMMISSIONER OF AGRICULTURE,

BY

E. W. HILGARD, T. C. JONES, AND R. W. FURNAS.

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1882.



WASHINGTON:  
GOVERNMENT PRINTING OFFICE.

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**The Reader Will Please Correct the following Errata:**

Page 48.—Heading of second column should read "filled" instead of filled.

Page 92.—The matter from the heading "Sugar Cane and Sorghum" to the heading on page 98 should be credited to E. W. Hilgard.

Page 98.—All from the heading to page 108 should be credited to R. W. Furnas.

Page 124.—All from the end of the paragraph headed "Small Fruits" to the heading on page 128 should be credited to E. W. Hilgard.

Page 128.—All from the heading on this page to page 137 should be credited to R. W. Furnas.

Pages 152 and 153.—All under the heading "Insect Pests" should be credited to R. W. Furnas.

Some additional verbal corrections will be readily made by the reader.



## LETTER OF TRANSMITTAL.

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Hon. GEO. B. LORING,  
*Commissioner of Agriculture:*

SIR: I transmit herewith a report of the commissioners appointed by you in August, 1881, in pursuance of a provision made by Congress "for procuring data touching the agricultural needs of that portion of the United States lying west of the Rocky Mountains and the Arid Region."

This commission was composed, besides myself, of the Hon. R. W. Furnas, of Brownsville, Nebr., and Judge T. C. Jones, of Delaware, Ohio; the former gentleman prominently identified with the horticultural interests of his State, and the latter well known as a prominent breeder of short-horn and other improved breeds of cattle. Your instructions to the commission embraced the following points:

To institute investigation and make reports upon—

1. The grape-culture and wine-making of the Pacific coast as it now exists, and especially the inducements offered by the soil and climate of New Mexico for viticulture, in reference to supplying the market with valuable grapes, wines, and raisins.

2. The animal industry of that portion of our country, its value, condition, and management generally, including cattle, horses, sheep, and swine.

3. The agricultural methods prevailing in the region designated, including cereal crops, their value, amount in aggregate and average yield per acre, the general management of land for horticultural as well as agricultural purposes, and the modes of fertilization.

You further requested me, as chairman of the commission, to appoint a meeting of the members on this coast as early as possible. Fearing that the pressure of other duties and engagements already incurred would prevent me from taking as active a part in the work of the commission as the case seemed to require, I hesitated to accept the charge, and so informed you. As, however, for reasons satisfactory to yourself, you declined to make another appointment, I consented to act, as far as practicable under the circumstances, in assisting my colleagues in their labors, and in editing and supplementing their reports.

Messrs. Furnas and Jones met me here September 6, and immediately took the field, visiting successively such portions of the State as were of most immediate interest in view of the progress of the vintage, fruit harvest, and agricultural exhibitions. Toward the end of October they left the State on the southern route, making observations in Ari-

zona and New Mexico, and reaching home early in November. Their reports on their respective spheres of observation reached me about the middle of January of the present year.

In editing and completing this report I have deemed it best, and in accordance with the object of the commission, to leave each member to formulate and record his own observations and opinions in those matters in which he felt himself most competent to form his judgment. It would be disingenuous to disguise the fact that, especially as regards California, a great deal has been said and written that is popularly considered as partaking largely of the bias usually ascribed to travelers in foreign parts—a kind of mild exaggeration, born of local enthusiasm and a safe distance from close criticism. This tendency to grandiloquence is, moreover, supposed to infect promptly any one who for any length of time exposes himself to the bewitching influence of California air and sunshine. Recognizing, therefore, the wisdom of your selection of two trustworthy and impartial judges, identified with the interests of their respective States, to observe and report on their respective specialties, I have made a point of allowing them to come to their own conclusions from the facts before them. If in expressing these opinions they have to a considerable extent adopted the language of California writers on the subjects in hand, I can but say that, having used the most commendable diligence and energy during the time at their command, they have every reason to know from personal observation the actual facts of the case.

So far, then, as the subjects treated by my colleagues are concerned, I have confined my own remarks to comments, or the making up of accidental omissions, in the body of their respective reports; distinguishing such intercalations, however, by my initials placed at the end.

As regards the matter contributed by myself, I have, in treating of subjects that have heretofore engaged my attention, made free use of such portions of the reports previously made by me to the regents of the University of California as bear upon the objects of the Commission. The limited publicity given to these reports outside of California, renders their contents substantially new to the general public, especially in the new connections in which the recasting has placed them.

If it should be thought invidious that the commission has given its chief attention to California, it seems to me that, even apart from the instructions above quoted, such action can be justified upon the ground that it is in California that the various conditions found in the "Arid Region of the United States" are realized within the smallest space, and have been longest subject to experiment and experience on the part of an intelligent and enterprising population.

Had the limited means at the command of the commission been spread over the whole of the territory west of the 100th meridian, the results would have been of so general a nature only as to add little to what is contained in the excellent report of General Powell. It may

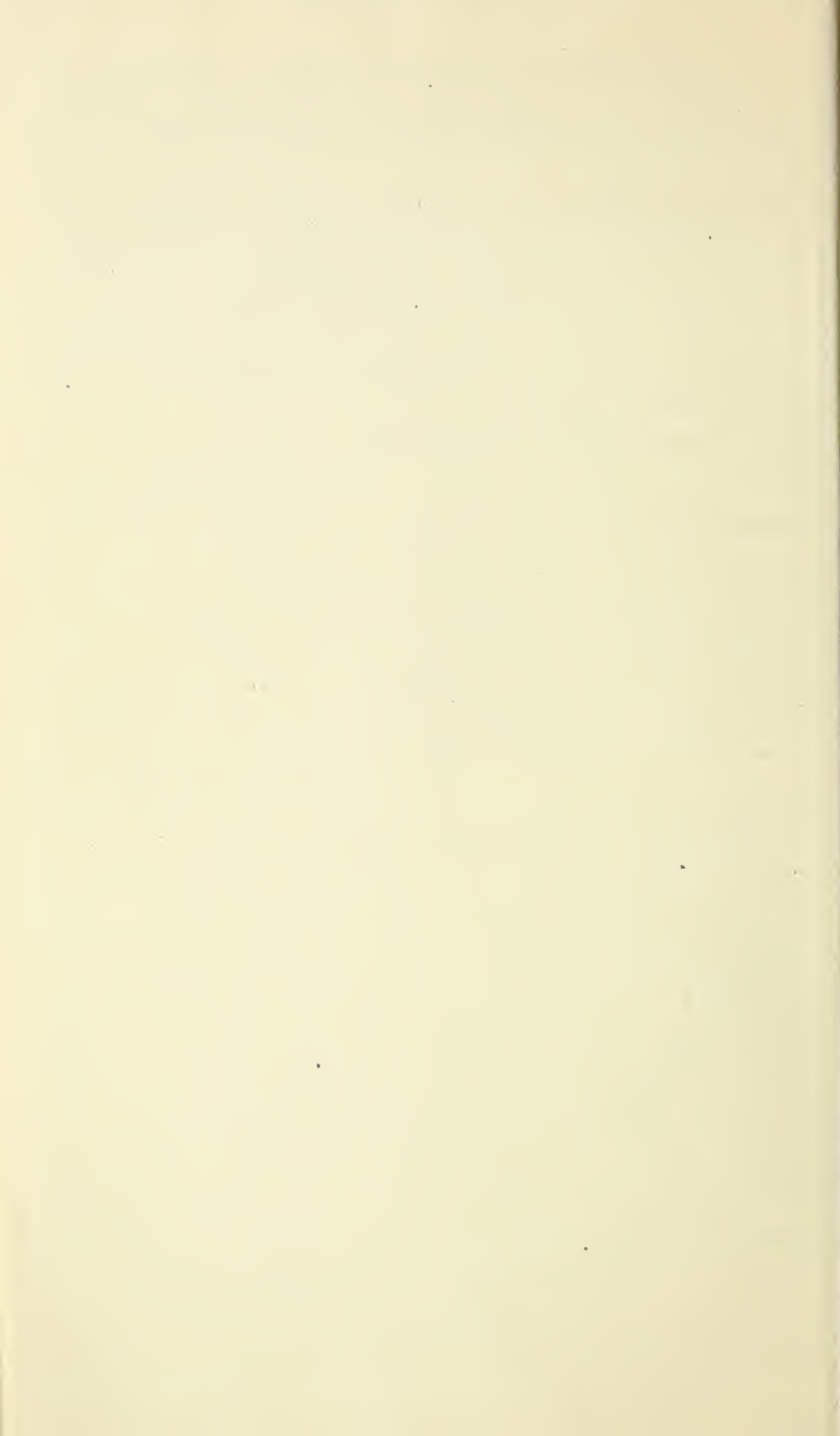
properly be presumed to have been the intention of Congress, in making the appropriation, to obtain something more detailed and specifically technical than the data given by General Powell, and with the means provided detailed study could not usefully be extended over any very wide area.

I would have greatly desired to add to the present report data relating to the peculiar conditions governing agriculture in Eastern Oregon, Washington, and Idaho, the region soon to be opened to communication with the world at large by the completion of the Northern Pacific Railroad. But my personal observations in that country have been too limited as yet to enable me to give more than a fragmentary account, and the time at command of my colleagues did not allow of such extension of the scope of their work.

All of which is respectfully submitted.

E. W. HILGARD,  
*Chairman of Commission.*

BERKELEY, CAL., *March 4, 1882.*



## INTRODUCTORY REMARKS ON THE WORK OF THE COMMISSION.

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BY R. W. FURNAS.

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Comparatively speaking, new conditions are found in California. Originally, what is now the State was regarded only as a mining region. The peculiar and admirable climate, even, was regarded as incidental, and of no particular practical value. The valleys, before the rush for gold, were considered valuable for grazing purposes, it is true. But isolated as they were, and the population sparse, the time was when cattle and even horses were actually slaughtered as a means of protecting the meager growing crops necessary to subsist settlers. After the gold fever had run a course, as it were, attention was given to tilling the soil, which was found peculiarly adapted to wheat, barley, and fruit-growing. Since that time great superiority has been claimed for these three industrial factors. For fruits of nearly all kinds, more especially the citrus family of semi-tropical fruits, wines, and raisin grapes, peaches, pears, plums, prunes, and figs, unequaled characteristics in matter of soil, climate, yield, quality, &c., have been claimed, and, after investigation, were almost universally conceded.

Both the limited appropriation and time at command of the commission were such as to preclude detailed visitation and personal observation of *all* localities. The object, therefore, has been to see and observe, so far as circumstances would admit, representative sections.

As a rule, the efforts of the commission were heartily seconded, and no pains spared to enable members to accomplish the objects desired. Special mention is due Hon. Horace Davis, ex-member of Congress, San Francisco, who was the author of the appropriation clause under which the commission acted. Also, A. N. Towne, T. G. Goodman, J. C. Stubbs, and B. B. Redding, of the Central Pacific Railroad offices, for use of records and statistics obtained through their courtesy. Prof. E. J. Wickson, editor of the Pacific Rural Press; Lathrop Brothers, Palo Alto; Judge B. P. Rankin, San José; J. B. Armstrong, Santa Rosa; R. J. Poppe, Sonoma; Prof. George Husmann, Napa; E. F. Smith, secretary of the State Board of Agriculture, Sacramento; Jewett and Decker, Marysville; General John Bidwell, Chico; I. W. Ferguson, Fresno; Ford Roper, Bakersfield; George Rice, secretary of the Southern Horticultural Society, Los Angeles; Elwood Cooper, Santa Barbara; Major Chace, San Diego; N. C. Carter, San Gabriel; Professor and Mrs.

Carr, Pasadena; S. C. Evans, Riverside; Russel Heath, Carpenteria, and others.

The facts and figures given were principally obtained on the spot, from actual observation and records.

In making up this report the writer has made liberal use of the reports of viticultural and horticultural commissioners, as will be seen by comparison, in some instances copying *verbatim*. Mainly, however, a condensation of both diction and matter, where used, has been made.

## CLIMATES OF THE PACIFIC SLOPE.

BY E. W. HILGARD.

The small visual angle subtended by the long stretch of coast from the Straits of Fuca to San Diego, at the distance from which it is viewed by the bulk of the population of the United States, and the fact that it is occupied by but two States and one Territory, makes it difficult for the popular mind to realize the great differences of climate embraced within these sixteen degrees of latitude, which on the Atlantic coast cover the coast line between the Gulf of Saint Lawrence and Charleston, S. C. It is true that as regards both the mean annual temperatures, and the lower extremes particularly, the difference between Cape Flattery and San Diego is very much less pronounced than on the Atlantic side, where the desolate shores of Labrador at once announce the confines of the Arctic regions, in striking contrast to the forest-clad hills that gird Puget Sound. Yet, while the conditions of temperature are such as to permit the culture of the same familiar flowers, garden and even some field crops, at Victoria and Los Angeles, the differences in the agricultural practices brought about by the variation in the rainfall are far greater than exist along the entire extent of the Atlantic coast. From Cape Sable of Nova Scotia to its namesake of Florida, a humid climate, with summer rains, prevails, and the cultivator of the soil is governed in his operations almost exclusively by the conditions of temperature; his time for sowing and harvesting is controlled and limited simply by the end and beginning of winter.

The same familiar *régime* prevails on the northern portion of the Pacific coast, in Washington Territory, Oregon, and the most northern part of California; and it is, doubtless, for this reason that so large a portion of the immigration to the coast from the northern countries of Europe tends in that direction. There the Scandinavian and North German has nothing new to learn; he finds only a fatherland under improved conditions, even to the plants familiar to his childhood, pine forests, mountains, and endless drizzling rains, the total annual outcome of which would at times reach several inches above his head. This region of heavy rainfall extends southward into California, to where the Sierra Nevada and the Coast Range unite in the grand mountain mass of Shasta. In the valleys surrounding that volcanic peak, the rain-gauge has accumulated as much as 108 inches of water in one season; but here already it falls in torrents during a comparatively short rainy season, many inches at a single downpour, with only an occasional thunder-storm from June to October, already indicating the approach of the region of rainless summers, which embraces by far the larger portion of the State of California. In the Sierra Nevada, of course, the summer rains extend farther to southward than in the Coast Range, and in the valleys, where the inhabitants can often see the dark cloud-caps gathering around the peaks, emitting flashes of lightning whose echoes fail to reach them,

and not disturbing in the least degree the serenity of the blue sky overhead or the intense dryness of the atmosphere. Thus the rainfall of 20 inches is carried in the high Sierras as far as the heads of Kern and King's Rivers, furnishing the water-supply upon which depends the irrigation of the fertile soils of the San Joaquin Valley. Thence south-eastward, the annual rain gauge abruptly descends to 8 and even 4 inches in the arid plain of the Mojave desert and the basin of Nevada.

Along the coast proper Cape Mendocino bears the reputation of a kind of water divide. Mariners expect a change of weather whenever they round it, and on land it marks the region where the character of vegetation begins to change rapidly from that of Southern or Middle California toward that of Oregon at and immediately north of the cape; the rainfall reaches an annual mean of 36 inches. A short distance southward, at Point Arena, it is only 20 inches; and, rising slightly in the region of San Francisco, it falls to 16 on the Bay of Monterey, 12 at Santa Barbara, and 8 to 10 at San Diego.

A similar but somewhat more rapid decrease of rainfall is observed in the Great Interior Valley. From 40 inches at Redding, its extreme northern end, and 25 inches at Red Bluff, 24 miles to southward, the annual mean falls to about 19 inches at Sacramento and to 16 at Stockton. Thence southward, the rainfall descends to a mean of only 10 inches at Merced,  $7\frac{1}{2}$  at Fresno, and  $4\frac{1}{4}$  at Bakersfield, near the southern end of the San Joaquin Valley, and separated only by the Tehachapi Mountains from the western margin of Mojave desert, in which the rainfall is still less.

Were these rainfalls of 20 inches and less distributed over the whole or even the greater part of an ordinary season of the temperate zone, it would be altogether inadequate for the growing of cereal or other usual crops of that zone; but since in California nearly the whole of it usually falls within six months (November and April, inclusive), and by far the greater part within the three winter months, during which a "growing temperature" for all the hardier crops commonly prevails, it becomes perfectly feasible to mature grain and other field crops before the setting-in of the rainless summer, provided only that the aggregate of moisture has been adequate, and its distribution reasonably favorable. The grain sown into the dust of a summer-fallowed field begins to sprout with the first rain, and thenceforward grows more or less slowly, but continuously, through the winter; is ready to head at the first setting-in of warm weather, from the end of March to May, according to latitude; and becomes ready for the reaper from the end of May to that of June. Once harvested, the grain may be left in the field for several months, threshed or unthreshed, without fear of rain or thunderstorms. As a matter of course, the grain-grower may also sow his grain at any time after the beginning of the rains at his option; and good crops are sometimes obtained from sowings made late in February. Usually, however, the late-sown grain is cut for hay when in the milk, in April and May; for since meadows can form no part of the agricultural system except where irrigation is feasible, the hay grasses commonly grown in the Eastern States are available only to a limited extent, and wheat, barley, and oats take their place. Again, there is no strict distinction or limit between fall and spring grain, since the sowing season extends from October to February. Thus, the winter months are a very busy season for the farmer in California, as he has to watch his opportunity for putting in his crop between rains. The time between laying by and harvest is nearly filled up by gardening and hay-

ing operations. The latter are occasionally interrupted by one or two light showers, rarely enough to injure the quality of the hay. Protracted rainy "spells," or thunder-storms, calling for a hasty gathering of the cut grain into cocks, are unknown in harvest time, hence spoiled or sprouted grain is scarcely thought of, except only in case of the sacked grain being left out so late as to catch the first fall rains.

It will thus be seen that while the winter months are the busiest season for the California grain-grower, midsummer finds him comparatively at leisure; the threshing of the grain crop and the baling of hay (both usually done by itinerant gangs of contractors) being all that is on his hands until the coming of the rains. It goes without saying that the California summer is vastly better adapted to the enjoyment of leisure than an eastern winter. In view of this peculiarity of the growing season of California, the propriety of counting production, rainfall, &c., by such "seasons" instead of calendar years, becomes obvious; and it is the universal and unconscious practice to do so. From this practice arises, also, some differences in the means of rainfalls as given in the Smithsonian tables on the one hand, and the "season tables" of California, herein adopted, on the other. But while the culture of hardy plants of rapid development was the first and most obvious expedient resorted to in order to utilize the fertile soils of the "arid regions" of California, that of selecting culture plants adapted to an arid climate was also soon tried. The way has been tried by the missionary Padres, who brought with them from the similarly arid climates of the Mediterranean region of the Old World the vine, the fig, the olive, and the citrus fruits—the lemon and orange. To these have since been added the fruits of the entire temperate and subtropical zone, each of which finds the proper conditions of success in some of the many and endlessly diversified climatic areas, zones, islands, and nooks which meet the traveler unexpectedly all over the State, and among which the most fastidious taste can hardly fail to discover something suited to his idiosyncrasy. It is this diversity, this constantly recurring charm of novelty and undeveloped possibilities that casts a spell over all those who have once experienced it, and are not governed merely by the desire for gain, but also by that of home-making. California has for years ceased to be the country of rapid fortunes, and many more have doubtless been lost than gained by indiscreet investments prompted by the still uneradicated tendency to risk all upon the accidents of a game, a mine, or a season; yet even those whom fate has not favored, and who have long left its shores, look back to California, its sunny skies and marvelous contrasts, with a feeling akin to that with which the Swiss emigrant remembers his native mountains and valleys.

#### WINDS.

The prevalent winds of the Pacific coast are from the west, the influence of the Pacific Ocean thus producing a temperate climate. This effect is partially cut off from the interior valley by the Coast Range, which also intercepts a part of the moisture carried by these winds; the remainder is condensed by the Sierra Nevada and Cascade Ranges, thus producing the arid continental climate of the interior plateau of Nevada, eastern Oregon and Washington.

North of Cape Mendocino the direction of the prevailing currents is more from north of west; southward, due west or slightly south of west, forming the "summer trade winds," which set in regularly some time in

May, and continue, with but an occasional interruption by a "norther," until October, laden with moisture from the warm high seas. In summer they strike the cold Alaskan Ocean current which comes to the surface and sets in-shore off Central California, producing dense fogs which during the summer months frequently cover the Coast country for 20 out of 24 hours, for weeks together. Beyond a slight drizzle, however, no water falls; and as the fog banks drift against and up the slopes of the Coast Range, they dissolve quickly before the intense heat and dryness of the summer atmosphere beyond. The moisture absorbed by the soil of the coast belt from these fogs goes far, however, toward maintaining the growth of the hardier herbaceous as well as of woody plants, no less than that of weeds, during the season of drought. In the great interior valley, the general direction of these winds is changed to "up-valley," that is, a little west of south in the Sacramento, and west of north in the San Joaquin Valley: a heavy westerly breeze flowing in, as a rule, through the joint outlet of these valleys, the Strait of Carquines.

From May to October, both inclusive, south winds are very rare, but during the winter months they bring the rains upon which the success or failure of crops depend. The winter rain-storms are usually heralded by heavy weather in Oregon or in the Shasta region, whence the rain wind works backward, so to speak, until it exhausts itself in the southern part of the San Joaquin Valley, where the San Fernando Range seems to form a partial weather divide, leaving the Los Angeles region more or less independent of the changes to northward. Sometimes the rain-storm works chiefly down the coast, leaving the great valley almost dry, in which case Los Angeles and San Diego usually get a fair proportion of benefit. Sometimes prolonged and severe storms cover the entire State, and extend far into Arizona and British Columbia. As thunder and lightning rarely form a part of the atmospheric disturbance, the rain usually falls gently and continuously rather than in torrents, and thus chiefly soaks into the ground, but sometimes a fierce south wind drives it for a day or two, and then generally there comes a change: the wind gradually veers to the westward, and then more rapidly to north-west and north, and with a heavy shower the sky clears suddenly and the "norther" sets in. Though not ordinarily bringing a very low thermometer, it often feels biting and penetratingly cold, because of its velocity and dryness, causing rapid evaporation. Before it the surface moisture quickly disappears, muddy roads become as rough as if frozen, and compact ground cracks after a few days. Any long prevalence of this wind is looked upon with dread at all seasons, on account of the waste of moisture which it involves even when cold. In autumn and spring, when its temperature is higher, the young grain often withers before it, and from May to September (when it fortunately is of rare occurrence), it sometimes becomes a veritable simoon, like the breath of a hot furnace, shriveling up the grain when in milk, and sometimes almost curing into hay the standing crops. To seaward of the Coast Range it is rarely of long duration, three days being its ordinary limit; but in the Great Valley, and especially in that of the San Joaquin, it is both more frequent and persistent, occasionally blighting in a week all the hopes of the grain-grower not able to resort to irrigation, and even drying the fruit on the trees. East winds are only of brief and local occurrence, being ordinarily cut off by the mountain ranges in their north and south course. They are usually the precursors of a "south-wester" with rain.

## CLIMATIC REGIONS OF CALIFORNIA.

The climatic subdivisions of California may conveniently be considered under the following heads, transition zones of greater or less extent intervening between the areas here defined:

1. The coast climates, with cool summers and warm winters, the ground rarely freezing even superficially, except in most northerly portion; westerly winds predominant. Subdivided into—

A. Region near and north of Cape Mendocino, with from 30 to 80 inches of annual rainfall, occasional summer showers and thunder-storms. Transition to the Oregon climate. Mean winter temperature of Eureka,  $47^{\circ}.0$  F.; mean summer temperature,  $58^{\circ}.2$  F.

B. Region of San Francisco Bay, southward to Santa Cruz, with from 25 to 16 inches of rainfall, and heavy summer winds and fogs; practically no summer showers. Average winter temperature at San Francisco,  $51^{\circ}$  F.; summer,  $56^{\circ}$  F.

C. Southern coast region, from Monterey to San Diego, 12 to 8 inches of annual rainfall; fewer fogs than in the San Francisco region; irrigation ordinarily needed for field crops. Mean winter temperature: Santa Barbara,  $54^{\circ}.3$  F.; San Diego,  $54^{\circ}.6$  F. Summer: Santa Barbara,  $68^{\circ}.2$  F.; San Diego,  $69^{\circ}.1$  F. Extreme temperatures: Santa Barbara,  $33^{\circ}$  and  $98^{\circ}$  between 1870 and 1880. Mean humidity,  $69^{\circ}.5$ ; variation from  $64^{\circ}$  to  $74^{\circ}$ .

2. Climate of the Great Valley of California, with high summer temperature and intensely dry atmosphere; no summer fogs. Subdivided into—

A. Climate of Sacramento Valley, with 20 to 40 inches rainfall; little irrigation. Mean winter temperature of Sacramento,  $47^{\circ}.9$  F.; summer,  $71^{\circ}.2$  F.

B. Climate of the San Joaquin Valley, with 16 to 4 inches rainfall. Irrigation needed for safety of all field crops, and more or less for all others. Winter temperature at Visalia,  $45^{\circ}.4$  F.; summer,  $80^{\circ}.8$  F.

C. Climate of the foothills of the Sierra Nevada, up to 2,000 feet elevation. Rainfall greater than at corresponding points in the valley, increasing at the rate of about one inch for every 150 feet. Summer temperature about the same as in the valley.

3. Mountain climates of the Sierra Nevada and Northern California (Siskiyou and Shasta region). Summer and winter well defined, snow lying during several months; rainfall from 20 at the south to 100 inches at the north. Region of fir and pine forests, and pasturage.

4. Semi-tropical region of South California: Los Angeles, San Bernardino, and San Diego Counties. Rainfall, 8 to 12 inches; irrigation universal; frosts rare, permitting the culture of semi-tropical fruits in the open air, despite of an occasional cutting back in severe seasons.

5. Arid Plateau climate of the Mojave and Colorado Deserts. Rainfall from 8 to 4 inches and less, irregular, some seasons almost none, so that annual vegetation lies dormant; to southward bordering the region of summer rains of Arizona and New Mexico.

## VARIATION AND PERIODICITY OF RAINFALL.

While the means of rainfall above given will not vary widely when a number of years are taken together, the variations from one year to another are often sufficiently great to tempt many to invest heavily in

putting in crops on the chances of a favorable season, which would bring a fortune at one venture, but sometimes result in a total loss, and consequent ruin to the investor. Such cases of agricultural gambling were at one time not uncommon, in the San Joaquin Valley especially; the turning point of profit or loss being a single light shower at the critical time, or the occurrence of a norther for a day or two. Much ingenuity has been spent in trying to forecast the weather for season in time to determine the chances of success; but it will generally be found that the oldest citizen, if he is candid, will be far more reserved in his opinions than later comers. However steady and reliable the summer climate may be, that of California winter is more difficult to forecast from day to day and from week to week; and, while there are certain rules that are ordinarily counted upon, the cases where "all signs fail" are very frequent, and surprises are abundant. A discussion of the observations made from 1849 to 1877, by Dr. G. F. Becker, late of the University of California, and now of the United States Geological Survey, seems to indicate as probable a cycle of thirteen years between extreme minima or drought years; and some data I have since obtained from the records of the missions seem to confirm still further this conclusion. The first minimum, within the time of the American occupation of California, occurred in the season of 1850-'51, when the rainfall at San Francisco (where the mean is  $23\frac{1}{2}$  inches) was only 7.4, while it had amounted to 33.1 the year before; the second minimum occurred in 1863-'64, when the rainfall at San Francisco was 10.1 inches; and the third was the season of 1876-'77, with 10 inches. The next succeeding season of minimum would be that of 1888-'89.

The following table, given by Dr. Becker, exhibits these facts, as also the probabilities deduced for the intervening years, from a discussion of the nature of the curves representing the observations.\*

*Observations, periodicity, and probabilities of rainfall, San Francisco.\**

Years.	Rainfall.	Years.	Rainfall.	Position in period.	Probabilities.
1850-'51.....	7.40	1863-'64	10.08	I	11.50
1851-'52.....	18.44	1864-'65	24.73	II	20.50
1852-'53.....	35.26	1865-'66	22.93	III	27.40
1853-'54.....	23.87	1866-'67	34.92	IV	30.50
1854-'55.....	23.68	1867-'68	38.84	V	28.30
1855-'56.....	21.66	1868-'69	21.85	VI	23.30
1856-'57.....	19.81	1869-'70	19.31	VII	19.30
1857-'58.....	21.88	1870-'71	17.10	VIII	19.60
1858-'59.....	22.32	1871-'72	34.71	IX	25.00
1859-'60.....	31.22	1872-'73	18.02	X	28.20
1860-'61.....	19.72	1873-'74	23.98	XI	28.50
1861-'62.....	49.27	1874-'75	18.40	XII	28.50
1862-'63.....	13.62	1875-'76	26.01	XIII	19.00
Totals.....	308.05		307.38		309.60
1849-'50.....	33.10	1876-'77	10.00		

\* Tennant's gauge.

Similar tables for Sacramento and Stockton exhibit the same general features.

From information kindly furnished me by H. H. Bancroft, esq., of San Francisco, it appears in the records of the early explorers of California the year 1805 is known as "El año del hambre" (the hungry year), the drought having been extraordinarily severe; and nearly the same account is given of the year 1817. It will be observed that these dates indicate a period of twelve years between themselves, and that the inter-

\* See Bulletin No. 31 of the University of California, February, 1878.

val from the last mentioned date to 1877 (for those drought years as yet no data have been found) is also divisible by the same number. It is quite intelligible that as the result of several concurrent and variable causes the period may vary between such limits as twelve and thirteen.\*

Should further observations confirm the existence of this definite periodicity, the forecast even to this extent would be of immense service to agriculture in California, since the nature of the crops, as well as their treatment, could, in a measure, be adapted to the circumstances of these "lean years." Still the portion of the valley lying south of Stockton will always be a region of predominant irrigation, while in the northern portion a proper and intelligent co-adaptation of crops and soils can render agriculture more or less independent of that necessity. As the matter now stands it is estimated that in the southern portion of San Joaquin County one good crop out of three may be made without irrigation, while south of Merced one in five is about all that can be counted on in the undulating uplands bordering the foothills. Other things being equal, much of course depends upon the nature and depth of soil, the perfection and depth of tillage, and the practice of after-cultivation as against broadcasting. To guard against the effects of northers, and to prevent all avoidable evaporation of the precious moisture, it is the universal practice to roll the grain-fields as late as it can be done without injury to the growing grain. On sandy soils this can hardly be overdone; but on clay soils, should they be too wet when rolled, the effect will be the exact reverse of what is desired, and great injury often results.

It is the general estimate that whenever the rains have been adequate to make the moisture from above meet that rising from below, a crop may be secured, if the season be reasonably favorable. And since the depth at which moisture is found at the end of the dry season will, other things being equal, depend upon the amount of rainfall during the previous season, it makes a material difference whether a droughty season has been preceded by a wet one (as was the case in 1850-'51), or whether a scant rainfall preceded a deficient one. In the middle portion of the valley the summer's drought will, on untilled soils, reach to the depth of from 3 to 5 feet, according to the nature of the soil; and this mass has to be remoistened fully to that depth to give promise of success for field crops. When the surface has, on the contrary, been kept in a state of good tilth during the summer ("summer fallowed"), the moisture will be found at a much less depth; the remoistening by the fall rains will be proportionally more rapid, and the chances for a crop materially increased from that cause alone.

In the extreme south of the San Joaquin Valley the annual rainfall rarely moistens the soil to a greater depth than 2 or 3 feet; and in digging or boring wells in districts not irrigated the materials are found dry as dust to the depth of 40 feet, and even more. At the first beginning of irrigation this entire mass has to be moistened before moisture will permanently remain within reach of the tap-roots of plants, and a very large amount of water is therefore at first required; but gradually the ground fills up, the water table, and with it the plane of moisture, rises more or less rapidly, the effect becoming perceptible at the distance of many miles in the porous soils of the plains; and ultimately the amount of water annually needed for irrigation becomes several times less than that needed during the first years.

\* See my article on "The Soils and Agriculture of California," in Report of the Department for 1878, p. 478.

## TIMBER AND FOREST CULTURE.

The occurrence of timbered lands is mainly governed by the existence of the proper moisture conditions. In the arid regions, therefore, we find timber belts of more or less importance bordering the streams, and thus marking their course at a distance; and we likewise find them forming large bodies on mountain chains whose elevation is sufficient to increase the rainfall to an adequate extent, and from these descending to a lower level in valleys, on usually the side least exposed to the afternoon sun. Apart from the denser forest growth of the mountain proper, we find, especially on the Pacific slope in California and Arizona, a scattered growth of hardy drought-resisting trees (largely oaks), which dot the plains and hill lands, producing the appearance of a park, or, as it is commonly expressed, "of an orchard," the low, rounded forms of these oaks resembling more that of orchard trees than their brethren of the oak forests east of the Mississippi. This feature is familiar in most of the pictures representing scenery on the Pacific slope south of Oregon, and more or less eastward to the Rocky Mountains. In but few cases is this oak growth so dense as to be entitled to the designation of a forest; nor is the timber usually available for other purposes than fire-wood, the wood being brittle, quarled, and of little durability. The supply of lumber for building and other purposes in the arts is therefore obtained either from the pine timber of the higher mountains or on the Pacific coast, from the rapidly diminishing redwood forests of the Coast Range northward of the Bay of Monterey, or finally from the forest regions of Oregon and Washington west of the Cascade Range. The hard woods for the purposes of the makers of wagons, agricultural implements, &c., are thus far brought from the Eastern States, via Cape Horn; although in the near future the woods of Mexico, now only available for ornamental purposes, will probably be brought into requisition. In the hands of the cabinet maker, the California laurel, and the maple, ash, and white cedar of Oregon, are common and highly valued materials.

## CAUSES LIMITING TIMBER GROWTH.

While the rainfall is the ultimate controlling factor of forest growth, there is a proximate one which exerts a very material influence upon the actual distribution of forests and extent of forests in the arid region, viz., fire. While powerless for harm in the land of scattered oaks, where the undergrowth is rarely heavy enough to injure a tree by its combustion, it acquires fearful efficacy in the region of dense forests; and the destruction thus caused is far greater than in the region of summer rains, where any forest fire is likely to receive a severe set back, if not extinction, within a week or two. Where the rainless intervals extend to many months, there is nothing to check or circumscribe the progress of the destructive element save the exhaustion of the fuel or the intervention of a bare ridge or mountain chain. The fearful depletion of the timber resources thus incurred is graphically depicted on the map of Utah Territory accompanying the report of General Powell on the arid lands, where the "area destitute of timber on account of fires" is shown to be at least equal to that actually timbered, whether densely or scatteringly, while in the regions still used as hunting grounds by the Indians these fires are largely intentionally started for the purpose of driving game, though in part attributable to carelessness on the part of

whites as well. The latter factor plays a conspicuous part in the country occupied more or less by settlers, where the neglected camp fire and the discarded cigar stump, as well as the paper gun-wads of hunters, form prolific sources of mischief, against which even laws have been enacted with but little benefit. While the warm, dry, autumnal northers sweep over the redwood forests of California, whose value is so well and fully appreciated by all, the entire population is on the alert to check incipient fires, and yet conflagrations by which thousands of acres are swept in a few days annually redden the skies in September and October. The same occurs in the pine forests of the lower slopes of the Sierra Nevada. It seems as though nothing but severe penal legislation, even against carelessness, inducing a gradual change of habit through the force of public opinion, could be effectual against an evil which continually endangers property, and even life, within a few miles of the city of San Francisco. With a more dense population, such disasters as that which lately befell a part of Michigan would be of annual recurrence in the wooded portion of the arid region. The easy success of timber plantations in the prairies and plains between the Mississippi and the Rocky Mountains is proof conclusive that their treelessness is due, not to a climate unadapted to tree growth as such, but to a rainfall so light, or so distributed that, in the fight for existence against fires and strong winds combined, the trees could maintain themselves only in exceptionally favored localities.

In the regions of scattered oak timber, the undergrowth, whether herbaceous or shrubby (*chaparral*), rarely makes a fire sufficiently hot to kill the old trees; but it, as well as the ranging of cattle, is quite effectual in preventing the growth of another generation of oaks. Even where this is not the case, the exceedingly slow growth of the oaks of the arid regions would render the replacement of the original timber too slow a process even for the fuel requirements of a rural population. Already in some portions of the San Joaquin Valley cord wood has to be hauled from the foot-hills to distances of 20 and 30 miles. In the interior territories, where the need of fuel in winter is so much greater on account of the severe climate, the distance from which fuel must be brought (usually from the mountains) is one of the determining factors in the location of settlements, and many are on this account placed in much less desirable localities than would have been chosen in the absence of this consideration.

#### INFLUENCE OF FORESTS UPON ARIDITY.

Apart from the question of timber supply, the depletion of forests, whether by fire or by the ax, exerts a most injurious effect, in respect both to the amount and availability of the rainfall. While the former relation may be disputed by some who will not recognize any broad facts unless reducible to figures and instrumental readings, there can be no question as regards the latter. The bare surface allows the rain-water to shed, and the snow to slide and melt much more quickly and abundantly than in the case of a forest covering, where the trees mitigate the beating of the rain, and the mulch of their leaves, as well as their shade, keeps the soil loose and pervious, and enables an undergrowth to exist which could not resist the direct impact of the wind-driven rain, the dry northern and the hot summer sun. Instead of coming down in torrents which score the mountain side and carry off the soil, and then leave dry parched gulleys, the water that falls in the forest, whether as snow or rain, soaks down gently, partly into numerous small

rivulets, partly into the ground, to reappear farther down, and, during the dry season, as springs. The effect of forests is, therefore, in all cases, to diminish the aridity of the surface, if not of the climate; though even the latter effect is reasonably predicable from changes wrought within historical times in the Mediterranean region of Europe and Asia.

A striking example of the local effects of trees in arid climates is found in the desert region of Africa, where the date palm supplies the chief means of existence. The utility of this tree is, of course, in a great measure a direct one, since it flourishes with a minimum of moisture and bears an abundance of nourishing fruit, but its utility does not end there; for it is in its shade alone that other useful plants, such as beans, melons, and other garden vegetables can be successfully grown, since the scorching rays of the noonday sun are thus mitigated. In extreme cases the tree is actually planted in pits as much as twelve feet in depth, from which it ultimately emerges with its crown only, forming a stout, short trunk quite unlike its usual habit.\*

We have a somewhat parallel case in the mezquit of the southern arid region in Arizona, New Mexico, and Texas, where a small tuft only of leafy branches alone is seen above ground, while the main body of the tree is below the surface, so that the camper has to dig for his fire-wood. In the valley of California the new-comer is often surprised to find extensive wheat-fields retaining all or most of their natural growth of scattered oaks; and to note that grain grown in the shade is not only not inferior, but in some seasons even decidedly superior, to that grown in the open space. The shade, it is true, is not very dense; but such as it is it acts in dry seasons as does that of the date tree above alluded to, in protecting the grain from the too intense heat of the summer sun, and turning the balance in its favor in severe droughts. This non-interference is in a measure, no doubt, attributable to the fact that, in consequence of the long summer's drought, the food roots of these trees of the dry plains lie deeper than those of their eastern brethren. The importance of finding trees adapted to the several climatic regions of the arid territory, combining endurance and rapid growth with utility, not only for fire-wood but for the general purposes of civilized life, can hardly be overestimated. Among the native trees, the cottonwood holds the chief place thus far, at least in the interior territories. It fulfills best the condition of rapid growth as well as hardiness, but it requires so much moisture that it must needs occupy the very valley lands which are most eligible for cultivation; moreover, its soft wood is far from being very desirable even as fire-wood, on account of its rapid burning; hence it has in the more eastern portion of the treeless country been replaced by more desirable trees, such as the oaks, maples, and, of late, the catalpa. It is quite likely that some of these trees, now strangers to the interior territories, will, when planted under the care and protection of man, be found adapted to the needs of that country.

But the search for timber trees that will fulfill the conditions, and meet the needs of so important an interest in this great region, should not be left to private enterprise alone, but should receive the fostering care of the general and State governments. The introduction of the eucalyptus tree into Algeria bids fair to rescue from the desert portions of that country long abandoned for permanent habitation on account of their aridity; and there can no longer be any doubt that the bare

\* See "A monograph of the date palm," in Petermann's *Geogr. Mittheil., Ergänzungsheft*.

treeless slopes, and even higher ridges, of the Coast Range of California, from San Francisco south, can be converted into a forest-covered country through the agency of the same hardy and rapid growing tree. Like the cottonwood, its wood leaves something to be desired in the way of hardness and, apparently, durability, although the tests thus far made with the young timber can hardly be considered decisive; but even if it should do nothing more than yield easily and cheaply the supply of fire-wood, while at the same time favoring the retention of moisture, and of the surface soil, now so constantly being washed away, and increasing the number and available yield of springs, it would confer a great boon upon the coast. In a portion of the great valley, likewise, the eucalyptus grows without farther assistance after the first year, and can readily be made to serve the same purpose for which the prairie-dwellers in Louisiana have long adopted the "China" (or pride of India) tree (*Melia azedarach*) there. From eight to twelve acres of these trees, pollarded into a bare trunk each winter, furnish the fuel needed for a small household. The eucalyptus bears even more severe treatment than the China tree, and is at least as prolific of wood growth, while much more resistant of drought.

#### RESULTS OF CULTURE OF THE EUCALYPTUS IN CALIFORNIA.

The subjoined statements in regard to the results of the growing of eucalyptus in California will be of general interest, as furnishing a measure of the profits to be derived from it; as compared with some of the ordinary field crops:

[Statements of Ellwood Cooper and J. L. Barker, Santa Barbara, January 7, 1882.]

Planted somewhat over 100 acres of *Eucalyptus globulus* and *E. rostrata* (*riminalis*,) with seedlings, 1872-'76, both inclusive, 6 and 8 feet apart, or about 1,000 per acre. One year's cultivation was given, but no irrigation. The trees are now (1882) from 40 to 80 feet high, the tallest 100 feet, with 2 feet diameter at 3 feet above ground. The average tree on the outside of the forest would make two railroad ties and one telegraph pole. No damage has been done by frosts or hot winds. The value of the land before planting was from \$10 to \$25 per acre; it is now worth from \$100 to \$400.

No one in the county besides ourselves has planted eucalyptus trees in forest form. In hedges and clumps there are in the county about 10,000 trees. Mr. Barker has 15,000. I have planted in clumps, hedges, and forests about 150,000, mostly blue gum and red gum (*E. globulus* and *E. rostrata*). I have, however, in all twenty-four varieties, nearly all of them doing well. The blue gum seems to grow more rapidly than the other varieties. The red gum (*E. rostrata*), however, is a good grower and will stand more drought than the blue gum. When they are so thick they do not grow so fast. Planting 6 by 7 feet, one acre will contain 1,000 trees. At six years the outside trees will give one-quarter cord of wood each. Planting 12 feet apart, many of the trees will give one-half to three-quarters of a cord. Lone trees with plenty of space, eight years old, will give one cord of wood. I have one tree 22 inches in diameter, 115 feet high, only eight years old; another, same age, over 2 feet in diameter, and 85 feet high.

[Statement of R. P. Thomas, Berkeley, Alameda County, January, 1882.]

Planted seven acres with seedlings of blue gum, sown in 1876; eight feet apart, or 680 to the acre. Cultivation was given the first year, but no irrigation. The average height of the trees at present is 60 feet, the maximum 100 feet, with 2½ feet girth at 3 feet above ground. No damage from frosts or hot northers. Each tree would now yield about one-fourth cord of wood; it is not good for railroad ties, but good timber for other uses when it can be kept dry. The value of the land before planting was \$100 per acre; present value, \$600.

I would state, in connection with the above, that, for planting the gum tree or eucalyptus, I would recommend particular attention to be given to deep and thorough cultivation before planting, and to plant only thrifty young trees. They should not be over 6 or 8 inches high, and should not be planted less than 16 feet apart. If planted closer, the trees will run up slender, and not make as much wood. My trees are planted al-

together too thick, and I don't think thinning out would remedy the thing, unless it is done before the trees get much of a growth. Great care should be taken in the selection of the young plants. A stunted tree when young will always be a stunted tree. Thrifty, vigorous plants make a thrifty and vigorous growth under all circumstances. Thorough cultivation should be given the first year, keeping the ground soft and all weeds down. There is no difficulty afterwards. Squirrels are a great pest in planting these trees, as they will cut off the young plants apparently for pleasure, or you might say to prevent an obstruction, as they prefer an open field. They do not eat the plants, but pass on, just biting them off apparently for mischief. It is next to impossible to destroy them, when all the surrounding fields are alive with them. I had great annoyance in this way, but obviated it, putting old coal-oil cans around the trees after cutting out both ends of the can. This seemed to frighten them off. The cans may be removed entirely after the first year. The cost of these tins is comparatively nothing. They can be found in abundance at any soap factory, where they have been used for packing tallow. I am now burning the wood of the blue gum in an open fire-place, and am astonished to see how well it burns green; in fact when burned green it is quite equal to most kinds of dry woods—giving a fire like unto hickory wood. I feel that the importance of this tree to California is not appreciated. It will in time clothe the surrounding hills with forests at great profit to the planter. I repeat that in planting the trees too much care cannot be given in preparing the ground. There should be no haste in planting: first get the land in condition, and when planted, guard against the squirrels, and you have no risk to take.

[Statement of Isaac Collins, Hayward's, Alameda County, January, 1882.]

In the winter of 1869-'70, J. T. Stratton planted 43 acres of *E. globulus* or blue gum, and two of *E. ciminalis* or red gum; seedlings of same season, 8 by 8, or 680 to the acre. Cultivation given at first, but no irrigation. The trees are now from 80 to 100 feet high, the tallest 100 feet, and 2 feet in diameter 3 feet above the ground; some larger have been cut down. No damage has ever been done by frosts or northers. The past season 20 acres have been cleared; their yield was 600 cords of cord-wood, 130 of butts and roots. In 1876, the Central Pacific Railroad Company got 40 ties for trial, and the telegraph company bought 800 poles for trial. The wood has not proved durable for these uses.

Briefly, I may state that 20 acres of eucalyptus timber land was purchased one and one-half years ago by a party, price \$210 per acre. He formed the plan of clearing it, and planting thereon a fruit orchard. He let out the contract of clearing off the eucalyptus to a party in Hayward's on the following basis: The contractors to pay \$800; they to clear the land of the timber and stumps, plow it and prepare it for the trees, dig the holes for trees. For all that labor and money paid they received all the timber as their pay. The job has just been or is nearly completed, and they give me a statement of its yield, viz: Six hundred cords of wood and 130 cords of split stumps. The owner of the property seems inclined to doubt their statement. He appears to think the quantity much in excess of 600 cords. Before they commenced clearing, or after they had cut and corded a few trees, I estimated that it would give 800 cords, but taking their statement as correct the returns from the 20 acres from the beginning are wood cut previous to 1876, 14 cords; wood cut in 1876, 149 cords; wood cut in 1877, 100 cords; wood cut in 1881, 730 cords; total 983 cords, at \$6 per cord, \$5,898; 800 telegraph poles, 75 cents each \$600; 40 railway ties, at 50 cents each, \$20; total, \$6,518, and to that amount add the \$800, will give \$7,318 in eleven years as the gross return. The same land if rented for farming purposes at \$5 per year (20 acres at \$5 per acre per year) would give during the term of eleven years, \$1,100. From the sum of \$7,318 would have to be deducted the cost of labor, raising the young trees, &c., as follows:

13,620 seedling trees, at \$8, per 1,000 .....	\$108 96
Cost of planting, plowing, &c., at \$3 per acre .....	60 00
For eleven year's cost of cultivating, &c., at \$20 per acre .....	400 00
Total .....	568 96
Rental of land eleven years .....	1, 100 00
Total cost of plantation .....	1, 668 96

From the value of the wood, \$6,518, deducting the labor, \$1 per cord, gives \$5,535; and taking from this \$1,668.96, the cost of the plantation, there remains a clear profit of \$3,866.04 on 20 acres of eucalyptus in eleven years, or an average of \$17.20 per acre per annum, rent paid.

Similar results and estimates have been reported from other portions of the State as far south as San Diego.

All experience and reports agree that the blue gum, and some other eucalyptus at least, cannot be tolerated within 25 or 30 feet of anything else that is intended to flourish. It is a rank feeder and consumer of moisture; its roots will be found intermingled with those of other plants even at greater distances than above mentioned, when such plants have been heavily manured. It will dry up the surface soil with great rapidity and completeness, and will follow moisture forty feet away; at the same time it will find its own supply in the depths of the subsoil when necessary, and flourish apparently equally well. On account of this ravenous absorption of moisture alone it serves a valuable purpose in malarious districts, as has been abundantly proved in Italy. It is estimated that over five millions of these trees have already been planted in California. Experiments made at the State Agricultural College with the jarrah (*E. marginata*), whose wood is so highly valued in Australia, have shown it to be much more liable to damage by frost than other species; it can only succeed in the southern portion of the State. Its resistance to drought has not been tested as yet.

One point of the inconvenience in the planting of eucalyptus is that it fails to propagate itself adequately in the present climatic conditions of California. It bears seed abundantly, but apparently the latter does not find, as a rule, the proper conditions for germination. Eucalyptus forests, therefore, do not seem to spread, or to renew themselves from young growth spontaneously springing up. Whether these conditions will be permanently maintained, or whether in large forests the natural process of renewal by seeding would occur, is an open question.

Except with the aid of the hand of man, therefore, the eucalyptus will not sensibly encroach upon the treeless area. But it is probable that other trees, accustomed to the trying climate of the Australian interior, will perform this service. There are several acacias which rival the eucalyptus in endurance of drought and in rapidity of growth; and many of them seed fully, and after a few years surround themselves with a young growth of seedlings. Such are, among others, *Acacia floribunda*, *melanoxylo*, *mollissima*, and *lophantha*. The latter especially seems to be adapted to the part of forming outposts on the margin even of the sandy desert, shading the ground with its low spreading tops, mulching it with its leaves, and so forming the beginnings of a surface soil, and through its numerous seedlings advancing steadily into the arid plains. It is objected to on account of its being frequently infested with scale and aphides, and thus forming a breeding-place for these pests, from which they spread to orchards and gardens. But it might be made to perform its special functions remote from where such objections would be important.

Some of the Australian myrtaceous shrubs, such as *Leptospermum* and *Fabricia*, seem to be capable of playing a similar part.

#### OTHER TIMBER-TREES FOR THE ARID REGION.

Some data regarding other timber, shade, and ornamental trees, on trial in the grounds of the California College of Agriculture, are given in the following extracts from a report made by Mr. W. G. Klee, gardener in charge of these grounds:

The collection of these includes a number of eastern deciduous trees, some of which are not planted nearly as much as they deserve, and others very little seen on this coast, so that little or nothing is known of their behavior outside of the experience of a few enterprising nurserymen.

## EASTERN OAKS.

These, as a general thing, have been very slow. Out of seven different kinds none have attained a height of more than eighteen inches during two seasons, while the average height is about eight and twelve inches, the growth falling off in the same order as they are mentioned here: *Quercus inbricaria*, shingle oak; *Q. alba*, white oak; *Q. tinctoria*, *Quercitron*, or black oak; *Q. nigra*, blackjack oak; *Q. coccinea*, scarlet oak; *Q. phellos*, willow oak, and *Q. Catesbaei*, barrens scrub oak.

Unfortunately, the most valuable of these, the white oak, failed partly, like several others, in germinating, the seed being badly worm-eaten, hence but a small number was raised.

Seeds of these and others missing are, however, now ordered again, and the collection will, doubtless, by next year, contain nearly all the North American oaks. It is a matter of surprise to see how different from all the mentioned list of oaks, the north European, or, as it is variously termed, the German or the English oak (*Quercus robur*), has behaved, which was planted at the same time as the rest.

Out of twenty trees measured none is less than 20 inches, and a number 3 feet high, thus surpassing the other two and three times in height, besides having strong side branches. As this tree has, from Australia, the reputation of being able to resist the fiery winds of the desert, there are good reasons for giving this valuable tree a trial in our interior counties, where wind-breaks and wood are badly needed; but it would be most advisable to plant the acorns in the fall of the year, on the spot where the tree is wanted to remain, as the tap-root formed penetrates very often three and four feet the first season. If, however, this is impracticable, there is no danger in transplanting the young trees after the first year's growth is ended; but it should be done then, or it is apt to become a rather risky business. Our trees here were transplanted the first year, and though on an average two-thirds of the tap-root was cut off, not a single tree went back.

The eastern wild cherry (*Cerasus serotina*) is a beautiful and fast-growing tree that deserves a place in any good-sized garden, and as an avenue and timber tree might be planted advantageously, as it furnishes very valuable wood for the cabinet-maker; its growth here in two years from seed is about 4 feet.

The eastern box-elder (*Negundo aceroides*) has here borne out its reputation as one of its fastest-growing, hardy, deciduous trees, and as such certainly deserves to be planted or tried in our interior counties, where the eucalyptus fails on account of the severe winter. Trees two years old from the seed are now from 3 to 5 feet 4 inches high. *Kalbreuteria paniculata* is also a rapid-growing and highly ornamental little tree, of Chinese extraction; it is termed bladder-nut tree on account of the fruit, *Carya porcina* (pig nut), *Carya tomentosa* (mockernut). Two species of hickories, have been tried, but have shown themselves to be extremely slow growers, having only reached 6 to 8 inches in height. Though valueless for their nut, these two species furnish good wood, and are being tried with that view; it must, however, be remembered that most of these decidedly tap-rooted trees require a long time for establishing themselves, and the first two years are generally spent in this manner.

Of the Japanese trees raised from seeds distributed by the Agricultural Department at Washington, the deciduous ones have made a fair growth; especially is this the case with two elm-like trees, *Planera cuspidata* and *Homoioiceltis*, which both average about 4 feet in height, started in February from the seed. *Planera* is a drooping tree. *Horenia dulcis*, a tree of the buckthorn family, recommended as a hedge plant, is also a fair grower; few plants, however, have been raised from the seed.

*Firmiana platanifolia* is a striking sterculiaceae tree, with large, sycamore-shaped leaves, on very long stalk; it resembles the *Paulownia* in habit of growth, but unlike that, the first year is a slow grower; no specimen is above 10 inches; seed started in February. Grows fairly the second year; deciduous here, but otherwise hardy. Is quite an acquisition, at least to our ornamental trees.

*Argania sideroxyylon* is a North African tree, said to produce fruit used as food for cattle; the wood exceedingly hard. It is perfectly hardy at Berkeley, but a slow grower thus far.

*Camphora officinalis* (the Japan camphor tree) promises remarkably well. It has been grown from seed with ease, and has partially been propagated with cuttings from woody branches. It is to be recommended for trial on a large scale in the moister coast region (red-wood lands). It has proved hardy in Berkeley, only the extreme growing ends being slightly nipped by severer frosts; grows very rapidly.

The evergreens, pines, spruces, and retinospora, received from the same source, are all very slow, and it is almost impossible to give any judgment in regard to their growth. A retinospora species is the most promising now. It should be mentioned that all these trees, timber and ornamental, have been grown together in a nursery located by a creek, which, however, is very low at all seasons, and nearly dry for three months of the year. The soil is a heavy loam, and was not in near as good a condition as desirable when planting was necessary. On the whole, all the trees have been sparingly irri-

gated; the small evergreens every three or four weeks, from July to October; the larger trees, as the American oaks, hickories, and Japanese deciduous trees, three times during the season, the English oak, *Kæbreuteria*, and wild cherry only once, in August, and box-elder not at all. While it may be urged that seepage has helped the unirrigated trees, there is very little probability of this having taken place to any great degree, the soil being too tenacious to allow this to occur; and, on the whole, it is my opinion that the growth of these trees would be far greater on good, porous bottom-land entirely without irrigation, which probably has been the experience of others.

It should be added that during the succeeding year (1881) the conclusions here foreshadowed have generally been sustained. The remarkable growth of the European oak has continued to outstrip beyond all comparison that of its American relatives, so that it may probably be used advantageously not only in the replacement of the slow-growing Californian oaks, but perhaps even as a vanguard for the advance of forests into the treeless region. Considering its native climate, this is certainly a remarkable result, which should encourage us in the prosecution of further experiments in the search for trees that will maintain themselves in the arid climates, and if possible will continue to encroach upon the treeless area unaided by man save in the way of protection from fire. Australia seems thus far to offer the most promising field for further acquisitions in this direction, but the arid regions of Africa and Asia will also doubtless furnish useful material, especially for San Diego and Western Arizona. The useful palms of Africa and Arabia might be made to take the place of the handsome but unproductive native species; the date palm particularly would doubtless find a congenial home alongside of the *Pitahaya*, or tree cactus, of Arizona. For the interior plateaus, useful precedents can be found in the plateau country of Asia, now rendered so much more accessible to research. Private enterprise, however, is quite inadequate to the accomplishment of these objects, which seem to belong peculiarly to the province of the United States Department of Agriculture.

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## IRRIGATION OF THE ARID REGION.

The subject of irrigation in the Arid Region has been treated so ably and fully in its general aspects in the report of General J. W. Powell, that a summary of his conclusions, with a few comments, is doubtless the best mode of presenting the main points here.

The lower limit of successful agriculture without irrigation is set by him at an annual rainfall of twenty inches, success at and even above that limit depending essentially, however, upon the mode of distribution of the rains through the year. The general limit of the region so circumscribed to the east is near the 100th meridian, running from about Brownsville, Tex., to a point 50 miles west of Pembina; it extends thence to the Sierra Nevada, and in California to the Pacific coast.

In the warmer portions of the region a larger additional supply of water is requisite to insure crops, the evaporation being greater. Again, the portions of lands lying near, and especially to westward of high mountains, are agriculturally favored by a participation in the greater precipitation due the condensation of moisture by such mountains.

On the mountains and high plateaus forests are found at elevations so great that summer frosts forbid the cultivation of the soil. Here are the natural timber lands of the Arid Region, an upper region set apart by nature for the growth of timber necessary to the mining, manufacturing, and agricultural industries of the country. Between the low, irrigable lands and the elevated forest lands there are valleys, mesas, hills, and mountain slopes bearing grass of greater or less value for pasturage.

As regards the amount of flowing water available for irrigation, the conclusion is that it is in general sufficient for only a small proportion of the lowlands—in Utah, for example, only about 2,262 square miles out of 80,000, or 2.8 per cent. The amount of water available for irrigation can be increased by winter storage, to an extent depending greatly upon local circumstances. Storage in the lowlands is wasteful on account of the great evaporation during the warm season.

Irrigation on a large scale, whether by storage or the diversion of larger streams, requires large capital and co-operative action; and in order to prevent forestalling, waste, and conflicts of rights, general laws regulating the appropriation and use of water in the Arid Region are necessary, and should be enacted as soon as possible. The pre-emption, homestead, timber-culture, and desert-land privileges are adequate for actual settlers on irrigable lands dependent on minor streams, but are insufficient for the settlement of the irrigable lands that depend on the larger streams, and also for the pasturage and timber lands, than is contemplated in either of the above privileges. A pasture farm requires not only a large area of land, but also a certain amount of accessible water supply. A "water front" of adequate supply should then be allotted to each pasturage tract as an inherent right, water-rights going with land titles, the latter being valueless without the former.

These are the main points made in reference to irrigation in the Arid Region by General Powell. While written, perhaps, more with a view to the yet unsettled regions of the interior, they embody essentially also the needs of the irrigation districts of California, as demonstrated by the actual experience of thirty years. In the conflicts that have arisen in consequence of the absence of the legislation suggested by General Powell, one point has been prominently brought out, to-wit, the irrepressible conflict between the provisions of the common law on the subject of riparian rights and the requirements of agriculture in a region requiring irrigation. The declaration of the former, that every riparian owner is entitled to the undiminished volume of the stream (intended evidently for the safe guarding of the interests of the uses of water-power) strikes at the very foundation of the use of water for irrigation purposes, and is thoroughly incompatible with such use, and, therefore, with the very existence of agriculture in the Arid Region. Yet, this law has been invoked again and again in California by riparian owners claiming the undiminished volume of the streams from those above them, while fully intending to use it freely on their own lands. Numerous costly and protracted lawsuits have been and are now pending in the courts of the State, which are embarrassed by the conflict of the acknowledged foundation of American civil law with the manifest equities of the cases before them. In one test case, at least, the lower court decided that the common-law doctrine does not apply to irrigation regions; but, while this is the common-sense point of view, it is doubtful whether the higher courts can, in the present condition of the code, sustain it. It is certainly of the most vital importance that this matter should be so settled by Congressional action in the Territories that similar conflicts cannot arise when, with the advance of the Territories to the dignity of States, the subject passes beyond the control of the general government. Again, the forestalling, by means of the pre-emption, homestead, or timber privileges, of all the water-supply from springs available during the dry season, has, in California, created a situation in which many such pre-emptors of the 150 acres are, as a matter of fact, "lords of all they survey," since no one can occupy the adjacent lands without paying them tribute for water-supply; and this

still is more emphatically true of owners of large tracts, Spanish and Mexican grants, &c., which were usually selected originally because commanding water-supply.

The control of water now used in irrigation ditches in California is almost altogether based upon the right of "prior appropriation" in pursuance of custom rather than law; a method not without its merits in respect to the promotion of irrigation enterprises, but liable to gross abuse in forestalling, since it places it within the power of the appropriator to carry the water to lands in which he is interested, to the detriment even of riparian owners, who, under the common law, are entitled only to so much water as they require for household and stock, but not for irrigation. It is needless to dwell upon the gross injustice and oppression which the principle of prior appropriation may work in its application when and where water is scarce, and upon the extent to which it is contrary to sound public policy to let such important privileges "lie around loose," to be picked up by whosoever can do so by virtue of the control of capital.

It is difficult to foresee how the many claims or rights acquired under this system in California can now be adjusted in accordance with the public interest, without a severe wrenching of what it is usual to consider "vested rights." It will obviously become necessary to resort to the State's ultimate right of eminent domain, in condemning the water available for irrigation to public use, under such regulations as will inure to the greatest good of the greatest number. But this fact emphasizes so much the more the pressing need of avoiding similar complications in the future, in the regions still subject to the control of the general government, by timely legislation definitely regulating the rights and uses of water in the Arid Region; not only with reference to that applicable to irrigation, but also with respect to pasturage lands as above noted. Provisions substantially covering the points embraced in the drafts of two acts contained in General Powell's report should become general laws as soon as possible. In framing these measures it should not be forgotten that irrigated land is very much more valuable and productive than that which is dependent upon the accidents of the seasons; not only because of its exemption from the risks and failures involved in the cultivation of unirrigated land even in the "humid" portions of the world, but also because of the important part taken by the solids dissolved or suspended in the irrigation water in increasing and maintaining the fertility of the soil. The irrigator is exempted from the necessity of supplying manure to restore the soil ingredients withdrawn by his crops, to an extent varying in different localities, but always taking the form of a very tangible balance in his favor, in some cases (as in that of the valley of the Nile for ages past) amounting to a complete relief from all consideration of the question of the maintenance of fertility which is intruding itself more and more urgently into the calculations of American farmers, and threateningly confronts every tiller of the soil in the Old World.

These considerations justify the adoption of a much smaller unit for the farm in irrigation districts; the more complete and systematic utilization of the soil's powers enabling a smaller area to subserve the needs of a family. The unit of 80 acres, instead of the usual 160 suggested by General Powell, is certainly amply large in soils of any reasonably adequate native fertility.

In these points of view may also be found a partial answer to the question, often asked, what inducement there is for the settler to occupy the regions laboring under so many natural disadvantages when so much

fertile land remains unoccupied in more favored regions? From an abstract point of view, the question seems difficult to answer; but concretely, the explanation lies in the fact that human nature will take risks where there is a reasonable chance of success, as is the case in humid climates; whereas in the arid regions, success being impossible without irrigation, but becoming a certainty with it, farming becomes a much more safe, satisfactory, and paying occupation. If, on the other hand, we inquire why it is that the abundant water supply of the humid regions is not utilized with the same view of reducing the success of crops to a certainty, instead of risking the disastrous failures that afflict them from time to time in the occurrence of droughts, we can but point to that same principle of human nature which renders gambling so dangerously attractive, and drives the "prospector" to continue in the search for new mines rather than to settle down to the working of those he has already discovered.

Aside, however, from these considerations, the treelessness of irrigation countries is in itself not a slight advantage to the settler of small means, since it relieves him from the necessity of incurring the great expense and delay of "making a clearing," an operation often involving, in humid climates, an expenditure altogether out of proportion with the productive value of the land. In the great valley of California, as in the prairies of the West, the plow can be put into the land without any preliminaries; but there is no heavy sod necessitating the use of correspondingly heavy draft, the first plowing being nearly as easy as the later ones.

In climates having a long growing season so far as temperature is concerned, the effects of irrigation on actual production are almost startling. Thus, in the southern part of California, as well as in Western Arizona, crops may be started at whatever season suits the convenience of the grower, except two in the year; and this holds true for market gardens as far north as San Francisco, where vegetables of nearly all kinds can be had in the market almost throughout the year. In Tulare and Kern Counties, five cuts of alfalfa have been taken off the same field in a single season, and ten tons of its hay made. So with sorghum, Egyptian corn, and pearl millet, when cut for forage, of which, with irrigation, three heavy cuts have been made, an enormous yield, which of course could be maintained only on a very strong soil, or later by the aid of manure. But irrigation enables the farmer to impart to the penny a nimbleness unheard of in regions dependent upon the seasons alone. The investment of a certain amount of money in land and manure can be "turned over" twice in the season, or even oftener, in a region of long summers. There is no reason why the same could not be done in the Southern States; but, as a matter of fact, it *is* done only where irrigation is compulsory.

#### IRRIGATION IN CALIFORNIA.

The commanding importance of the subject of irrigation in the State of California has repeatedly secured for it legislative attention, but no general measures toward ascertaining the resources of the State in lands and waters adapted to irrigation were taken prior to the year 1878, when an act was passed providing for the appointment of a State engineer, whose duties were defined to be, "under the direction of the governor, to investigate the problems of the irrigation of the plains, the condition and capacity of the great drainage lines of the State, and the improvement of the navigation of rivers." A succeeding portion of

the act imposes the duty of inquiring into and reporting upon "the question of the flow of *débris* from the hydraulic mines into the streams, and the injury to agricultural lands by the flow of *débris* thereon."

Between 1878 and 1880 the work on both of these important branches of inquiry was actually prosecuted under the able direction of Mr. William Hammond Hall, as State engineer; and in January, 1880, he submitted to the legislature, then in session, his first report, an able, thorough, and highly important document. It gives succinctly and systematically the main facts regarding irrigation in other countries, as well as in California, compares and discusses the differences of climate, soil, and agricultural practice in the irrigated regions of the world, as well as in different portions of California; also the legal aspects of the question of water-supply, and the difficulties which in California, as well as elsewhere, have arisen from a failure to place the whole matter, from the outset, upon equitable and distinctly defined basis. Drafts of bills to be passed by the legislature, tending to remedy existing defects and forestalling their recurrence hereafter as far as practicable, are also given. Numerous tables showing the area of watershed, measurements of supply, both in streams and ditches, area irrigated, areas capable of irrigation, &c., attest the diligence and good judgment with which the work was conducted. Most of the numerical data hereinafter given are taken from this report, which deserves to be more widely known. Unfortunately, the agitation in regard to the mining *débris* question, which has increasingly irritated the public mind ever since the passage of the act providing for the building of dams to impound the tailings of the hydraulic mines, has overshadowed the irrigation problem for the past two years, and caused such a curtailment of the appropriation available for that branch of the work, that the report made to the legislative session of 1881 contains but few additional data relating thereto, while reiterating the recommendations previously made in regard to the establishment of a consistent and equitable system of water-rights, the need of which is doubly emphasized by the many law suits involving such rights that have vexed the courts for several years past.

#### IRRIGABLE LANDS OF CALIFORNIA.

The main irrigable area in the State is the great Interior Valley, embracing altogether about 30,000 square miles. Of this area, about 11,300 square miles belong to the San Joaquin Valley, from the Cosumnes River to the Tejon Mountains; a maximum length of 260 miles, by from 30 to 70 miles in width. It is here, as well as in the southern region (Los Angeles, San Bernardino, and San Diego), that the irrigation question assumes the character of a vital problem, a *conditio sine qua non*. In the Sacramento Valley, irrigation is but little resorted to on the east side of the river, where, on the contrary, the mining *débris* problem agitates the public mind, and mining ditches furnish the supply of irrigation water chiefly to the foothill lands and mountain plateaus; while on the west side, in the counties of Yolo, Solano, and Colusa, irrigation is again prominent, though not so vital as in the San Joaquin Valley, on account of the greater annual rainfall. Irrigation in the San Joaquin Valley is thus far practically confined to the portion lying east of the trough, and traversed by the rivers issuing from the Sierra Nevada. The total of the dry plain lands of this "east side" embraces an area of 7,687 square miles, of which about 69 per cent. may be assumed to be irrigable from the current water-supply of the streams. Since the trough of the valley lies much nearer the Coast Range, in fact

touching the foothills at Buena Vista slough, in Kern County, the area of the "west side" is very much smaller, viz., about 2,689 square miles.

All south of Tulare Lake, and a large portion north of the lake, on the west side, may be classed as non-irrigable land, not only on account of the absence of a sufficient water-supply, but by reason of the general unfitness of the soil for cultivation by irrigation. The sources of supply for irrigation are Tulare Lake, the San Joaquin River, and the small streams of the Coast Range.

I remark, in reference to this statement of Mr. Hall, that, as I have shown by the analysis of its waters, Tulare Lake is altogether unfit, either as a source or even as reservoir of irrigation waters, on account of its alkalinity, as stated more in detail below. The small intermittent creeks flowing from the Coast Range are but little to be relied upon in this connection, the more as the porosity of the formations in that region renders storage very precarious. Supposing King's and the San Joaquin River to be the only available sources of supply, the irrigable lands of the west side would, according to Mr. Hall, be about 718 square miles, or 460,000 acres, making the grand total of lands, irrigable from sources adjacent to the plain of the San Joaquin Valley (exclusive of storage in higher reservoirs), about 6,000 square miles, or 3,840,000 acres. Of this vast area of highly productive soils, only about 188,000 acres, or about 5 per cent., are estimated as being at present under irrigation.

Artesian water is to a limited extent already used for irrigation in the San Joaquin Valley. In a few cases saline and alkaline waters have been obtained from the wells, but a considerable number have water that is no more objectionable than that of Kern River at least. Of late such wells yielding abundant streams have been obtained in Tulare County, in a region much troubled with alkali, which they will help to subdue. The possibilities of the valley in this respect have hardly yet been approximately ascertained, as it is very important they should be.

In the Sacramento Valley the lands irrigated from Cachè Creek aggregate to about 13,400 acres. There are no data for estimating the other irrigated lands of the plain, but the amount of irrigated land in the foot-hills of the Sierra (chiefly opposite the central portion of the Great Valley) may be taken at about 9,000 acres.

With the exception of Cachè and Putah Creeks, on the west side of the Sacramento Valley, no important amount of irrigation water can be derived from the Coast Range, except through winter storage, which has not thus far been practiced. To seaward of the Coast Range small tracts of irrigated land are found from San Francisco southward, but they form the exception northward of Santa Barbara. In the Salinas Valley it is not convenient, from the small volume of the river and the lack of tributaries, and fair crops are made without it. Farther south it is more or less practiced in many of the seaward valleys, very generally so in that of Santa Barbara, and thence southward increasingly, until in the Los Angeles region the maximum proportion of irrigated lands is reached, the total in the counties of Los Angeles and San Bernardino reaching nearly 85,000 acres, and but little land being cultivatable without them.

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## SOILS OF THE ARID REGION.

The first impression produced upon the explorers of Western plains and plateau lands, treeless, and at certain seasons almost bare of any of the familiar vegetable covering of the surface, was, that the soil was naturally sterile, and ever would be, the more so as at many points

nature seemed to have done what Attila threatened to inflict on all communities that should attempt to resist his advance, "sowing salt," so that nothing should grow there for evermore. Thus the "Great Western Deserts" came to be proverbial, and many were the regrets that nature should have destined one half of the territory of the United States to remain a howling waste.

The general recognition of the fact that water alone is wanting to render these deserts productive of whatever crops their climatic position will permit is of comparatively recent date, although this view was long before held and asserted by meteorologists. The results produced by irrigation in Colorado and Utah have now rendered this a familiar truth; and while it is true that in a climate of deficient rainfall the process of soil formation, as well as the soils themselves, differ in some respects from those familiar to us in the regions of summer rains and abundant vegetation, yet the advent of the life-giving water, with judicious agricultural treatment, soon does away with all that would interfere with profitable culture.

But little has so far been done in the systematic investigation of the soils of the arid regions\* outside of California; but what has been done seems to show that the majority of the soils of the Arid Region possess certain advantages of chemical composition over those, *e. g.*, of the southern portion or the Alleghany Range. Chief among these are a remarkably high percentage of potash and a large proportion of lime. This difference is rather, perhaps, to be accounted for as one of the effects of the arid climate than as the result of a fundamental difference in the composition of the rock materials that have contributed to their formation. This will be appreciated when it is considered that these soils have for ages been subject to a most thorough system of summer-fallowing, unaccompanied by the leaching process, which is inseparable from an abundant rainfall, and which is particularly effective in depleting soils of lime, the especial promoter of thriftiness in production.

In the examination of the soils of California, carried on partly under the auspices of the tenth census, and continuing under those of the State College of Agriculture, these peculiarities are strikingly shown. The lime percentages of the soils of Middle and Southern California are on an average from four to eight times as high as in the soils of the Carolinas and Georgia; while the potash percentages are quite commonly as high as those found only in the richest soils of the Mississippi bottom. The phosphates also range higher on an average, though not to a similar extent, as lime and potash. On the other hand, the humus content of these soils is usually low, a natural result of the great facilities offered to oxidation by the dry condition in which the soils normally exist. A general description of the prominent soil features of California is here given, as illustrative of what occurs, more or less, throughout the Arid Region; especially so as regards the important feature of the "alkali soils," which, as will be seen, so far from being especially sterile, are in some cases simply permeated by an excess of mineral plant-food, and therefore of high intrinsic or virtual fertility.

#### SOILS OF CALIFORNIA.

While it would be impossible to give, in any brief space, a detailed account of the great variety of soils occurring within the wide area of the

\* I must on this point differ with General Powell, Director of the United States Geological Survey, who, in his able report of the lands of the Arid Region, remarks that "too much attention has been paid to the chemical composition of soils," &c., So far as I am aware, we are in a condition of dense ignorance as regards the composition of the soils of the entire region between the Rocky Mountains and the Sierra Nevada.

State of California, only a few of which have as yet received any close examination, some general statements may be made to show the high value of some of the apparently most arid lands, when subjected to the life-giving influence of irrigation.

As regards, first, the Great Valley, the two climatic divisions defined above are maintained also, measurably, as concerns the soils. Broadly speaking, it may be said that in the northern division (the Sacramento Valley) the soils are prevalently loams, more or less heavy, largely interspersed with tracts of heavy clay or "adobe" soils, often the exact counterpart of the "prairie" soils of the Mississippi Valley; while in the southern portion, or San Joaquin Valley, the bulk of the soil is altogether prevalently sandy, occasionally to the extent of rendering them sterile; and what is there called "adobe," by way of contrast, would mostly be elsewhere considered a moderately clayey loam. As to intrinsic fertility, it would be difficult to decide between the two divisions; for while the heavier soils, other things being equal, are usually the richer in plant-food, and therefore the more durable, the great depth of the light soils of the San Joaquin Valley seems to compensate in a measure for the somewhat inferior percentage of plant-food. This is the more true, as the "sand" is to a considerable extent not simply siliceous, but consists largely of comminuted granitic and eruptive rocks, with an admixture of the ancient slates, or rather schists, which cover the flanks of the Sierra and constitute the proverbial "bed rock." Moreover, the "foot-hills" are commonly bordered, on the valley side, by a rolling plateau land, underlaid by the marly strata of the Tertiary formation; and these, commingling with the materials brought from the higher lands, from naturally marled soils, whose thriftiness when under irrigation contrasts strikingly with their barren aspect during all but the winter and early spring months, so long as they remain in their natural condition.

From Redding, at the head of the Sacramento Valley, to Bakersfield, at that of the San Joaquin, the valley has along its eastern border a belt of upland, varying in width from one to twenty miles, and from fifty to twenty feet above the natural drainage level, the soil of which is a yellow or reddish loam of varying character, evidently formed by an intermixture of the red soil of the foot-hills with the valley deposits. Much of this land, which is mostly too high to be reached by the present irrigation canals, has a singular hillocky surface, known as "hog wallows" doubtless the result of aqueous erosion in past periods. These "hog-wallow" lands differ essentially both in their character and origin from those similarly named in Texas and other Gulf States (which are mostly heavy prairie soils), and even as far south as Merced County produce excellent cereal crops, as well as fruits, without irrigation.

On the western or Coast Range side of the valley the soils are usually materially different. The Coast Range consists in the main of gray tertiary and cretaceous materials, prevalently clayey northward of San Francisco Bay, but growing more and more sandy, on the whole, in a southward direction. Hence, we find extensive tracts of very stiff "adobe" soils of very variable degrees of fertility on the western side of the Sacramento Valley, and as far south as the southern line of San Joaquin County, where the widely gaping cracks of the adobe, during the dry season, attract the attention of even the casual passer-by. Southward, the soils lying at the foot of the Coast Range become increasingly sandy, as do the bordering hills, until in the region opposite Tulare Lake it is reported to be a "sandy desert." This statement may require to be taken with a considerable grain of allowance, since in the

absence of any opportunity for irrigation, and of any serious attempts at settlement thus far, the capabilities of the region can hardly be said to have been fairly tested.

The soils of the western border of the Sacramento Valley are at many points materially and most beneficially modified by the admixture of materials contributed by the tributary valleys heading within the region of eruptive or volcanic rocks, whose southern portion has become noted for the high quality of the wines produced in the valleys of Sonoma and Napa. These soils are also originally red, as is still the case on the mountain sides and higher benches of the valleys; and while less suited to cereal culture, they seem to be pre-eminently adapted to the perfecting of the higher qualities of fruits.

The orchard products of Vacaville, widely known for their excellence, are grown on such soils; and the fruit-growing region of Solano and Yolo Counties, the present center of the raisin industry, is covered by the joint deposits of the Sacramento River and Putah Creek, the latter one of the main drains of the volcanic region.

Soils quite similar to these, both in origin and productive qualities, exist on the opposite side of the valley, where the Tuolumne, Mokelumne, and Cosumnes Rivers traverse the volcanic tufas that cover the gold-bearing gravels of Table Mountain. As regards their general chemical character, the soils of the entire valley (of which quite a number have been analyzed, partly under the direction of the State Agricultural College, partly under those of the Census Office), are throughout remarkable for a high percentage of lime, which rarely falls below four-tenths of one per cent., and most commonly ranges from one-half to one and a quarter per cent. This circumstance explains, in a measure, the high thriftiness of these soils, allowing the rapid development and generous fruiting which accompanies the minimum allowance of moisture, and maintains the farmer's hopes that the success of a single season will suffice to wipe out the financial failures of two or three dry seasons. A generous allowance of potash accompanies the lime even in the very sandy soils of the Tulare Plains, mostly exceeding four-tenths, and ranging as high as one and a quarter per cent. The phosphates are on the whole low in the sandier soils of the San Joaquin Valley, but high in the adobe soils of both divisions.

The red soils of the foothills have already been mentioned. The character of the foothills of the Sierra Nevada throughout its course along the Great Valley, varying from a moderately clayey loam (as in the placer region of Eldorado and Placer Counties) to a heavy, though not uncommonly gravelly, is an orange-red clay. This character seems to be sensibly the same, whether the soil be derived from the decomposition of the ancient slate "bed rock" or directly from the granitic rocks; thus creating a presumption that the two rocks are closely related.

Where the foothill soils either obtain a sufficiency of moisture naturally, or can be irrigated, they prove abundantly productive, and are rapidly acquiring a special reputation for the excellence of their fruit product, both of orchards and vineyards. While at present it is in the main a region of spring pastures, it is doubtless destined to be in the future one of small farms producing products of high value. The soils are highly charged with iron (ferric hydrate or rust) to the extent of from 7 to over 12 per cent.; which being finely divided, imparts to them the intense orange-red tint so familiar in the region of the placer mines, and during the dry season manifesting itself in the equally familiar red dust that disguises the natural tints even on the trees themselves. The soils of the foothills, so far as they have been ana-

lyzed, agree with the soils of the valley in having a high percentage of lime, from about one-third to one and a half per cent., while the supply of potash and phosphates, as well as of organic matter, is smaller, and sometimes low, though never, apparently, inadequate for present productiveness, in the presence of so much lime.

The soils of the Coast Range vary greatly in the different portions of that broad belt of hilly land. In the middle portion, more or less directly related to the Bay of San Francisco, the "adobe" character is prevalent, not only in the valleys, but even on the summits of its rounded ridges, where in favorable seasons the yields of grain may be as high as in the valleys themselves. The soil is usually many feet in depth, with only here and there a rocky knoll projecting through it; cracks wide open in summer, and when the rains come somewhat abruptly and violently, the water, descending quickly to the underlying bed-rock, gives rise to innumerable land slides, sometimes of considerable extent, and of vital importance to land owners. In the valleys intersecting such regions, and notably along the border of San Francisco Bay, there lie highly fertile tracts of "black adobe," or black prairie soil, sometimes so stiff and waxy as to be difficult to till, but under good treatment and in favorable seasons profusely productive. The adobe tracts are intersected, at right angles to the bay, by the belts of lighter sediment brought down by the present streams. In the country lying northward of the bay, the soils formed by the eruptive and volcanic rocks assume increased importance, and constitute the leading feature of the grape-growing region of Sonoma, Napa, Solano, and Yolo Counties, as well as, farther north, in Lake and adjoining portions of Colusa and Mendocino. Here the lower portions of the mountain sides are frequently constituted of the heavy tertiary and cretaceous materials which form adobe, while the upper portion consists of igneous rocks yielding lighter soils, often deeply colored with iron, and more especially adapted to fruit culture. The valley soils are of course a mixture of both, and it is on such composite soils that the enormous yields of from twelve to fourteen tons of grapes per acre are sometimes obtained.

Of the soils of the mountainous regions of Mendocino and the country northward to the Oregon line, but few data have thus far been obtained. Specimens of valley soils, and especially of that of Eel River, in Humboldt County, seem to show a great similarity to those of the coast valleys south of San Francisco Bay. It is a gray silt with very little coarse sand, many feet in depth, with high percentages of potash and phosphates, but deficient in lime, and probably from that cause difficult to till, and somewhat unthrifty after continued cultivation. Southward of San Francisco Bay, where with otherwise similar composition the lime percentage is large, this inconvenience is not observed, and these silty valley soils are remarkable for their retention of moisture near the surface throughout the dry season—a highly valuable property in the dry climate. "Adobe" soils are exceptional in the southern Coast Range region, gray loams or silts, or sometimes sandy soils being on the whole predominant in the uplands also. In the "semi-tropic" region of Los Angeles, San Bernardino, and San Diego, the uplands or "mesas" which occupy the larger portion of the surface have usually a reddish, gravelly loam soil, more or less heavy in different localities, but on the whole remarkably uniform in its character. It seems to be a modification of the "foothills" soils northward of the Sierra San Fernando, but of greater depth, more easily tilled, and with higher percentages of plant food, especially of phosphates. Hence, though of the disconsolately arid aspect of a gravel bed in the dry season, these mesa lands when irrigated

prove profusely fertile, and in spring are covered with a dense carpet of bright flowers. For fruits adapted to the climate, they are probably excelled by few so far as quality is concerned; although, on account of greater facility for irrigation, the lower levels and the terraces or benches along the streams have chiefly been occupied.

The soils of the Colorado River bottom is a light, pale-colored loam of great depth, highly calcareous, with over one per cent. of potash, but a comparatively low amount of phosphates for a river bottom. It proves extremely fertile where cultivated.

The soils of the Mojave and Colorado Deserts have received but little attention and examination thus far. While a portion of the surface is covered simply with drifting sand underlaid by rock or hard-pan, there are in the Mojave Desert, at least, extensive tracts possessing a soil of fine gray silt, on which the yucca tree attains a luxuriant development; while others are covered with low but dense growth of hardy shrubs, and grass enough to render the spring pasture valuable and nutritious, while the sheep crop the leaves of shrubs later in the season. Plainly, a large portion of this desolate-looking country evidently re-awaits only the life-giving influence of water to be at least available for stock-raising, and to no inconsiderable extent for cultivation also. The lower portions of the Colorado Desert especially are so severely afflicted with alkali of a corrosive character that, being incapable of drainage on account of being below the sea level, their reclamation seems hopeless.

#### TULE LANDS.

This is the name applied in California to all lands, whether littoral or inland, bearing as an important ingredient of its vegetation the tule or rush which, of course, varies in kind according to location near to or remote from saline tide-water. In the coast marshes the tule is prevalently the rush, properly so called (*scirpus lacustris*); while the fresh-water marshes in the upper portion of the delta of the Sacramento and San Joaquin, as well as in the upper portions of the courses of these rivers, consist largely of other species, notably the cat-tail rush (*typha*). All these lands are, of course, subject to overflow, and need protection by levees.

The surface of the marsh lands is covered with a matted mass of roots from one to several feet in depth, in all stages of decay; the lower portion being in a peaty condition, and sometimes available for the manufacture of peat. Occasionally this mass is afloat, so as to rise and fall more or less with the water; in most cases, however, a solid sediment soil of high productiveness underlies the roots at a moderate depth. It is customary to set the latter on fire during the dry season, when they gradually burn down to the soil, enriching the latter with its ash. Into the ash grain-crops are sown, often yielding enormous returns, especially on the islands of the delta above Suisun Bay. The largest body of tule lands lies to northward of that bay. Irrigation is, of course, unnecessary in most of these naturally moist lands, where cattle find abundant pasture throughout the dry season, even when they remain in their natural condition, and still better where pasture grasses have been introduced; they are therefore at first a natural stock-raising region.

The prevalently bold and rocky coast of California and Oregon presents but few and small marsh areas outside of the Great Valley and Bay region.

#### ALKALI SOILS.

This name is applied in California, and throughout the Arid Region, almost indiscriminately to all soils containing an unusual amount of

soluble mineral soils, whose presence is frequently made apparent by the "efflorescence" or blooming out on the surface of a white powder or crust, soluble in water. This alkali becomes most apparent in dry weather following upon rains or irrigation. Later in the season it usually becomes less perceptible from intermixture with dust, as well as from the failure of the soil-water to rise near enough to the surface. The first rain, dissolving the salty substances, carries them partly into the water-courses, but chiefly back into the soil, whence they rise again at the recurrence of dry weather. It will readily be inferred that this phenomenon occurs chiefly in low lands of an alluvial origin, and thus includes, prevalently, soils of great native fertility.

The immediate source of the alkali is usually to be found in the soil-water, which, rising from below and evaporating at the surface, deposits there whatever of dissolved matters it may contain. Such water, when reached by digging, is by no means always perceptibly salty or alkaline; and the same is mostly true of the soil an inch or two beneath the surface; for since the soil, acting like a wick, draws up the soil-water and allows it to evaporate at the surface, it is there, of course, that all the dissolved matters accumulate, until the solution becomes so strong as to injure or kill all useful vegetation. The injury will usually be found to be most severe just at or near the crown of the root where the stem emerges from the soil.

One obvious and practically important conclusion to be drawn from the above considerations is that the more water evaporates from the surface of the soil within a season the more alkali salts will be drawn to the surface. Hence, within certain limits, a greater rainfall will bring up a larger amount of alkali; or if, instead of rain, surface irrigation is made to supply an additional amount of water, the same effect will be produced; always provided that the rainfall or irrigation does not go so far as to actually wash a portion of the salts definitely beyond the reach of surface evaporation into lower strata, from which springs or seepage will carry them into the country drainage.

The measure of rainfall or amount of irrigation water that will accomplish one or the other of these opposite results depends in a large measure upon the nature of the soil, as well as of the underlying strata. It is more difficult to wash the soluble salts out of a clay soil than out of a sandy one; and the moisture and accompanying salts will keep rising through the former from greater depths and for a greater length of time after the cessation of rain or irrigation.

Roughly speaking, there is an obvious inverse relation between the rainfall and the prevalence of alkali in the soils; thus, the concurrent increase of alkali and decrease of rainfall to southward is most obvious in the Great Valley of California, but it is also observable more or less to seaward of the Coast Range. The alkali question is of general importance chiefly in that part of the State lying southward of the city of Sacramento. In the region north of that latitude, the more copious rainfall seems to keep soils leached of their alkali, if, indeed, it is naturally as abundant as in the San Joaquin Valley.

Another conclusion resulting from the principles above mentioned is that in the practice of irrigation the nature of the water used is of great importance, since what it contains of soluble salts will be left in the soil by evaporation, helping to swell the mass of alkali year after year, until it may become so great as to render the land unfit for cultivation; provided, again, that the amount of irrigation water used is not so great as to sink through into the strata supplying the country drainage, carrying with it its soluble ingredients also.

The alkali question can hardly be said to possess any general importance east of the Mississippi and Missouri Rivers, where the abundant rainfall suffices, as a rule, to keep in check any injurious accumulation of soluble salts in the soil. It is chiefly in the neighborhood of saline springs that this inconvenience is noted, and the extent of land so withdrawn from profitable culture is ordinarily insignificant. The saline seashore or reclaimed marsh lands constitute the only important cultivatable areas of a similar character, and the means to be employed in their reclamation are well and anciently known. In the Tertiary region of the State of Mississippi we occasionally find tracts of several acres rendered uncultivable by the alkaline and magnesian salts that ascend from the underlying saline clays into the soil, and many years ago I was led to recommend the use of lime and under-drainage conjointly for the decomposition and removal of the magnesian and other salts infesting such lands.\*

Two factors contribute toward rendering the phenomenon of alkali soils much more common in the country lying west of the Mississippi. One is the rapid decrease of rainfall as we advance westward; the other the geologically demonstrable fact of the evaporation in the interior of the continent, first of a great Mediterranean Sea, and subsequently of extensive lakes; whose saline residues have partly been accumulated in their deposits and partly remain dissolved in residuary lakes, such as Great Salt Lake and the "sinks" of numerous streams between the Rocky Mountains and the Sierra Nevada. Even east of the former range in Nebraska, Kansas, and Colorado, alkali tracts are not uncommon, though not usually as extensive, and certainly not as general in their occurrence, as in the undrained country to westward. Hayden's Report of the Geological Survey of Nebraska gives a number of analyses of alkali from that State, proving the composition of these salts to be similar to and quite as variable as is the case with those of the Great Valley of California.

So far as I am aware, no systematic investigation and discussion of this subject, in its relations to agriculture, has been made outside of the State of California, where the preponderance of the agricultural interest and the frequent interference of the alkali with the extensive culture has forced public attention to the question, the more because of its intimate connection with the all-important subject of irrigation. I have therefore considered it best to present somewhat in detail the experience and results obtained in the work done in California under my direction, and published in the reports of the Agricultural College of the University of California for the years 1877, 1879, and 1880. I have added thereto such matter as has since accrued, with such as could usefully be extracted from the reports of the United States surveys.

#### EFFECTS OF ALKALI.

While the corrosive action exerted by the alkali salts upon the upper roots and root-crowns of crops is the common and most serious source of injury, there is another which manifests itself mainly in the heavier class of soils thus afflicted, when the soluble salts consist largely of carbonate of soda or potash. This is the difficulty, or almost impossibility, of producing a condition of true tilth, in consequence of the now well-known tendency of alkaline solutions to maintain all true clay in the most impalpably divided or "tamped" condition, that of well-worked

\* See Report on Agriculture and Geology of Mississippi, 1860.

potter's clay, instead of the flocculent one which it assumes in a well-tilled soil. As this cause of injury is not so well known as the one first mentioned, it will be pertinent to adduce an example observed and studied in the neighborhood of Stockton, San Joaquin County, California, from where a belt of land of this character, about a mile wide and fourteen in length, traverses the valley diagonally to the foot-hills of the Sierra.

This area is readily recognized by its pitted or "pock-marked" appearance, the low portions being impregnated with alkali and more or less incrustated with it on the surface during the dry season, while after rains pools of dark-tinted water remain standing on them for weeks after the higher portions are dry and in tillable condition. These higher portions, forming hillocks and ridges, elevated on an average 10 to 18 inches above the alkali spots, and also bordering the whole tract, consist of a fine, mellow, loam soil, such as would be chosen for a garden, and very productive wherever the alkali does not influence it. Unfortunately, it lies so intimately interspersed with the alkali spots that it is practically impossible to cultivate one without the other. A short time before my visit the owner, Mr. C. L. Overhiser, had made a desperate attempt to conquer the refractory alkali soil. A mixed tract of the two soils had been plowed, cross-plowed, rolled, and harrowed until the harrow produced no further effect, and the result was a seed-bed of soil clods ranging from the size of a pea to that of a billiard ball, but no tilth. At the same time the portions of the "ridge" soil so treated were reduced to an ashy condition of tilth. Some of the alkali land had also been heavily manured, and a fair stand of grain was springing up, but Mr. Overhiser stated that, in accordance with previous experience, he expected to see the stalks "spindle up" and turn yellow about the time of going to ear, unless the weather continued unusually moist, so as to prevent the rise of the alkali to the root-crowns.

Inspection seemed to show that the two soils differ but little in mechanical composition, not nearly enough to account for such difference of tilling qualities, for when worked into a paste with water it was difficult to say which of the two was the heavier soil, and on drying from this condition both formed lumps about equally hard. For the final determination of this question, the two kinds of soil were subjected to comparative mechanical analyses. Both subsoils are very much alike in appearance, being of a gray tint, very compact, and disposed to be cloddy. Both show an alkaline reaction on litmus paper (bluing the red paper), the subsoil of the alkaline spots being, however, decidedly the stronger. The mechanical analysis of the two surface soils resulted in showing that the difference in their proportions of clay and sandy ingredients of the several grades is so slight that under ordinary circumstances it would be insensible in tillage. The chemical examination of the soils resulted thus: The non-alkaline surface soil shows with blue litmus paper a faintly acid reaction (as is usually the case in cultivated soils). The alkaline surface soil shows a sharply alkaline reaction on litmus paper, and portions of it exhibit on the surface white needle-shaped crystals, apparently of carbonate of sodium. In the dead-furrows on the alkali tract stood puddles of dark-colored water, an analysis of whose solid contents is given below, alongside of that obtained by leaching the alkali soil in the laboratory, evaporating the coffee-colored lye, and burning off the vegetable matter. The total amount of residue obtained by the latter process amounted to a quarter of one per cent. of the dry soil. Of this amount 0.158 was again soluble,

0.093 remaining behind as earthy salts, &c. The soluble part was constituted thus:

Constituents.	Soil extract.	Dead-furrow puddles.
	<i>Per cent.</i>	<i>Per cent.</i>
Carbonate of sodium.....	52.74	64.01
Chloride of sodium.....	38.08	13.06
Sulphate of sodium.....	13.26	} 22.93
Tri-sodic phosphate.....	1.83	
	100.91	100.00

The insoluble part of the aqueous extract gave—

	Per cent. of dead-furrow puddles
Carbonate of calcium.....	14.02
Tri-calcic phosphate.....	5.37
Tri-magnesian phosphate.....	5.77
Silica (soluble in $\text{Na}_2\text{CO}_3$ ).....	24.37
Iron oxide, alumina, and some clay (by difference).....	50.47
	100.00

It will be observed that notwithstanding the presence of considerable amounts of neutral sodium and calcium salts (which tend to render the soil more tillable), that of about 0.08 per cent. of carbonate of sodium was sufficient to render the soil practically untillable. Although this effect is much less perceptible in the case of soils containing less clay, it cannot fail to be, in many cases where it is not obvious, a determining cause in turning the balance of profit and loss the wrong way, especially in critical seasons. The change of carbonate of soda to some other form, at least, is therefore among the most important points to be gained in the reclamation of alkali lands; and fortunately this can be accomplished with little cost or difficulty by the application of gypsum or land plaster.

Another damaging effect of the alkaline carbonates upon the soil is the dissolution of their humus, which manifests itself in the dark color of the water standing on alkali spots, and the black rings left where such water evaporates; whence the popular name of "black alkali." When leached with water such soils will often appear almost white, and will remain unthrifty for some time, until the humus is restored by vegetable decay. The application of gypsum prior to leaching, however, renders the humus insoluble again, and thus prevents its waste.

#### RECLAMATION OF ALKALI LANDS.

The most obvious remedy for this evil is, of course, the leaching out of the injurious salts by flooding, and, if possible, underdraining. This method is habitually resorted to in sea-coast marshes, near the mouths of rivers, after the salt water has been excluded by embankments. The limited salty spots so frequently met with in the uplands of some regions are promptly cured by a few underdrains, through which the winter rains wash the salts definitely beyond the reach of the soil-water. Such spots are very commonly found extraordinarily fertile afterward. The problem of affording relief, however, becomes much more difficult when either a stratum of saline water or an earth-layer containing much saline matter lies a few feet beneath the surface in a level region, as is, unfortunately, very often the case in California. When this happens, the

evil can only be mitigated, but scarcely altogether cured. According to the value of the land to be reclaimed, one or several of the following remedies may then be employed:

1. When the alkali is not very abundant or very noxious, frequent and deep tillage may afford all the relief needed. For, inasmuch as the damage is in most cases the result of an excessive accumulation at or near the surface, it is clear that frequent intermixture of the surface layers with the deeper portions of the soil may so dilute the injurious salts as to render them powerless for harm. Moreover, since a perfect tilth of the surface greatly diminishes evaporation, it tends to diminish, concurrently, the accumulation of the alkali near the surface. The same effect may be produced by mulching, or by covering the surface with sand. With the aid of deep tillage, it is often possible to raise on salty sea-shore lands root crops, such as beets or carrots, which absorb a large amount of soluble salts and sensibly relieve the soil, so that cereal crops may be grown the second or third year.

2. Underdrains may so far lower the water-table from which the saline matters are derived, and may so far favor the washing out of the salts during the rainy season, that the latter will thereafter fail to reach the surface so as to accumulate to an injurious extent with reasonably deep tillage. The roots of plants will go deeper for the requisite moisture, but will not be injured by the weak saline water below. With the aid of underdrains, in many cases a comparatively small amount of irrigation water may, when applied at the proper time, be made to produce the leaching effect upon the surface soil that would otherwise require a long time and a much larger quantity of water in order to wash the alkali into the country drainage.

3. When the quantity of the salt or alkali is small, but its nature such as to be nevertheless very injurious or corrosive, the evil may be greatly mitigated, or sometimes completely relieved, by the application to the soil of chemical antidotes, cheaply procurable in commerce. In order that the proper antidote may be chosen, it is of course necessary to determine the nature, and in a measure the amount, of the "alkali" by chemical analysis. The salts usually found in the California "alkali" soils, so far as they have come under my observation, are of three kinds:

*a.* Neutral alkaline salts, such as common salt, Glauber's salt, sulphate of potassium, &c. These are injurious only when present in large quantities, and relief can then be obtained only by washing them out of the soil by flooding, underdraining, &c.

*b.* Soluble earthy and metallic sulphates and chlorides, such as Epsom salt, bittern, chloride of calcium, alum, copperas, &c. The cheap and efficient antidote to these substances is lime; in some cases even a natural calcareous marl will answer the purpose.

*c.* Alkaline carbonates and borates. These, especially the former, are injurious in the smallest amounts, rendering the soil-water caustic and corrosive, and in clayey soils rendering it almost impossible to obtain good tilth, by their peculiar action upon the clay. They are most abundant in Southern California, while the second and first class seem to prevail in the Sacramento Valley.

The antidote to these, the true alkali salts, is gypsum or land plaster. The efficacy of these antidotes depends, of course, upon the presence of water, without which they cannot act on the "alkali." They should be sown or spread on the surface, and plowed or harrowed in, to a moderate depth, just prior to irrigation, where that is used; in the case of plaster, put in with the grain; in that of lime it should be put in just before a rain, or irrigation, and not at the same time with the grain or

other seed. The amounts to be used of either of these substances will, of course, depend altogether upon the quantity of alkali in the soil, and upon the amount of surface evaporation allowed in cultivation. It therefore varies, and must be ascertained by experiment or analysis in each individual case. Their effect is to convert the corrosive or otherwise injurious salts into "neutral" ones, such as Glauber's salt or common salt, which are from ten to twenty times less injurious than, *e g.*, the carbonate of soda. It follows that when soils are very highly charged with the latter substance, even its conversion into neutral salts may not suffice to render the soil capable of profitable culture. To effect this it may be necessary to aid the antidote by leaching-out in bad cases. On the other hand, the antidote will, in any case, adapted to its use, aid either of the other methods of obtaining relief. The farmer afflicted with alkali should therefore not feel discouraged or disposed to condemn as useless any one of the measures of relief here described simply because the result is not perfect. The three should be combined whenever possible to the extent justified by the pecuniary value of the land.

In districts afflicted with the carbonate of soda in the soil, it has been found in numerous cases that the simple use of gypsum conjointly with summer tillage, to keep the soil loose, has sufficed to enable land that never before produced anything of value to bear abundant crops. But the failure to secure a similar result in neighboring fields, at times, has caused unnecessary discussions as to the utility of gypsum. It should be remembered that where the amount of soluble salts present in the soil is very large, gypsum may mitigate, but cannot altogether relieve, the trouble; its action must be supplemented by other means calculated to remove the soluble salts from the soil. In case carbonate of soda should not be present, gypsum will effect no improvement at all. To ascertain this is not at all difficult. The presence of carbonate of soda or potash is generally indicated when the water standing on the low alkali spots is of a dark-brownish tint, from the dissolution of the vegetable matter or humus of the soil; in other words, it is what is popularly known as "black alkali." Such alkali will, moreover, impart a brown tint to paper dyed yellow with turmeric; or it will turn the juice of red cabbage green, or the color of blue litmus paper red. Again, if water be shaken up with gypsum and allowed to settle, and some of the clear alkali water added, the gypsum water will be rendered turbid.

#### ANALYSES OF "ALKALI."

The following table shows in detail the composition of "alkali" salts occurring at different points in California, Nevada, and Utah. The analyses of those from California, as well as of that from Reno, have been made at the laboratory of the Agricultural College of the University of California; the rest are taken from the Report of the United States Survey of the Fortieth Parallel. The summations and minor ingredients are not in all cases given here, the object being to exhibit chiefly the agricultural bearings:

Table showing in detail the composition of "alkali" salts occurring at different points in California, Nevada, and Utah.

Locality.	Soluble salts in 100 soil.	Potassium sulphate.	Potassium carbonate (salicratas).	Potassium chloride.	Sodium sulphate (Glauber's salt).	Sodium carbonate (sal soda).	Sodium chloride (common salt).	Sodium borate (borax).	Sodium nitrate (saltpeter).	Sodium phosphate.
CALIFORNIA.										
Corvallis, Los Angeles County.	1.68	8.74	.....	.....	51.19	.....	22.366	.....	.....	.....
Westminster, Los Angeles County.	0.49	20.62	6.59	.....	.....	61.48	10.573	.....	.....	.....
Anaheim, Los Angeles County.	.....	.....	.....	.....	.....	.....	Much.	.....	Little.	.....
Riverside, San Bernardino County.	.....	.....	.....	Little	77.45	0.69	22.17	.....	.....	.....
Merced Bottom, No. 18, Merced County.	.....	.....	.....	.....	Little.	Chiefly.	Little.	.....	.....	.....
Merced Bottom, No. 19, Merced County.	1.00	.....	.....	.....	3.88	63.09	1.21	.....	10.72	4.10
San José, Santa Clara County	14.70	.....	2.92	.....	75.98	14.59	6.79	.....	.....	.....
Benton, Mono County	.....	.....	.....	.....	Much.	Chiefly.	Much.	.....	.....	.....
Sherman Island, Sacramento County.	.....	.....	.....	0.19	.....	.....	5.94	.....	.....	.....
Curtis' Ranch, near Stockton	3.73	.....	.....	.....	75.85	6.97	16.38	.....	.....	1.18
Overhiser's alkali soil, Stockton.	0.15	.....	.....	.....	13.26	52.74	33.08	.....	.....	1.83
Overhiser's alkali soil, Stockton.	1.02	.....	.....	.....	22.92	64.01	13.064	.....	.....	Little.
Hueneme, Ventura County.	.....	5.637	.....	.....	42.50	.....	22.104	.....	.....	.....
Goshen, Tulare County	1.40	.....	.....	.....	44.242	32.98	16.74	.....	.....	1.97
Mojave, Los Angeles County	.....	.....	0.58	.....	35.38	12.03	31.48	.....	.....	0.92
Colton, San Bernardino County.	.....	.....	.....	.....	26.73	53.08	12.28	.....	.....	0.60
People's Ditch, Tulare County.	.....	.....	.....	.....	1.22	88.09	1.00	.....	.....	.....
Sumner, Kern County	.....	.....	.....	.....	19.20	.....	57.14	.....	.....	.....
Dos Palmas, San Diego County.	.....	.....	.....	.....	29.60	.....	29.44	.....	.....	.....
Lemoore, Tulare County	.....	.....	.....	.....	Chiefly.	.....	Little.	.....	.....	.....
Emigrant Ditch, Fresno County.	.....	.....	.....	.....	.....	Chiefly.	Little.	.....	.....	.....
Collinsville, Solano County	.....	.....	.....	.....	Some.	.....	Some.	.....	.....	.....
Skaggs' Springs, Sonoma County.	.....	0.12	.....	0.97	.....	78.54	2.95	12.90	No. 1, trace.	LiC <sub>2</sub> O <sub>3</sub> 0.03
NEVADA.										
Reno	.....	.....	.....	.....	Chiefly.	.....	Some.	.....	.....	.....
Buffalo Peak	.....	1.94	0.94	.....	63.38	.....	70.81	.....	.....	.....
Humboldt Lake	.....	.....	.....	11.62	4.50	24.94	39.57	.....	.....	0.14
Truckee Desert	.....	.....	.....	.....	.....	.....	95.67	.....	.....	.....
Clover Valley	.....	1.94	.....	.....	33.88	39.04	24.96	.....	.....	.....
Spalding's Marsh	.....	9.32	.....	.....	.....	.....	89.47	.....	.....	.....
Peko	.....	.....	.....	.....	4.60	83.57	7.55	4.49	.....	.....
UTAH.										
Dugway Station	.....	.....	.....	.....	1.05	.....	86.33	.....	.....	.....
Salt Lake	.....	3.57	.....	.....	6.21	.....	75.08	.....	.....	.....

Table showing in detail composition of "alkali" salts, &amp;c.—Continued.

Locality.	Calcium phosphate (bone earth).	Calcium sulphate, (gypsum).	Magnesium sulphate (Epsom salt).	Magnesium chloride (bittern).	Organic salts of lime and magnesia.	Organic matter.	Salica.	Total.	Antidote.
CALIFORNIA.									
Corvallis, Los Angeles County.	0.51	.....	.....	.....	.....	.....	.....	100.27	Drainage.
Westminster, Los An- geles County.	.....	.....	.....	.....	.....	.....	.....	99.262	Gypsum.
Anaheim, Los Angeles County.	.....	Much	Little.	.....	.....	.....	.....	.....	Drainage.
Riverside, San Bernar- dino County.	.....	.....	.....	.....	.....	.....	.....	100.301	.....
Merced Bottom, No. 18, Merced County.	.....	.....	.....	.....	Large	.....	.....	.....	Gypsum.
Merced Batton, No. 19, Merced County.	.....	.....	.....	.....	.....	17.01	.....	100.00	Do.
San José, Santa Clara County.	.....	.....	.....	.....	.....	.....	.....	100.28	Do.
Benton, Mono County	.....	.....	.....	.....	.....	.....	.....	.....	Do.
Sherman Island, Sacra- mento County.	.....	.....	93.17	.....	.....	.....	.....	99.30	Lime.
Curtis' Ranch, near Stockton.	.....	.....	.....	.....	.....	.....	.....	100.378	Gypsum.
Overhiser's alkali soil, Stockton.	.....	.....	.....	.....	.....	.....	.....	100.81	Do.
Overhiser's alkali soil, Stockton.	.....	.....	.....	.....	.....	.....	.....	100.00	Do.
Hueneme, Ventura County.	.....	2.49	25.61	0.75	.....	.....	.....	99.092	Lime, drainage.
Goshen, Tulare County	.....	.....	.....	.....	.....	1.57	.....	100.00	Gypsum, drainage
Mojave, Los Angeles County.	.....	.....	.....	.....	.....	18.88	0.73	100.00	Do.
Colton, San Bernardino County.	.....	.....	.....	.....	.....	7.10	0.210	100.00	Do.
People's Ditch, Tulare County.	.....	.....	.....	.....	.....	9.21	0.480	100.00	Gypsum.
Sumner, Kern County	.....	0.96	18.31	.....	.....	20.87	.....	100.00	Drainage, lime.
Dos Palmos, San Diego County.	.....	0.772	1.25	12.341	23.67	.....	2.922	100.00	Lime, drainage.
Lemoore, Tulare Co. ....	.....	Little	Moder.	.....	.....	.....	.....	.....	Drainage.
Emigrant Ditch, Fresno County.	.....	.....	.....	.....	.....	.....	.....	.....	Gypsum.
Collinsville, Solano County.	.....	.....	Chiefly.	.....	.....	.....	.....	.....	Lime.
Skaggs' Springs, Sono- ma County.	Ca Cos 1.08	.....	Mg Cos 0.54	Sr } Bd } 0.13	.....	.....	.....	3.42	Gypsum.
NEVADA.									
Reno	.....	Little	Some.	.....	.....	.....	.....	.....	Drainage.
Buffalo Peak	.....	.....	.....	.....	.....	.....	.....	99.13	Do.
Humboldt Lake	.....	.....	.....	.....	.....	.....	3.25	.....	Gypsum.
Truckee Desert	.....	1.63	.....	.....	.....	.....	.....	.....	Drainage.
Clover Valley	.....	.....	.....	.....	.....	.....	.....	.....	Gypsum.
Spalding's Marsh	.....	.....	.....	.....	.....	.....	.....	.....	Drainage.
Peko	.....	.....	.....	.....	.....	.....	.....	.....	Gypsum.
UTAH.									
Dugway Station	.....	9.11	1.90	.....	.....	.....	.....	.....	Drainage.
Salt Lake	.....	0.57	.....	9.95	.....	.....	.....	.....	Do.

It will be noted that all the various classes of "alkali" salts mentioned above as occurring in California are also represented in Nevada; while in Utah, as Clarence King observes, the occurrence of the carbonates of the alkalies is on the whole rare, common and Glauber's salts, with other sulphates and chlorides, being predominant, and the effect of the salts upon vegetation on the whole less fatal.

A point of great importance to the agriculture of these regions ap-

pears from even a cursory inspection of the table, viz., that in many cases phosphates, nitrates, and potash salts form a notable proportion of the "alkali." These are the substances of which the withdrawal by cropping causes sterility of the soil, and the purchase of which forms a standing item of outlay in the farmers' accounts wherever a regular system of husbandry is established. Ordinarily they are found in traces only in the water permeating even the richest soils, the amount present being so small, or in such a condition of insolubility, that they are retained in the soils; but here we find them to be present in such large proportions as to form a regular part of the circulating soil water, the inference being that such soils, when freed from the injurious portions of the "alkali," would be extraordinarily productive, and would remain so permanently, without any additional supply of manure, if it could be assumed that soil water of similar composition would continue to ascend from below. But even if this should not happen, the amounts shown to be actually present in a soluble condition are far from insignificant in themselves, apart from their pointing to some prolific source of the supply. Taking, for instance, the case of Overhiser's "alkali" soil in the above table, we find that the apparently insignificant percentage of soluble phosphates, when calculated to percentage of the total soil (0.0064 per cent. of phosphoric acid) amounts in absolute weight, per acre of soil taken twelve inches deep and weighing about three and three-quarter millions of pounds, to no less than 240 pounds, a quantity which being absolutely available to crops would, *e. g.*, suffice for sixteen crops of wheat of 25 bushels to the acre; or, expressed differently, it is equivalent to a ton of best commercial superphosphate, for which \$45 would have to be paid. At least an equal amount must, moreover, be estimated to be present in the soil in the ordinary condition—mechanically absorbed and insoluble in water, yet available to plants. Hence, the above estimate of wheat crops, for which the soil contains an immediately available supply, must be at least double; and after that is exhausted there would still probably remain a supply as great as is ordinarily present in soils.

It should be noted that, in the case of these phosphates, the addition of gypsum would prevent permanently their being washed out of the soil, even in case the leaching-out process were to be resorted to; yet their availability to vegetation would not thereby be impaired. It is highly probable that in many cases where phosphates have not been determined by the analysts, their presence has simply been overlooked, and that their occurrence is much more general than is now proven. The amounts of potash found in some of the "alkali" salts are so great as to justify the conclusion that the supply of this ingredient in the corresponding soils is practically inexhaustible; for the fact that they circulate in the soil water proves that the soil must in the first place have been fully saturated with them, apart from what is actually in solution, and that in all probability the supply comes from the permanent water-table. To this extent the cultivators of such soils would be permanently relieved from the necessity of replacement by manure. The large percentage of potash salts in the water of Great Salt Lake recalls the statement repeatedly made, that certain alkali deserts in Southern Nevada are covered with immense supplies of salts so rich in potash as to render them directly merchantable, so soon as communication shall be established, for the purposes for which kainite is now imported from Germany. As regards the nitrates, it is obvious that they are locally formed in considerable amounts in the arid regions of North America as well as in that of Bolivia. Minute quantities can be detected in almost all

cases in which the carbonates of sodium or potassium form a large proportion of the soluble salts, but it is only under exceptional circumstances of location and rainfall that they can accumulate to a notable extent. Such is the case of the alkali tract in the bottom of the Merced River, from which the specimen, No. 19, was taken. It lies in a local basin of impervious limestone, and forms a low ridge which is only exceptionally overflowed by the river, and that after previous rains, so that even the salts that have bloomed out on the surface are not usually washed away. The niter-bearing deposits of alkali discovered in 1881 near White Plains, Nevada, and since examined more closely by Messrs. Redding and Scupham, of the Central Pacific Railroad Company, occur under circumstances quite similar to those existing in the Tarapaca Desert in Peru. The locality, since named Nitre Hill, is on the southeastern side of the sink of the Humboldt River. It occurs in crevices of decomposing rocks, as well as in the soil of the desert, and consists in the main of a mixture of niter with common salt, the former constituting from 10 to 30 per cent. of the soluble salts.

It is but reasonable to hope that more extensive investigation will show the conditions to be such as to justify exploration, furnishing a home supply of a substance which, however important in war, is not less so in the peaceful art of agriculture; nevertheless, it is quite probable that in the cultivation of regions possessing a climate suitable to the generation of niter deposits, the artificial addition of the latter as a commercial manure will rarely be necessary. Since nitrates are not retained in a soil percolated by water, the use of drainage or leaching-out of the soluble salts will result in the removal of this important fertilizing ingredient from the soil. When known to be present, therefore, the process of washing out should not be carried further, each season, than is needful for the success of crops, and all the means mentioned for reducing the injurious effect of the corrosive salts on the grown roots (above mentioned) should be employed. It goes without saying that in each case crops adapted to the particular circumstances will, other things being equal, bring the best returns. Experience has already in many cases demonstrated the extraordinary productiveness of some "alkali" lands when reclaimed by the means described.

#### EFFECTS OF IRRIGATION ON ALKALINE SOILS.

During the past two or three years complaints of the increase of alkali on irrigated lands in the upper part of the San Joaquin Valley, especially in the counties of Kern, Tulare, and Fresno, south of King's River, have become more and more frequent. During a personal examination of that region in March, 1880, this important matter was brought prominently to my notice by many farmers. Much difference of opinion prevailed as to the causes of the evil, but there was no question as to the fact of the increased "rise of the alkali."

The latter phrase, commonly used in this connection, really contains the clew to the whole problem. It is emphatically true that the alkali salts rise from below, through the agency of the water evaporating upon the surface. Irrigation has not only increased the amount of water evaporating from the surface, but it has also caused a much greater depth of subsoil to be drawn upon for its alkali. That in many cases the strata lying at depths of from four to six feet from the surface are much more highly charged with soluble salts than the surface soil is painfully apparent from the aspect of the material thrown out in digging the irrigation ditches, and now lining the banks of the

latter. In some portions of the "island," embraced between the several outlets of Kern River, south of Bakersfield, these embankments appear as though covered with snow, and the alkali can be bodily picked up by the hand. It would seem as though the rains would have leached these earth-piles long ago; but the rains usually falling in that region are so light that the soluble salts are only washed into the soil to a few inches from the surface, and within a few days after evaporation has again brought them back in the shape of a white crust. In digging wells in the light sandy soils of the "plains," from King's River southward, it has often been found that no perceptible moisture existed, even at the depth of from twenty to forty feet, until after the region had been irrigated here and there for several years. The amount of water needed is at first very large, but when the soil is once filled down to the drainage level, one-half and even one-third of the water previously used will suffice to grow a grain crop.

The rainfall in this region is usually so small (4 to 8 inches) as to suffice only for moistening the soil to the depth of a few feet, and during the time required for the evaporation of this natural moisture the short-lived vegetation of the region rapidly passes through its development. That vegetation consists of a comparatively small number of species of bright spring flowers, which in their season cover the entire country with a dense and beautiful carpet, one and the same flower occupying the ground almost exclusively at times, for many square miles, by virtue of the law of the "survival of the fittest." Were there any crop of a habit similar to these flowers that could be profitably grown on these plains, irrigation could obviously be dispensed with. The settlers of the region have tried what seems to be the next best thing, viz., to grow grain crops of a short period of growth, and therefore needing irrigation only during a small portion of the dry season. In so doing they have moistened the soil to a considerably greater depth than was reached by the rain water before, and as a consequence the annual evaporation has greatly increased. The irrigation water, moreover, has brought with it, from these depths, all the supply of alkali salts that before had gradually been washed beyond the reach of the ordinary rainfall by an occasional wet season. Each succeeding irrigation, followed by evaporation, tends to accumulate the salts nearer the surface, so that finally the root-crowns of the grain crops are "burnt up" before even beginning to head. The evil will, of course, be greatly aggravated if the water used for irrigation originally contains any considerable amount of alkaline salts, which are superadded to those already in the soil strata. Some important practical bearings of this point will be discussed further on.

#### REMEDIES FOR THE "RISE OF THE ALKALI."

It is obvious that the "rise of the alkali," following upon irrigation, cannot be remedied by the use of the chemical antidotes alluded to above. While they do convert the most injurious salts, carbonate of soda and sulphate of magnesia, into much less active compounds, yet these will remain in the soil, and if in sufficient quantity will ultimately become noxious to shallow-rooted vegetation especially. In some districts afflicted, the natural alkali consists only of such "neutral" salts, as common and Glauber's salt; as, for instance, in a part of the rich Mussel Slough country around Hanford, Tulare County, where, at the time of my visit, dead spots were appearing in the magnificent grain fields, at the time when the grain was but a few inches high, the evil being

worse wherever the crop was late and had not yet shaded the ground. Moreover, it was obvious and strikingly worse wherever the soil was sufficiently clayey to form a hard crust on the surface, a fact well known and recognized by farmers in the alkali regions, but often ascribed simply to the constriction of the stems by the contracting crust. The effect of the latter may, it is true, be noticed in adobe districts, where there is no alkali, and undoubtedly bears its share in doing damage, but the injury it creates is doubly great in alkaline soils.

In the early stages of the growth of cereals, the pulverization of this crust may be accomplished by harrowing or rolling, with great benefit to the crop. But in the upper valley it can rarely be done after the last irrigation without considerable mechanical injury. That a soil having such a surface crust dries much more rapidly than the same soil when kept in good tilth, is a fact too well known to require discussion. The dense crust absorbs water much more powerfully than does the loose soil beneath. The moisture is forcibly drawn from the latter into the surface crust, and there evaporates quickly under the influence of air and sunshine, hardening the crust more and more, and accumulating therein an increasing amount of alkali. To illustrate this, imagine a sponge, representing the loose soil, to be saturated with water, and a hard-burnt brick, representing the crust, to be laid upon it; the brick will take all the water from the sponge. Yet, if the brick be soaked in water and the sponge pressed on it, the sponge will not take up a particle of moisture. It is thus obvious that in alkaline soils the formation of a surface crust must of all things be avoided. In other words, as stated above, "deep and frequent tillage" is one of the foremost needs in such soils. And as this condition cannot be fulfilled in the case of broadcast crops, the conclusion is that broadcasting, and with it practically grain-growing, must ultimately be abandoned in the alkali regions, and hoed crops substituted, which will admit of the ground being kept in perfect tilth throughout the season.

#### CROPS FOR ALKALI SOILS.

The condition of preventing evaporation from the surface is also measurably fulfilled by such crops as "alfalfa," which not only thoroughly shades the ground, but in addition causes almost the entire evaporation water to pass up through its deep roots to the leaves, so as not to reach the surface at all. Such accumulation of alkali in and around the roots as can occur under such circumstances is too much diluted to hurt the plant. The fact that alfalfa succeeds perfectly on ground too much charged with alkali to grow grain is notorious; only care must be taken to prevent injury to the root-crowns, while the plants do not yet cover the surface, by timely irrigation.

If circumstances permitted the profitable cultivation of alfalfa on so large a scale, the alkali districts would perhaps have little cause to seek further. The experience with alfalfa, however, clearly points the way for the selection of crops better suited to the circumstances than grain, whose shallow roots are much more liable to alkali corrosion than is the case with the tap-rooted, or other deep-rooted plants. It is among these, then, that the alkali regions should seek for crops, of which the product shall be sufficiently valuable to bear the expense of inland transportation, under which these districts are now suffering. Next to these, the search should be for such as will be successful in alkali lands, provided the soil be kept well tilled through the dry season, *i. e.*, "hoed" crops.

In the former category, one of those standing foremost in promise is probably cotton, the success of which in that region is already shown by experiments made, the profitable production being at present limited only by the demand for the staple on this coast, which may soon be increased by the establishment of cotton factories. Of other textile crops, hemp, jute, and ramie at once suggest themselves for trial.

Of oil crops, the castor bean is perhaps the most available and most certain of success, always excepting the despised "white mustard" or "wild turnip," whose rank growth as a weed shows what might be done with it if grown for the manufacture of rape-seed oil. Root crops, being too bulky for profitable shipment by rail, will not be available to any great extent at present, unless as dairy feed, in conjunction with alfalfa, for conversion into butter and cheese. But beets, carrots, turnips, sweet potatoes, &c., all fulfill, to a greater or less extent, the conditions above formulated for successful culture in alkali soils. The culture of fruits, both large and small, that can be shipped in the dried condition, or in the shape of jellies, &c., is also an available industry, scarcely yet touched in the alkali regions. Raisins and prunes especially deserve attention as pretty certain of success.

Among hoed field crops available for that region, sorghum and sugarcane deserve attention. It is true that in general the presence of a large supply of soluble salts in the soil is deemed unfavorable to the profitable production of sugar, since it is apt to render the juice difficult to crystallize and to increase correspondingly the proportion of molasses produced. Actual trial, however, can alone determine the question here, and the results of some experiments made in this direction during the past season will be found in another place in the present report.

It would really seem as if in the broadcast culture of cereals, the farmers in the alkali districts had made the worst possible selection for the permanent good of agriculture in their region. That a change of system in this respect is imperative, can hardly be questioned by any candid observer of the facts. And it may well be questioned whether the necessity imposed by nature, of more varied and careful farming than has heretofore obtained, may not prove a blessing in disguise when rightly understood and acted upon. The planting system enriches a few individuals, almost always at the cost of the soil's permanent productiveness. It is small farms and intelligent culture that constitute the prosperity of an agricultural community.

#### SUB-IRRIGATION VS. SURFACE IRRIGATION.

The injury arising in alkali lands from the formation of a consolidated surface or crust, subsequent to irrigation by flooding, suggests at once the application of the water in such a manner as to avoid this evil, viz., by sub irrigation. To a certain extent the advantage so secured is well understood in the irrigation districts, the water being often applied only by the use of furrows or ditches, which divide the land into narrow bands, and from which the soil is moistened by "soaking sideways" from the ditches. The great multiplication of the latter, and their interference with the operations of culture on the large scale, have generally caused the use of this mode of irrigation to be restricted to small cultures. Even a cursory inspection of the state of things in the alkali regions shows that in the plots sub-irrigated by ditches the rise of the alkali has, as a rule, been very much less than in the case of adjoining

ones irrigated by flooding; and, in the latter, the high spots that have not been covered with water frequently escape damage, while the low portions are scorched with the alkali. This, at least, is the result when the amount of alkali present is not very great. When the soil is very heavily charged, the high spots being the first to dry, are also the first to be injured by the alkali drawn to the surface by evaporation, while in the low spots the grain may reach a greater development before being killed. Manifestly, the object to be attained is to prevent the irrigation water from reaching and evaporating from the surface at all, if possible. To accomplish this fully it would be necessary to know how far upward water will rise when applied to the several soils. Some data concerning this point are given in books on agricultural science, but they are not of such a character as to permit the prediction of this measure with respect to any other given soil. We know in general that in coarse, sandy soils water rises rapidly, but only to a moderate height, stopping there; while in soils composed of fine materials, whether clay or fine silty matter, or both mixed, the rise is slow, continuing for months in some cases before reaching the highest point, which may, however, be twice or three times as much above the water surface as in the case of sandy soils. For instance, in coarse, sandy soils, like those of portions of the plains of Tulare, or of parts of Stanislaus, the water may, in the course of three or four days, reach its highest point at twenty inches; while in adobe soils, or in the gray silt soils of Eel or Santa Clara Rivers, it may take ten days to reach the same height, but will continue to rise slowly for several months before reaching the maximum height of about 50 inches.

These points are illustrated by the following table of results, obtained by placing in a vessel containing water, kept at a constant level, wide glass tubes filled with the different soils, and recording from hour to hour, at first, then from day to day, the heights reached by the ascending moisture.

No. 1.—Coarse, sandy soil, from Morano Station, Stanislaus County, may be considered as representing the more "open" plains soils of Kern and Tulare Counties.

No. 2.—Hill adobe soil, from the campus of the University. A very refractory clay soil, very tenacious when wet, and when dry, untilled, opening into wide, gaping cracks to 18 inches depth.

No. 3.—Light sediment soil, from Mr. Blanchards' orange orchard, on the first bench of the Santa Clara River Valley, at Santa Paula, Ventura County. Is remarkable for remaining moist within 20 inches of the surface throughout the season, the water table being at 15 to 20 feet below the surface; very easily worked at all times.

No. 4.—Same as the last, but somewhat compacted by light ramming or tamping in the tube, as it would be if left untilled.

With the exception of No. 4, the above soils were in a condition of perfect tilth.



This table illustrates forcibly some important points in the management as well as in the natural peculiarities of soils. The coarse sandy soil represents not only its kind, but also any well-tilled soil; while, on the other hand, the adobe soil illustrates the case of any compact soil, whether naturally so or rendered so by imperfect tillage or the prevalence of carbonate of soda. The extreme slowness of the ascent of the water toward the end of its possible rise shows why a poorly-tilled adobe soil will open into gaping cracks a short time after the cessation of rains; while a well-tilled soil, maintaining both a quicker supply from below and a slower rate of surface evaporation, may maintain moisture throughout the dry season. At the same time, it informs us that sandy soils stand in especial need of a more dense subsoil, capable of drawing up moisture from greater depths than it is possible for a sandier mass to do, and thus supplying moisture to the roots of plants, while allowing but little surface evaporation.

In the case even of the light sediment soil from Santa Paula the difference between the rate of ascent in the tilled and the compacted soil is very apparent, and, in the case of the adobe, subsequent experiments showed that, when in the compacted state, the rate of ascent may be less than half of what it is in the lower portion of the column representing the tilled adobe.

The many and somewhat complex bearings of this subject on the chief varieties of soils in the alkali region will form the subject of farther investigation, now in progress. One point, however, may even now be usefully discussed, viz., that while it is certain that water applied to a soil like No. 1, at the depth of 24 inches, cannot reach the surface at all, and can, therefore, evaporate but very slowly, and not in such a manner as to accumulate alkali to an injurious extent near the surface; it does not, therefore, follow that in order to produce the same result in the adobe or silt soils the water has to be applied at the maximum depth of 50 inches. For, in a field planted with any growing crop, the leaves of the latter evaporate a very large amount of moisture, thus intercepting that which would otherwise rise to the surface and evaporate there. This is a matter of every-day experience. The inference is, that ditches or pipes designed for sub-irrigation would not in such soils require to be laid to any unreasonable depth in order to prevent the rise of alkali resulting from surface evaporation.

It is obvious that in this connection the subject of sub-irrigation by means of a system of pipes, of whatever material, acquires exceptional interest for the alkali districts, since its judicious use would not only obviate the rise of the alkali, but also accomplished a great saving of irrigation water—the latter being a matter of especial importance where the water itself is somewhat tainted with alkaline salts, as will be shown below. That this system is not likely to be used in connection with the growing of field crops on a large scale, is true, since the expense of the pipes is too great for any land not yielding very high returns. But when the continued rise of the alkali renders lands, intrinsically fertile, incapable of farther production, under the system of surface irrigation, the owners will needs have to take their choice between the abandonment or the adoption of such systems and objects of culture as will yield them profitable returns under the circumstances. The culture of cereals must “go to the wall,” and that of grapes, fruits, and such other crops as can be made to yield high returns under intense culture must take its place. It is not, perhaps, unreasonable to hope that the improperly so-called “asbestine” sub-irrigation pipe (consisting of hydraulic cement pipe that can be cheaply and rapidly laid by a

special appliance, at an expense not exceeding, it is said, \$35 per acre) may become so generally available by the home manufacture of the material as to form a practical solution of this great problem.

It should not be forgotten that, with a slight change in the manner of laying and outletting, this sub-irrigation pipe may be made to serve also for underdrainage; so that land provided with it could be completely leached of its surface alkali by flooding during the season when water is abundant.

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## LAKE AND RIVER WATERS OF THE GREAT VALLEY, AND THEIR QUALITY FOR IRRIGATION PURPOSES.

In the foregoing discussion of the "alkali" question it has been tacitly assumed that the soluble salts already in the soil alone need to be considered, the water used in irrigation being regarded as pure water only. This, however, is far from being actually the case with any natural water, and in the alkali districts especially the irrigation water is almost always more or less impregnated with the very same salts whose presence in the soil is so objectionable. It is obvious that when the amount of salts so added annually is at all considerable, it may ultimately so swell the quantity in the soil as to give rise to trouble. My attention was first directed to this subject by reports from the lands bordering upon Tulare Lake, to the effect that, although to all appearance of the best alluvial character, they would either not produce at all, from the outset, or else would cease to produce after a few years when irrigated with the water of the lake. The beginning of the investigation of this subject was given in the last report published. (See report for 1878-'79, p. 27.) A soil from the southeastern corner of the lake had been analyzed, and found to contain, in abundance, all the elements of fertility, yet it would produce nothing, and that under circumstances which led me to believe that the trouble was caused by alkali (carbonate of soda) contained in the soil. Analyses seemed to confirm this supposition, but at the time the report went to press the water of Tulare Lake itself had not been examined. Water samples were soon afterward received and analyzed, and the result showed it to contain so much alkali of the most corrosive character as to render it utterly unsuitable for irrigation. It then became apparent that one of the great bodies of water in the State that had been counted upon for irrigation purposes might have to be altogether rejected. The importance of the question led me to make the matter the subject of special inquiry during a visit to the upper valley, made under the auspices of the United States census, in March of the present year.

A personal examination of Kern Lake, and of the region lying between it and Buena Vista Lake, as well as of the Mussell Slough country, of Tulare County, satisfied me that in none of these rich agricultural sections could the slightest increase of alkali be safely risked; and analyses subsequently made of the waters of both Kern and Tulare Lakes prove that a very few years' use of the water now filling either of these reservoirs would be promptly fatal to the productiveness of the lands irrigated. As regards Kern Lake this is obvious enough from a casual examination and tasting of the water. Having been shut off from the natural influx of Kern River for a number of years, it has been rapidly evaporating and receding from its former shores, so that at the time of my visit a difference in level of over four feet had been produced in fifteen months, leaving high and dry a boat wharf built at that time.

About eighteen months before all the fish and turtles in the lake had suddenly died, creating a pestilential atmosphere by their decay, and even the mussels were mostly dead, a few maintaining a feeble existence. A strong alkaline taste and soapy feeling of the water fully justified their choice of evils. The tule marsh, laid dry by the recession of the lake, was thickly crusted with alkali, and the tules dead, except where still moistened by the water of the lake, showing that the latter was not yet too strong for such hardy vegetable growth, albeit fatal to animal life.

Buena Vista Lake was stated to be in a similar condition, but not yet quite so far advanced in evaporation, and still maintaining some animal life in its waters, having lost its connection with the river more recently. Tulare Lake is well known to be full of fish, and as it annually receives the overflow of Kern and the regular inflow of King's River, its evaporation and recession has been much slower; yet its water's edge is now distant several miles from the former shore line, and, as the water of the rivers is more and more absorbed by irrigation, it will doubtless continue to recede until a point is reached at which the regular seepage from the irrigated lands will balance the evaporation. This epoch would seem, however, to be quite in the future as yet, for the rate of recession has, apparently, not sensibly changed in the last few years.

It is not likely, in any case, that the water of the lake will be more abundant or less impregnated with mineral matter than is now the case, at the time when the state of equilibrium shall have been reached. In order to assure a fair determination of this important point, water samples from the opposite ends, as well as from the middle of Tulare Lake, have been analyzed, with the results given below. The sample of Kern Lake water was taken by myself, on the north shore of the lake, March 24, 1880. Tulare Lake water, No. 1, was taken about 300 yards off shore, near the southeast corner of the lake, inside of Root Island, near land lately reclaimed by Mr. E. R. Thomason, of San Francisco. Samples Nos. 2, 3, and 4 were taken according to my directions, near the middle of the lake, under orders of the King's River Canal and Irrigation Company, respectively, at the surface, at ten feet depth and at twenty feet depth. Of these, only one (No. 3) was fully analyzed, the total of solid contents only being determined in the case of the others, whose composition could not, of course, differ in any material respect. No. 5 is water taken by Mr. E. Jacob, of Visalia, at a point off the mouth of Mussel Slough, in the estuary of King's River. March 28, 1880. The sample was taken from the surface at a time when a strong northwest wind prevailed, which of course had a tendency to bring a larger admixture than usual of the fresh water of King's River:

Grains per gallon of—	Total residue.	Carbonate of soda.	Common Glauber's salts, &c.	Carbonate lime, magnesia, and silica.	Vegetable matter.
Kern Lake.....	211.50	64.37	115.41	9.29	22.43
1. Tulare Lake, south end .....	84.44	27.92	37.85	13.44	2.28
2. Tulare Lake, middle, surface.....	81.95	35.30	35.96	5.37	5.32
3. Tulare Lake, middle, 10 feet below surface.....	81.83	30.46	39.49	7.47	4.41
4. Tulare Lake, middle, 20 feet below surface.....	81.72				
5. Tulare Lake, near mouth of King's River .....	38.55	13.46	15.01	5.11	4.97

To convey to those unaccustomed to the consideration of such matters an idea of the meaning of the above figures, it may be stated that the solid contents of river waters vary usually from 5 to 12 grains per gallon. The water of Tulare Lake, where it is undiluted by the inflow of King's River, is therefore about ten times, and that of Kern Lake about twenty-six times, stronger than an average river water. Even this, however, conveys but an inadequate idea of the relation sustained by these waters to organic life. The average sea water (containing mainly common salt) is about ten times stronger than the water of Kern Lake, as regards its solid contents. Yet, in sea water fresh-water fish live freely during part of the season; while in Kern Lake the fish died at a time when, according to a minimum estimate, the water must have had about twice the strength of Tulare Lake, or about one-thirteenth of the strength of sea water. This shows strikingly the deadliness of the Kern Lake alkali, as compared with sea salt; or, in other words, of Kern Lake water as compared with tide water.

In comparing the quality of the alkali of Tulare Lake with that of Kern Lake, we find that in the former the proportion of the carbonate of soda (being the chiefly injurious ingredient) is about 1 to 2.83 of the whole solid contents, while in the latter this ratio is 1 to 3.28.

A part of this difference is, however, due to the large amount of vegetable matter dissolved in the strong lye filling Kern Lake; and, when allowance is made for this, the ratio becomes nearly the same in both waters.

As regards the relation between common and Glauber's salt on the one hand, and carbonate of soda on the other, in these several cases, it appears that in the evaporation process there is a gradual relative decrease of the carbonate of soda; for we have for this ratio:

Locality.	Carbonate of soda.	Common and Glauber's salt.
Tulare Lake, near mouth of King's River .....	1	1.11
Tulare Lake, middle .....	1	1.29
Tulare Lake, south end .....	1	1.35
Kern Lake .....	1	1.78

Whether this change in composition arises from a chemical change of the carbonate of soda or from an actual accession of the other salts is not easy to determine. The latter is the more probable explanation, inasmuch as actual veins and strata, several inches thick, of what from the description appears to be mainly Glauber's and common salt, have been found in the region between Tulare and Kern Lakes, in digging ditches. But whatever may be the cause of this slight difference in the composition of the alkali in the different portions of Tulare Lake, that difference is not sufficient to invalidate the broad conclusion that the water of that lake, as at present existing, is unfit for any of the ordinary processes of irrigation.

To prove this it is only necessary to consider what is the amount of the alkali that, under the usual practice, would accumulate near the surface. Ten inches of water is the usual estimate of what is needed in the course of the year to perfect a crop. Now, one gallon of water will cover about  $1\frac{1}{2}$  square feet 1 inch deep, or two-thirds of a gallon 1 square foot; or  $6\frac{2}{3}$  gallons per square foot is equal to 10 inches depth of water.

Assuming the average solid contents of Lake Tulare water at 80 grains per gallon, this quantity, upon evaporation, will leave near the surface, upon each square foot irrigated, 533 grains or about  $1\frac{1}{2}$  ounces of alkali. This amount pulverized and strewn over the surface would cover the whole of it thickly with white—a phenomenon already but too familiar to the farmers of that region. That the operation could not with impunity be repeated many years on any soil, least of all on such as are already more or less charged with alkali, scarcely requires discussion.

To illustrate the latter point, a tule soil, taken by Mr. E. Jacob, of Visalia, from his land near the mouth of Mussel Slough, was leached with water to ascertain the amount of alkali present. This was found to be 0.32, or about one-third of one per cent. Of this, supposing it to be of the same composition as that found in the water of the lake, about three-eighths, or, otherwise expressed, one-eighth of one per cent. of the whole soil is carbonate of soda, amounting to over two ounces in each cubic foot. This is within the limits of endurance of ordinary vegetation, at least in so fertile a soil; but double or triple it by evaporation, and that limit is passed.

To this conclusion, nevertheless, it is objected by some that the borders of Tulare Lake are thickly edged with vegetation in many places, and that in some cases garden plats have been successfully irrigated with the lake water for several years. One such case is reported by Mr. Jacob, of Visalia, who took sample No. 5 of the above table of analysis from the mouth of a small canal serving for the irrigation of a vegetable garden, which was doing well at the time. A few other similar cases have been mentioned to me. These, however, do not invalidate at all the conclusion that the lake water cannot serve for general irrigation, as usually practiced. Even the strongest water in the lake, near its southern end, is not so strong as to injure the roots with which it comes in contact, so long as it is not concentrated by evaporation. But in the low tule lands thus far tried this cannot occur to any great extent, on account of the constant presence of surplus water, and the frequently repeated irrigation, by which the strength of the alkali in the soil is kept below the point of injury. But it would be quite otherwise where the same water, used sparingly two or three times during the season, would evaporate so as to accumulate all its alkali near the surface. Yet it is probable that if the soil so irrigated were to be leached by a very copious and continued flooding once a year, so as to carry the accumulated alkali into the underground drainage, the water might be used with impunity. This would be especially the case with land underdrained, and could be more readily accomplished the smaller the amount of water originally used. The minimum amount, undoubtedly, would be the outcome of pipe sub-irrigation, referred to above, and would be applicable to the case of orchards, vineyards, &c. It might even be possible, in some cases, to make the same pipe system serve the purpose of irrigation at one time, and that of underdrainage at another. But, in whatever way accomplished, a leaching-out of the alkali, accumulated from evaporation of such waters from time to time, would be a necessary condition of their continued use for irrigation purposes.

This principle applies, in fact, to many more cases than is ordinarily supposed. Irrigation, without proper provision for drainage, has in the past, in very many cases, been the cause of the abandonment of lands once abundantly fruitful, which were supposed to be exhausted by culture, but in reality had simply become overcharged with injurious salts, or alkali, from the ever-repeated evaporation of enormous quan-

tities of water, whose solid contents, though naturally very small, had nevertheless been too strongly concentrated in the soil. This naturally leads us to the consideration of the river waters of the San Joaquin Valley, and their relation to the origin of the alkaline character of the waters and soils of the upper valley.

#### GEOLOGICAL HISTORY OF THE VALLEY OF CALIFORNIA.

That the great valley of California was in remote (Quaternary) times a great inland lake, which disappeared in consequence of the breaking through, first, of Carquinez Straits, and afterwards of the passage of the Golden Gate, is a matter scarcely doubted even by the casual observer. A glance at the map also shows that, from some cause not yet fully understood, there exists in the southern part of Fresno County a ridge across the valley by which the waters of King's River are thrown southward into Tulare Lake. At present this ridge is intersected at its western end by Fresno Slough, through which the surplus waters of Tulare Lake or of King's River, can find their way into the San Joaquin. But previous to the formation of this outlet the entire upper valley, evidently, was a shallow lake, of which Kern, Buena Vista, and Tulare Lakes are the remnants. From the data given below, it appears certain that the entire lake of the great valley had a somewhat alkaline water: and they also show that, probably, the residuary lake of the upper valley was more strongly so at first, and rendered more so in the course of long periods of evaporation, during which "sheets of alkali" (to use the language of the workmen who dug the Kern Canal) were formed among the alluvial deposits of the western margin of the valley.

It is only thus the fact already alluded to, viz., that the deeper portions of the Kern Valley alluvium are most strongly impregnated, can find its explanation. Whence did all the alkali come? A partial answer to this question is readily found in the frequent "blooming out" of soluble salts on the face of hillside cuts. Evidently a good deal of such salty matter pre-exists in the geological strata of the valley, and must be continually washed out by percolating water, which carries it into the lower portions of the country, and finally into the lakes themselves. But it would be difficult to account for the large accumulation of these salts in the Kern Valley if there were not some more copious and lasting source. For this we would naturally look to Kern and King's Rivers themselves, and analyses of the waters of these rivers were accordingly made, with the results given below:

#### ANALYSES OF WATERS OF THE GREAT VALLEY.

At my suggestion, an investigation of the waters of the chief rivers entering the valley between King's River and the Sacramento was undertaken by Mr. Horace G. Kelsey, of Merced Falls, as a graduating thesis at the University of California, in 1881. This includes the results given below under Nos. 12 to 15, both inclusive. The analyses of the water of the Sacramento and Los Angeles Rivers were made for the State board of health by Mr. Walter Jones (of the class of 1878, University of California), and published in the report of that body for the year 1878. To facilitate comparison, the table includes again the analyses of the lake waters already given above, and also analysis of the water found a few feet beneath the surface at Point of Timber, Contra Costa County, near the junction of the San Joaquin and Sacramento, in such abundance as to suggest its use for irrigation.

No. 1.—Water from Los Angeles River, taken from a hydrant in the city of Los Angeles, September, 1878.

No. 2.—Water taken from the grand cañon of Kern River, in April, 1880.

No. 3.—Water from irrigation ditch of the Kern Valley Irrigation Company, taken at a point two miles below Bakersfield. Both the above samples were furnished by the superintendent of that company. The water at that time was just beginning to receive the melting snows, and was slightly turbid, and of course somewhat diluted, as compared to its condition in winter.

Nos. 4 to 10 have been described as above.

No. 11.—Water taken from King's River, at Kingsbury, June 19, 1880, by Mr. J. D. Schuyler, of the State engineer corps.

No. 12.—Water taken from King's River, at Kingsbury, in November, 1880, before any rains had fallen.

No. 13.—Water taken from the San Joaquin River, at the crossing of the Southern Pacific Railroad, in November, 1880, after the first rains; perfectly clear.

No. 14.—Water taken from the Merced River, at Snelling, Merced County, in December, 1880, after the first rains had raised the river slightly above the lowest water-mark. It was slightly turbid with clay, which filtration could not remove, but was eliminated after evaporation.

No. 15.—Water taken from the Mokelumne River, at Woodbridge, San Joaquin County, in November, 1880, after the first rain, which had slightly raised the river. Water slightly opalescent from suspended clay, and residue corrected for same, as in No. 14.

No. 16.—Water of the Sacramento River, taken from a hydrant in the city of Sacramento, September 19, 1878. The data have been recalculated from the published results, so as to conform to the mode of presentation here adopted, which explains the apparent discrepancy of the tables as here given.

No. 17.—Water from a well at Point of Timber, Contra Costa County, furnished by Mr. T. W. A. Carter, of that place. This water is found abundantly about eight feet below the surface in that region, and, if available for irrigation, could be obtained in unlimited quantities by pumping, but the inhabitants stated that it "would kill the soil."

Grains per gallon of—	Total residue.	Carbonate of soda.	Common Chlorides, &c.	Carbonate of lime, magnesia, silica.	Vegetable matters.
1. Los Angeles River.....	17.53	.....	8.37	9.16	.....
2. Kern River (cañon) .....	9.49	1.23	1.77	5.55	0.95
3. Kern River (ditch) .....	9.62	1.23	2.21	5.33	0.85
4. Kern Lake .....	211.50	64.37	115.41	9.29	22.43
5. Tulare Lake (south end) .....	84.44	27.92	37.85	13.44	2.28
6. Tulare Lake (middle surface) .....	81.95	35.30	35.96	5.37	5.32
7. Tulare Lake (middle, 10 feet below surface) .....	81.83	30.46	39.49	7.47	4.41
8. Tulare Lake (middle, 20 feet below surface) .....	81.72	.....	.....	.....	.....
9. Tulare Lake (near mouth of King's River) .....	38.55	13.46	15.01	5.11	4.97
10. Tulare Lake (near outlet of west side canal, 10 feet below surface) .....	76.00	30.95	33.95	6.60	4.50
11. King's River (June) .....	4.13	0.003	0.86	3.27	.....
12. King's River (November) .....	5.03	.....	.....	.....	6.19
13. San Joaquin River .....	4.54	0.45	0.15	2.15	0.89
14. Merced River .....	5.64	0.19	0.09	4.18	.....
15. Mokelumne River .....	6.97	.....	0.42	4.42	3.70
16. Sacramento River .....	6.69	0.27	1.42	5.00	.....
17. Point of Timber (San Joaquin Delta), well water .....	67.75	10.83	48.41	7.41	1.10

The following table shows more in detail the composition of three of the waters given above, in a general manner:

Ingredients.	Los Angeles, city hydrant, river water.	Tulare Lake, middle, ten feet below surface.	Sacramento River, city hydrant.
Carbonate of soda		30.46	0.27
Chloride of sodium (common salt)	1.004	20.27	} 1.42
Sulphate of sodium (Glauber's salts)	4.134	7.54	
Carbonate of lime	0.382	2.49	0.31
Carbonate of magnesia	4.287	4.21	0.25
Silica	1.171	0.69	1.85
Sulphate of lime	0.776		0.42
Phosphate of lime	2.182		1.48
Iron and manganese carbonates	0.259		0.63
Alumina	0.100	0.29	0.07
Vegetable matter		4.41	
Total residue	17.530	81.83	6.69

In discussing the quality of these waters, in reference to irrigation, it must be understood that the group of ingredients mentioned in the fourth column of the first of the above tables, viz., carbonates of lime and magnesia and silica, are not only useful to vegetation, or unobjectionable, but are also very soon deposited and retained in the soil. We therefore leave them out of consideration, so far as the alkali question is concerned. For this the carbonate of soda and the salts mentioned in the third column are of chief importance, and among these, the corrosive carbonate of soda is the most noxious by far. The prominent facts shown in the above table may be thus stated: The water of the Los Angeles River, though containing a large aggregate amount of solid ingredients, has none of the carbonate of soda, but only neutral and earthy salts, of which a very large amount is injurious. This fact, together with the perviousness and free drainage of the lands irrigated, explains why it is that even those which have been longest under cultivation and irrigation in that region do not show any serious increase of alkali, and may never do so if abundance of water is used, at least from time to time. But, as irrigation water becomes more closely utilized and relatively more scarce, the leaching process will occur less frequently, and the accumulation of alkali salts near the surface will become more and more apparent.

In the water of Kern River, the proportion between the carbonate of soda and the other salts is almost exactly the same as in the water of Tulare Lake, in the proportion of about one to twenty-two. In other words, if twenty-two gallons of Kern River water were boiled down to one gallon, the alkali in this water would, in quantity and quality, be the same as in the water of Tulare Lake; and if this gallon was still further reduced to about three pints and a half, the remaining water would have about the composition of the water of Kern Lake, as it was in March, 1880. Comparing the water of King's River with that of Kern River, we find that in the latter the aggregate amount of solid residue in the water is less than half that found in Kern River. This, however, is to some extent due to the season at which the water was taken, it being then diluted with snow water. For purposes of comparison, we should take the figure obtained for the residue in November, when the solid contents were at their highest amount. But even on this basis we find that the amount of carbonate of soda in the King's River water is utterly insignificant, being not yet one hundredth of a grain per gallon, against about one and a quarter grains per gallon of Kern River water, while on the same assumption the percentage of other soluble salts is about twice as great in the latter.

Of the other rivers of the valley the San Joaquin shows the highest amount of carbonate of soda, but yet only about one-third as much as Kern River. The Merced has less than one-sixth as much of the same, the Sacramento less than one-fourth. Between the latter two we find the Mokelumne with none at all, there being some chlorides of magnesium or calcium in solution, to the extent of about one-tenth of a grain per gallon—an insignificant amount. The water of the Los Angeles River, likewise, is free from carbonate of soda; but its aggregate of soluble salts is somewhat high, exceeding in this respect even Kern River by one and a half grains. It is credited with a very large proportion of phosphates, as is also the Sacramento River. In the other analyses made these were not determined for want of material.

It appears from these comparisons that of the streams examined the Mokelumne has naturally the best water from the irrigator's point of view. King's River comes next, with a water whose purity is the more remarkable as its sources lie so near those of the Kern. The Merced comes next, having somewhat less of the objectionable carbonate of soda than the Sacramento; but, if corrected with gypsum, its waters would be placed at head of the list as the purest of all. The San Joaquin River has the smallest total of solid contents of all the waters taken at the same season, but contains over twice as much carbonate of soda as the Merced; if corrected with gypsum, its water would contain less than half as much of soluble salts as that of the Sacramento, one-half less than King's River, and only one-fifth as much as that of Kern River.

It will thus be seen that the correction of the irrigation waters of the valley by means of gypsum would in all cases but that of the Mokelumne effect a very important improvement as regards the safety of their continued use on soils of which but too many have already the full dose of alkali compatible with profitable cultivation. The change could doubtless be easily accomplished by interposing, at suitable points in the ditches, sluice boxes filled with coarse fragments of gypsum, renewed from time to time as the action of the water converts the gypsum into carbonate, or common limestone. Or, the gypsum may be applied to the soil itself, and thus be made to neutralize not only the soda of the irrigation waters but also that in the soil itself, at the same time introducing a useful fertilizer. The amounts to be thus used effectively may vary, according to circumstances, from 200 to as much as 1,000 pounds for the first application; smaller doses to be used thereafter at such intervals as experience may dictate.

Precautionary measures of this character should be employed as soon as possible by the inhabitants of the fertile valley of Kern River. Those using its waters should keep in mind that their evaporation annually to the alkali already in the soil a small but not inappreciable amount, which in some cases may, after a few years, prove "the straw that breaks the camel's back;" and that, therefore, some of the means mentioned above as remedies against this kind of alkali especially should be currently employed to keep it in abeyance. Tillage after irrigation, the planting of deep-rooted crops instead of grain, and the use of gypsum as a neutralizer of the worst ingredient, the carbonate of soda, are the measures that suggest themselves as the most feasible; while sub-irrigation, and especially the leaching out of the alkali from time to time by long-continued flooding and underdrainage, are more radical remedies for future use.

The water from Point of Timber offers some interesting points, suggestive of a state of things that may have to be taken into consideration in all plans for the irrigation of the west side of the San Joaquin Valley. From its location, this water might have been conjectured to

derive its ingredients from tide-water percolating into the loose strata. So far from this, its composition is closely analogous to that of the water of Tulare Lake, except that the proportion of carbonate of soda is considerably less, and therefore it is not likely to be as injurious in its effects on vegetation. Yet the inhabitants report here, also, that to irrigate with it "kills the soil," *i. e.*, renders it unproductive. It will doubtless do so when applied in small quantities only, and repeatedly. But it is likely that if used as suggested in the case of the Tulare water (that is, so as to leach the alkali out of the soil once in a season, into the underlying water-table), it might be successfully employed for irrigation, especially if, at the same time, the carbonate of soda were neutralized by the use of gypsum. If it be thought too fanciful to suppose, as has been done, that the alkali-water stratum at Point of Timber represents the seaward seepage of Tulare Lake itself, it is nevertheless quite probable that it does represent the quality of the underground drainage of the west side of the San Joaquin Valley, and is connected with the persistent appearance of "alkali spots" at every low place in the valley, from Antioch up to Kern Lake.

With the lights now before us, it can hardly be regretted that the old Westside-ditch, which was to irrigate the lower country with the corrosive waters of Tulare Lake, was not successful. The lake level is now several feet below the bottom of that outlet, and the lake keeps receding annually, and its alkali becomes stronger as the mass of the water decreases. It is difficult to say where it will stop; but if, as is probable, a state of equilibrium is reached whenever the waters of Kern and King's Rivers shall have fully filled the parched depths of the plains by a more general system of irrigation, it is not at all probable that the lake water will thereby become fresher; on the contrary, such seepage water will be likely to bring into it the alkali now dried up in the lower strata, and the annual evaporation will concentrate the solution more and more. It would certainly be most desirable to utilize the lake as a great reservoir for irrigation supply. But to render this practicable, it would be necessary first to empty out or displace the mass of alkaline water at present occupying the basin. The discussion of the feasibility of such an undertaking, however, belongs to the province of the Engineer Corps.

From the facts above given regarding the alkali soils and irrigation waters of California, the importance of investigating thoroughly not only the quantity but also the quality of the waters available for irrigation in the arid regions is sufficiently obvious. The facts as nature has made them should be elicited and plainly set before the people, so that money may not be invested in useless undertakings, or damage done which it may be difficult to undo thereafter. There are, probably, but few river waters in the world of such composition or natural purity that continued irrigation without correlative underdrainage, can be practiced without in the end causing an injurious accumulation of soluble salts in the soil. In India, according to the testimony of Prof. George Davidson, the evil effects of such practice have become painfully apparent, and to such an extent that after the expenditure of enormous sums for bringing the water upon the fields, the government now finds itself face to face with the costly problem of its economical removal, by drainage, so as to relieve the soil of the accumulated "alkali," which has rendered it unfit for cultivation. An early attention to this matter, with such foresight as will prevent the occurrence of similar difficulties, cannot be too earnestly recommended to all interested in the lands needing irrigation, from the Pacific coast to Colorado and Kansas.

# THE FIELD CROPS AND ANIMAL INDUSTRIES OF THE PACIFIC COAST.

BY T. C. JONES.

The commission is directed to make observations, and to report upon the agriculture, horticulture, and live stock industries of those portions of the territory of the United States lying west of the Rocky Mountains and the arid regions, with a view to furnishing data to aid the department in determining the needs of these industries in the regions mentioned.

In this paper it is proposed to deal first with the agricultural methods prevailing, including cereal crops, their value, amount in aggregate, and average yield per acre, the general management of the land for agricultural purposes, and the methods of fertilization.

## CEREAL PRODUCTIONS IN CALIFORNIA.

The chief cereal crops are wheat, barley, and oats. There is but a small portion of the land in California, south of the northern tier of counties, that will produce paying crops of Indian corn without irrigation. In some of the valleys of the Coast Range of mountains, north of San Francisco, we saw fair crops of this grain growing where there had been no irrigation, and on some of the low lands near Marysville and in the neighborhood of San José. The lands upon which these crops are grown are mostly of the character here called *adobe*, the soil being black and fertile and having a large percentage of clay mixed with the humus.

In essential characteristics this land resembles much of the low plain and prairie lands of Ohio, Indiana, Illinois, &c., and like them it dries up in summer, and its surface is checkered by cracks which remain from early summer until the soil is opened by the autumn rains. But these tenacious soils are more difficult of cultivation here than similar soils in the Mississippi Valley in the same latitude, because they are not subject to the ameliorating frosts of winter which there penetrate to the depth of from 12 to 30 or 36 inches. The beneficial effect of this hard freezing in rendering stiff clay soils friable is well known. In California, therefore, the work of plowing these adobe soils has to be done in early spring or postponed until the autumn rains set in, usually not earlier than the middle of November.

The work of seeding is then pushed on as rapidly as possible, as the sooner the wheat is put in the ground after this period the better. The general practice has been to sow wheat after wheat, and for some years it was argued that this might be continued indefinitely without exhausting the land, and the practice is still continued by many cultivators. In the friable, sandy lands of the San Joaquin Valley it is a common practice to sow wheat on wheat stubble, simply harrowing it in, without plowing, and in some instances without sowing fresh seed, the

waste wheat on the stubble being regarded as sufficient. But intelligent farmers, who carefully observe the results of their cultivation, are very generally of the opinion that this practice, which seems to have originated with capitalists who have embarked in wheat growing as a speculation, as Southern planters have in the production of cotton, is seriously detrimental to their lands—first, because under this practice the land soon becomes full of noxious weeds, and second, because it has been found to be slowly but steadily deteriorating in fertility.

Hence the best cultivators recommend what they call in California summer fallowing, though it is wholly unlike the cultivation so designated in the Eastern States and in Europe. The land is broken up in spring, say in March or April, when the soil is in proper order, and then left without further cultivation until the latter part of August, when what is here called *dry seeding* begins, the wheat being sown broadcast and harrowed in. All this work is done in a sort of wholesale and hurrying manner, as if the main purpose was to see how much could be done in a day with the least number of men. The breaking up is done with the gang plows drawn by four to six horses, and the rotating seed-sower is put on a wagon and so attached as to be operated by motion of the wheels. The harrow, which is more than double the width of those used in other parts of the country, is drawn by four and sometimes by six horses. In this way from 15 to 25 acres a day are sown. This is the cultivation found in the great valley of the Sacramento and San Joaquin, extending a distance of no less than 350 miles from north to south, and containing about 14,000 square miles—a vast level plain, mostly dotted over with native oaks, which, with their low and expanding branches and evergreen foliage, make this region one of enchanting beauty, and it is of extraordinary fertility for the production of this great world-recognized standard cereal. Nowhere in the world, probably, is wheat produced with so little labor or of such uniform excellence.

A remarkable peculiarity of the grand trees seen in almost all the fertile valleys of California is, that they seem to interfere very little with the growth of crops under their wide-spreading branches, which we suppose must be attributed to the fact that the roots run perpendicularly down into the soil in search of moisture, instead of spreading out near the surface, and thus destroying the vegetation within their reach. A large proportion of these countless thousands of acres are uninclosed, and we see, as we ride over the wide expanse, but few buildings and very little stock—a few pigs to pick up the wheat which is dropped from the over-ripe heads as the grain is harvested, and only the horses required to get in the seed and to reap the crops. We saw no reapers and binders, no wheat drills or horse-power threshers. The crop is cut with a header, which is propelled by four to six horses placed behind it. The grain is cut high, leaving 2 to 3 feet of the straw in the stubble. The header cuts about 18 feet in width, is managed by two men, and requires three wagons with four horses each to haul the grain from the header to the stack, with, of course, one hand to each wagon and two at the stack, say, in all seven men and twelve horses, harvesting perhaps 30 acres per day. The expenses would be, say, seven men, at \$2.50 each per day, \$17.50, which with teams, wagons, and header will make a total expense of \$25 to \$30 per day, besides board. There is no question about the capacity of these lands to yield large crops of wheat, where there is proper cultivation; but, as already observed, the methods of cultivation are peculiar, and when the work is carefully done it is far from being the best, or what in older countries would be called good.

Notwithstanding this negligent management, there are, in average

years, many large tracts yielding enormous crops, say from 30 to 40 bushels per acre. But the average yield is below the usual estimate of the inhabitants, who generally insist that the Sacramento Valley will average 25 to 30 bushels per acre, while the most reliable, practical farmers informed us that even in the upper part of this valley, where deficiency of moisture to make the crops is rare, and where the quality of the land is of the highest excellence, 20 bushels is a fair average, one year with another, with what they call good cultivation.

By the department report for 1879 it appears that the total acreage under wheat in the State of California was 2,500,000 acres, and total yield 35,000,000 bushels, or an average of only 14 bushels per acre. In 1877 the yield was still lower. From 2,315,789 acres in wheat there were but 22,000,000 bushels reported as the product, while the yield of 1876 is put down at 30,000,000 bushels from a total acreage of 2,307,692. These yields, as compared with those of other portions of the Union, are not large, and certainly far below what California is capable of producing on the same acreage under a better system of husbandry.

Of the grain crops of California, the next in importance is barley; the acreage in 1879 being 630,500, and total product 14,501,500 bushels. For the same year the oats crop amounted to 5,072,000 from a total acreage of 153,700, or an average of 33 bushels per acre.

The same year 100,500 acres in corn produced 2,814,000 bushels, or an average of 28 bushels per acre.

The total value of these several crops for the year 1879 was:

	Total.
Wheat, per bushel, \$1.23 .....	\$43,050,000
Barley, per bushel, 56 cents.....	8,120,840
Oats, per bushel, 67 cents .....	3,398,307
Corn, per bushel, 79 cents.....	2,223,060
Total value of cereals .....	\$56,792,207

This comparison of the cereal crops of the State accounts for the prominence of the wheat products in the agriculture of California, though the exceptionally fine appearance and high quality of the grain have much to do in establishing the reputation of this great coast State as a wheat-growing country.

Comparing these products with some of the States in the valley of the Mississippi, we have striking illustrations of the vast difference in the productive capacity of our soil and climate in different parts of the country in nearly the same latitudes.

Thus, Illinois reports for 1879 a product of—

	Bushels.	Acres.	Value.
Wheat .....	44,896,830	2,400,900	\$48,039,608
Corn .....	212,221,000	4,088,500	96,788,310
Oats .....	47,070,400	1,489,700	12,071,008
Barley .....	575,000	25,000	339,250

#### ANIMAL INDUSTRY.

Before proceeding further to detail the methods prevailing in the cultivation of cereal crops, it will be convenient to state briefly our observations upon the animal industry of this region—its condition, management, value, etc., as required by our instructions—because, in our view of the matter, the condition of this industry has a very material bearing upon the profit of the business of growing crops.

## HORSES.

The department report puts the number of horses in California, in January, 1880, at 273,000, valued at \$46.18 per head; total value, \$12,607,140.

The writer hereof does not know by what means the department ascertained the value of farm stock in the different States; whether from the reports of local tax assessors or its own correspondents. This value seems low, as compared with the value of horses in other States. For example, Oregon reports the average price at \$51.93 per head, and Nebraska and Minnesota each at over \$64 per head.

If the horses in and about the principal towns and cities of California, as we saw them, are to be taken as average specimens of the horses of the State (and from our observations in the farming districts we should say that they were not much above the average), the horses of California are certainly not inferior in excellence to those of other great breeding States. Indeed, we are inclined to the opinion that, as roadsters and stock for general purposes, the horses seen about San Francisco, Oakland, Sacramento, &c., are superior in average excellence to any we have seen in any other part of the country.

## HIGH EXCELLENCE OF THE HORSES.

This excellence was so striking that special efforts were made to obtain, by observation and the opinions of the most intelligent breeders, the particulars of their breeding. When the immigration consequent upon the gold discovery began the best stock to be found in the east were always selected by the enterprising adventurers. Many of these were of superior blood, and all were selected with a view to secure the spirit and endurance required to withstand the hardships of the long and tedious overland journey. Of these a due proportion, of course, were mares, and it is the concurrent testimony of all the parties with whom we conversed that these animals were of large size and of fine form for roadsters, and generally possessed unmistakable indications of good breeding.

As early as 1860, thoroughbred and trotting stallions of the best class had been brought over the mountains and were advertised in the California papers, as we were shown by Mr. J. C. Simpson, of Oakland, who had collected and preserved these old advertisements, and who is, by the way, a gentleman who ranks very high as an authority on all questions relating to blooded horses.

Still it occurred to us that the infusion of superior blood of the east, as above set forth, was hardly sufficient to account for the uniform excellence of the horse stock as now seen in Central California. It seemed to us clear that the stock of mares in the State at the time this infusion began must have been very far above the average of the Spanish horses seen in New Mexico and Texas at that time, and this opinion was corroborated by the testimony of Mr. Simpson, based upon very extensive observation and inquiry. But in addition to much information from the best posted horse fanciers who have been familiar with the history of breeding in the State for the last twenty or thirty years, we conversed with many gentlemen connected with old Spanish families that had been extensively engaged in breeding horses before the country was acquired by the United States. Among these may be mentioned Judge Sepulveda, of the superior court at Los Angeles, whose father was born there in 1804, and was as early as 1826 largely engaged in breeding horses and cattle.

## EARLY HISTORY OF BREEDING IN CALIFORNIA.

All the horses at this period were Spanish, brought here from Mexico, by way of Lower California, and were selected with a view of securing the highest excellence.

Horses were kept in immense numbers; every proprietor of a hacienda was a breeder of horses. The father of Judge Sepulveda kept from two to three thousand head, and was especially careful in the selection of stallions and breeding mares. The mares were divided into bands, called *manadas*, of, say, forty to seventy, of uniform characteristics and frequently of uniform colors, with stallions selected to match. Bay, chestnut, and gray were the most approved colors. The mares of a newly formed band were kept together for a few days with the appointed stallion, called *saranon*; after that the stallion would keep them together and keep out all intruders. The grazing land was of every variety of character—hills, valleys, and plains—some high and hard, gravelly soil, and some low and boggy. In winter, while the ground was moist, care was taken to herd the horses on high and dry ground, to keep their feet hard and sound. In the dry weather of summer they were allowed to run where they pleased. Colts were castrated at the age of two years. The breeding mares, as well as the stallions, were allowed to run perfectly wild, it being supposed that breaking them impaired their vigor and spirit. In each band, however, there was a lead mare that had been handled and could be led. The best breeders had their vaqueros constantly looking after their stock, arranging the bands, and seeing that they did not get off the proper range, &c.

The horses of that period, we were assured, were of fine form and good size, frequently from fifteen to sixteen hands high, and always of wonderful spirit and endurance, with exceedingly sound legs and feet. Shoeing was never thought of in those days, and it was a very rare thing to find a horse lame from any cause.

These horses were, of course, like all the best Spanish stock, descended from Arabian or Turkish ancestry, and had the general characteristics of that blood.

When the tide of immigration set in from the East, after the discovery of gold, there sprang up a brisk demand for horses about the mines, trading points, and cities. Purchasers came to the great breeding districts about Los Angeles, Santa Barbara, &c., in search of stock, and invariably selected the largest and best animals, and as a consequence the horses in this part of the State began to deteriorate, especially in size; while about the cities and the mines the quality of this stock showed a corresponding improvement, as these choice mares were crossed by the fine stallions imported from the east.

The climate of the Pacific coast doubtless has much to do in producing this high excellence observed in California horses. Atmosphere so dry, so pure, and so exhilarating is certainly favorable to the development of the high spirit and energetic action so generally observed here.

As to the methods practiced by California breeders in general, they are simple enough. The mares and foals are out summer and winter, and have but little grain, except what they pick up on the stubble. This refers, of course, to the mares owned by ordinary farmers. There are many stables of highly bred horses, one at least (that of Governor Stanford) equal in the number and excellence of its stock and the amount of money expended in its management to any in the United States. At stables of this character horses are fed oats, with mill feed, chopped straw, &c., with hay. But the hay is always oats, wheat, or barley, or

wild oats, cut a little green, while the grain is in the dough. But as upon the farms (or ranches, as the people here, *in defiance of the usages of civilization*, persist in calling their farms), horses are seldom kept in stables. There is, therefore, from this branch of stock breeding but very little manure made to aid in maintaining the fertility of the soil.

We add in reference to this department of animal industry of California, that we are convinced that in average excellence for general use, the saddle and road, and the farm, the horses about the cities and in the central part of this State are not surpassed by those of any country with which we are acquainted.

In Great Britain the coach horse and the hunter, that were found in such excellence forty years ago, are now sadly depreciated in size and character. Breeding in that country is now chiefly confined to two classes of horses, to-wit, the race-horse, for short distances and light weights, and the heavy draft horse. It is the same in many parts of our own country, with the addition of a strain of trotting horses, bred almost exclusively with the view to mere speed, in an unnatural and unprofitable pace, for the race-course. We were, therefore, glad to see on the Pacific coast such a grand class of useful and stylish general-purpose horses, when horses of this sort are so generally deteriorating elsewhere.

#### CATTLE.

"No cattle, no corn," is an old English maxim, and when the inquiry was made as to how much corn a farm would produce, it was common to answer "that depends upon how many cattle you keep." Cattle and sheep, it was assumed, must be kept on the farm to make manure, and, according to the English notion, this stock, to be of any benefit to the land, must be well kept, for it was said "if the cattle are fed straw, the manure will be straw, the crop will be straw, the farmer will be straw, and all will be straw together."

The department report puts the number of milch cows in California in January, 1880, at 473,400; average price at \$28.65, which is about \$2 per head higher than Ohio, Illinois, and Michigan, and \$6 higher than Kentucky; while the cows in Oregon are valued in the same report at less than \$18 per head.

But "other cattle" in California are valued at only \$18.47 per head, while in Ohio they are \$22.37, Illinois \$21.09, Kentucky \$19.05, and Oregon \$11.39.

By the report of the California Board of Equalization for 1880, compiled from reports of county assessors, the average value of cattle is put at \$10.39 per head.

Six hundred and thirty-eight thoroughbred cows are valued at an average of \$56.82 per head, and 111,846 "American cows" are put down at \$19.59 per head, and 72,938 "graded cows" at \$18.94 per head; 96,055 calves are valued at \$4.91 each, and 4,419 oxen at \$30.95; 12,966 beef cattle at \$18.45.

These conflicting valuations do not furnish reliable data for determining the value or condition of this class of stock in California.

From our own observations we should conclude that the reports of the local assessors as to the number of thoroughbred cattle in the State was very far below the actual total of even the counties therein reported, if the report includes full-blooded cattle of all the different breeds, as Shorthorns, Jerseys, Herefords, Devons, Dutch, Ayrshire, &c.

The house of Miller & Lux, of San Francisco, is believed to be the largest breeding and meat-producing establishment, probably, in the United States, handling stock of equal excellence. This firm alone

has no less than 500 full blooded shorthorn cows and heifers of all ages, besides large numbers of grade Durhams among the 22,000 cows they keep for breeding beef cattle; and about 250 high-grade cows, having all the characteristics of full-blooded Shorthorns, on a dairy farm of 600 acres, part of an estate of about 40,000 acres they own in the Santa Clara Valley, near Gilroy.

For this farm of 600 acres, and the use of the 250 cows, the tenant (Mr. Davis, a very skillful dairyman) pays an annual rent of \$4,500; besides all the calves at the age of four months.

The product of this dairy in 1880 was \$17,000 worth of cheese; also made about 60,000 barrels of pork.

Miller & Lux have in all about 700,000 acres of land, situated in the counties of San Mateo, Santa Clara, Merced, Fresno, Tulare, Monterey, and San Benito. These lands are nearly all inclosed, and the cattle and sheep of this firm are only allowed to run out on the plains in spring and summer until grass dies—say, till the middle of August. They estimate 5 acres of this land sufficient to graze a bullock through the year.

This house gave us prices as follows: Veal calves at three to eight months old, \$8 to \$12 per head. The cattle they purchase at three to five years of age, generally in Nevada, cost about \$25 per head. These cattle are mostly bred in Oregon. Hides of bullocks sell for about \$7 each, and of cows for \$4. Beef in dressed carcass sells from \$4.50 to \$6 per hundred. Mutton, dressed carcass, \$3.50 per 100 pounds. Bullocks weigh about 600 pounds net, sheep (wethers), say, 50 pounds, and ewes 45 pounds; calves about 200 pounds net. Dairy calves are killed young, say at four to six weeks, and sell for 8½ cents, average weight 75 pounds, and are mostly from counties of Maria and Solano, chiefly common stock, as dairymen in these counties do not use blooded bulls. August and September are the months when beef cattle are in the best condition; after this they begin to decline, and the great majority of California cattle become quite thin before the grass gets nutritious in spring.

On the Miller & Lux estate, in Santa Clara County, we were shown 160 Durham steers about three and a half years old, that were estimated to weigh 1,700 pounds, live weight, and they were of a character that would rank nearly first class in Eastern markets. These bullocks were on what was here called fair grass (October 13), but all dried up, and as they thought of little value, except a part that was in alfalfa, and this, they said, while much esteemed by some for dairy cows, was not very profitable grazing for beef cattle. These bullocks were being fed corn in the shock (small Yankee corn), with a daily allowance of pumpkins.

We were also shown a lot of Oregon bullocks, purchased in Nevada, about 150, three to four years of age. These were cattle of fair quality, but not in good flesh; weighing, perhaps, 1,350 pounds, average, and most of them showing indications of Shorthorn blood, as these gentlemen said was common with the Oregon steers. They cost \$27 per head, and would have brought in Chicago double that money, and in the spring of the year a good deal more.

It seemed strange to us to see cattle of this size and quality in such lean condition at this time of year, and appeared to indicate that they had been on very indifferent grass.

#### THE DAIRY.

Our observations in regard to the dairy interests of California may be appropriately given here.

The cheese dairy on the estate of Miller & Lux, in Santa Clara County, has already been referred to, as showing that this industry is one of the most profitable connected with the agriculture of California. But this establishment is well managed, the cows being grazed largely on alfalfa and fed wheat bran and shorts, oil cake, middlings; corn and pumpkins being fed to pigs. Cost of bran and shorts averages \$14 per ton.

There are about 3,000 cows in dairy in this part of the Santa Clara Valley, that is, near the town of Gilroy, making annually, as we were told, about 1,000,000 pounds of cheese, which, according to our observation, is mostly of good quality.

The valleys of the Coast Range of mountains are believed to be well adapted to this industry; the pastures being better and lasting longer than in the great valleys of the Sacramento and San Joaquin.

Many of the dairymen here, perhaps most of them, do not feed their cows, and these count May and June to be their best months, during which time the cows make very large returns on the native grasses. The counties producing the largest amount of cheese are all in the Coast Range region, to-wit, San Luis Obispo, 786,552; Sonoma, 500,000; San Benito, 350,000; Santa Clara, 88,795; Marin, 68,318; Los Angeles, 55,000; Monterey, 55,000; and the largest amounts of butter are produced in the same region, to-wit, Marin County is reported as producing no less than 3,468,680 pounds annually; Sonoma, 3,000,000; San Luis Obispo, 1,135,126.

There are also good grazing lands in some parts of the Sacramento and San Joaquin Valleys, where the dairy industry is pursued to some extent. Thus we find Tulare County produced 443,850 pounds of butter, Sacramento 385,000, and Yolo 200,000 pounds.

The cows used in these dairies are mostly such as are seen in many of the Eastern States, or what is called common or unimproved stock. In the Santa Clara Valley there is quite an infusion of Shorthorn blood, as in some of the counties in the Sacramento Valley and in other parts of the State. The reasons given for this preference for this blood, are that the half-bred Shorthorns are generally good milkers, and always produce good calves to rear, either for beef or milk, and the cows themselves, when no longer wanted in the dairy, always make more valuable carcasses of beef than milking cows of any other breed. In many dairies, however, we observed some cows of Jersey blood, especially those in the neighborhood of the towns and cities.

In the Santa Cruz and Pescadero region there are perhaps nearly 5,000 dairy cows. Some of these are grade Ayrshires and some grade Jerseys, with a few Devonshires. On one single estate, that of Mr. Laird, we learned there were about 200 full-blood Shorthorns.

There seems quite a spirit of improvement among the cattle-breeders of this part of the State, especially those engaged in the dairy business, who are resorting very largely to pure blood, mostly to the Jersey and Shorthorn; the latter, as we learned, being most in demand, because they are believed to be superior for beef and cheese, and they regard cheese as much more profitable than butter. The Ayrshires are esteemed as excellent milkers and good for both butter and cheese.

It is the common practice at these dairies to save fifteen to twenty per cent. of the heifer calves to supply the places of the aged cows that are annually drafted for slaughter.

We have already observed that the report of the State board of equalization of California, giving the number of thoroughbred cows in the State as only 628, must be grossly erroneous, and have shown that

the single firm of Meesrs. Miller & Lux must have more than half that number of thoroughbred Shorthorn cows in milk, and that Mr. Laird, in Santa Cruz County, has nearly 200 of the same breed.

Mr. Robert Ashburne, an Englishman, who occupies 700 acres of land near Baden, in San Mateo County, has nearly 100 head of pure Shorthorns, a considerable portion of them being imported by himself. Half of this herd must be breeding cows; and we suppose Colonel Younger, of San José, whose herd numbers about 60 head, has 30 or 40 cows. This would give a larger number in the herds of these four proprietors of this single (Shorthorn) breed than the report gives of all the pure breeds in the whole State.

As to Shorthorn bulls, they are to be found in all the cattle-breeding districts in California and Oregon. Messrs Miller & Lux, we believe, have 250 to 400 in service. Many of the dairies use these bulls, and sell the bull calves to the ranchmen who are breeding cattle for beef.

We have not been able to find any reliable statistics as to the proportion of the cattle of California that are improved or "graded" stock. It appears to have been the purpose of the State authorities to obtain this information from local assessors for the use of the State board of equalization in 1880. But, as already stated, these returns seem to be exceedingly defective, so defective, in fact, as to be of little value.

The total number of cattle of all sorts, according to these returns, we make only 622,874, and this includes 96,055 calves, while the United States Agricultural Department report for the same period puts the number at 1,472,100.

Many of the local assessors omit to give the number of cattle in their counties, and a note to the report of these statistics made by the State board states that only the assessors of Butte, Shasta, and Monterey "seem to know what *graded* means, being a term used by stock-raisers to indicate the produce of a thoroughbred sire and dam of unimproved blood."

We do not indorse this definition. When stock-men speak of grade cattle, grade sheep, &c., they mean stock that has been improved by an infusion of the blood of some established breeds. The sire may be purely bred or half bred, or the dam may be a full blood and the sire a scrub, or both sire and dam may be half bred, or grades. In either case, or whatever the proportion of pure blood, where the progeny shows in any degree the characteristics of the superior blood, it is called a *grade*, and where there is a predominance of the pure blood, as seventy-five per cent., which would be the result of two crosses, the animal is called a *high grade*. Some years ago there was a distinction made by breeders in some parts of the country between animals called "full bloods" and those denominated thoroughbreds. Four crosses of pure blood were held to constitute full bloods, while "thoroughbred," as applied to cattle, implied a descent in all the crosses from imported animals of the pure breed.

In Great Britain, the term "thoroughbred" is applied only to the *race-horse*. There all Shorthorn cows are admitted to register in the herd books that have four crosses of recorded bulls; and bulls are required to have five such crosses to entitle them to rank as well-bred Shorthorns.

The reports of the local assessors show the proportion of unimproved, or "American" cows, as they are here designated, to the "graded" cows to be one hundred and eleven to seventy-two, and we believe from the observations we were able to make that the spirit of improvement among the breeders of cattle in California is quite general.

But the system of feeding and management of this most important class of farm stock, so far as respects its influence upon the productiveness of the soil, is about as bad as it can be, if we except a portion of the dairies, and a few herds of blooded cattle. The stock, as a rule, is without shelter throughout the year, which, on account of the wonderful mildness of the climate, is not injurious to the cattle. But with the large majority there is no feeding, summer or winter, or pasturing on cultivated grasses. Such grazing as the native forage plants yield is really of what may be denominated high excellence, but only during a small portion of the year, as we were told by the most reliable and practical graziers, not exceeding in average years four months. The native grasses and plants begin to grow, say in the latter part of November or beginning of December, but contain, as we learn, little nutritive value before April, and by the latter part of July they are mostly dried up and withered. Upon this dried forage, with the fat-producing seeds of some of the plants (as the bur-clover), the cattle subsist until, say January, and from that time to April upon the new grass that has started up from the seed since the rains. The consequence is that a large majority of the stock is found to be very low in flesh before the good grazing period arrives.

It is stated in the valuable work of Mr. John S. Hittell, entitled "Resources of California," that—

Nineteen out of twenty of the cattle of California never get any food save such as grows indigenously with the open country, and they always suffer for it. From March to July the pasture is abundant and excellent, and the cattle are fat from July to October in ordinary years. The grasses and clovers, though dry and brown, are nutritious, and the cattle still remain in good condition; but from October to January they grow lean rapidly, and almost every year a considerable number die by starvation. In 1856 70,000 head died in Los Angeles County alone by starvation, one-third the entire number in the county, which has now (1879) but 27,000 in all. In 1863 and 1864 the loss by starvation was estimated at 200,000 to 300,000.

In the spring of 1863 Santa Barbara County had 97,000 head, and only 12,000 head in the spring of 1865.

#### EFFECT OF THIS SYSTEM UPON THE STOCK, AND BEEF AND DAIRY PRODUCTS.

As stated by Mr. Hittell, during this period, from March to July, the cattle are fat, or, more accurately, they become fat by the latter part of this period, and the rapidity with which fat is accumulated, say during the months of May and June, is extraordinary; but it is observable that the muscular system, so severely impaired during the long period of poor keep, is not restored, and therefore the cattle which are fat are not *fleshy*, and do not weigh as cattle of the same age and quality that are well kept through the year.

The fact here stated is clearly demonstrated by the appearance of the beef in every butcher shop, which, as a rule, in summer and early autumn, shows an unusual quantity of fat inside and outside the quarters. But in depth and thickness the lean flesh is surprisingly deficient, as it is also in what is called the marbled characteristic, that is, the mixture of fat with the lean, so essential to excellence in beef.

The quality of the beef produced under this system is moderately good. It is as tender as the flesh of the same grade of cattle in the Mississippi Valley, but it is not of high excellence in flavor, as might be expected from the character of the herbage upon which the cattle feed, which at the period of its highest excellence is, as wild grasses are generally found, without the agreeable perfume of the cultivated varieties.

It is well settled that grazing is essential to the production of the

highest quality in juiciness and flavor, as well in mutton as in beef; therefore in Great Britain, the cattle that are intended to furnish Christmas beef for wealthy epicures, are "made," on grass alone, or in exceptionally severe weather in winter the cattle are allowed a little hay of the best quality. But they are never fed oil-cake or turnips, because of the supposed injurious effect upon the flavor of the flesh.

The same observations will apply to the products of the dairy, especially to the butter. California butter is sweet and well made. In no part of the country can less bad or rancid butter be found, or butter more generally well worked and properly salted. But with all this, it lacks flavor—the high flavor of the Chester County (Pennsylvania) butter, or butter of other districts whose pastures abound in blue grass, white and red clovers, sweet-scented vernal grass, &c.

But we have observed a marked difference in the quality of these products when beef cattle have been fed corn, pumpkins, and the wild oats hay cut in proper time, and when the same, with carrots, beets, bran, shorts, &c., have been fed to cows and especially where they have had a run on what is here called Australian rye grass,\* but which is really, we suppose, the same as the rye grass so generally cultivated in Great Britain and some of our Eastern States.

The alfalfa, too, so universally esteemed here, is beneficial in increasing the quantity of these products, though there is a difference of opinion in regard to its influence upon the *quality*, some insisting that it imparts an objectionable flavor to the milk and butter, while others insist that this is not the case. It certainly improves the color of the cream and butter.

#### INFLUENCE OF THIS SYSTEM UPON THE SOIL.

From what has been already said, it is obvious that the system of feeding and grazing cattle in California is most seriously detrimental in its influence upon the productiveness of the soil.

In the first place, the cattle, during a large portion of the year, subsist upon dry herbage, containing the most meager percentage of nutritious or fertilizing matter, so that if all the excrement were saved and applied in the most judicious manner, where it was most needed, it would be of very little value. But when we reflect that nearly all the cattle in California are out of doors day and night throughout the year, and a large proportion on ranges that are never expected to be cultivated, we see at once that the arable lands of the State, excepting those in a very few locations, derive but little benefit from the manure made by the large number of cattle (estimated at nearly a million and a half) now grazed in California.

#### SHEEP.

Wool-growing is one of the leading industries of the State. The department report of 1879 gives the number of sheep in January, 1880, as no less than 7,646,800. The average price is reported at \$1.62, and total value at \$12,387,611. This is largely in excess of the number found in any other State.

Texas, which ranks next, has 5,148,400; Ohio, 4,080,400; Nevada, Colorado, and Territories, 4,019,600. New York comes next with 2,205,800; Missouri, 1,523,200; Wisconsin, 1,316,100. The number in Oregon is 1,265,100, and the price per head only \$1.46, while in Nevada, Colorado,

\* More properly the Italian rye grass with longer spikelets than the English variety, which does not resist drought so well.—E. W. H.

and the Territories the price per head is \$1.92. In Texas, \$1.89; Wisconsin, \$2.39; Missouri, \$1.82; Ohio, \$2.83.

The yield of wool, where sheep are fairly managed, from flocks of good grade, is claimed to be six to seven pounds per head.

Mr. Parks, of Marysville (speaker of the house of representatives), who owns about 10,000 head of sheep, informed us that the average yield was about  $2\frac{1}{2}$  to 4 pounds per head at the spring shearing (in April or May), and  $2\frac{1}{2}$  to 3 pounds at the September shearing.

Colonel Hollister, of Santa Barbara, who has 60,000 head of sheep, says he keeps them on 100,000 acres of land, shears but once a year, in April or May, and gets, say, 8 pounds per head in the dirt. Colonel Hollister drove sheep from Illinois in 1852; started with 6,000; came by southern route, and arrived out in fifteen months with 3,000 head; and this was the pioneer flock of well-bred merino sheep. Previous to this the sheep of California were only the coarse, native sort, that would not shear over 2 pounds of wool, and make not more than 40 pounds of mutton. These sheep have only the native grass, &c. Colonel Hollister has no experience with cultivated grasses.

According to the testimony of these gentlemen and many other flock masters, the lambs are dropped from February to May, and a large percentage is lost on account of storms, &c. There is no shelter. Breeders insist that it would be impracticable to provide sheds.

Mr. Parks thinks the average proportion of lambs reared is about 600 to 1,000 ewes. A large portion of the sheep here are grazed upon the swamp or "tule" lands in summer, and upon the hills in winter. A wool grower keeping 5,000 head of sheep told us he was paying a land company in Los Angeles County three cents per head per month throughout the year for pasture. The range, he says, was better a few years ago than now; well stocked at that time with bur-clover and alfalfa, which are now giving place to fox grass and other inferior sorts.

Everywhere we observed that the large flocks were Spanish merinos, of which breed there are many breeding flocks of the highest excellence and of unquestionable purity of blood, equal, we think, to any found in the older States. We also saw some excellent sheep of the French merino sort, of very large size, with enormous fleeces of wool of the best quality. But the blood usually resorted to for the improvement of native flocks has been the Spanish merino, as bred in the wool-growing States east of the Mississippi, and we suppose there can be little doubt but this breed is better adapted to the system of sheep husbandry generally practiced in California than any other.

Southdown sheep are bred to some extent, and are favorably regarded. The long-wools have been tried, and Cotswold crossed on the merino are well spoken of. We notice by the report of the State board of equalization for 1880 that only 6,375 sheep are reported under the head of "imported or fine," by which we suppose is meant full-blooded of any breed, and these are assessed at a valuation of \$603 per head, and only twelve of the fifty-two counties of the State have the credit of owning these well-bred sheep.

Wool is generally not in good condition, and while the price of wool as scoured here for shipment east is, say, 65 cents per pound, the price in the dirt is 16 to 24 cents per pound.

The product of the southern part of the State comes to market in much worse condition than the northern wools; and the fall clips, being shorter than the fleeces sheared in the spring, sell for one-fifth or one-sixth less money.

The average prices in the San Francisco market of wool from California and Oregon, for 1879, were as follows:

Varieties.	June.	October.
	Cents.	Cents.
Native .....	12½ to 13	12 to 15
California.....	16 to 25	16 to 26
Oregon.....	18 to 25	18 to 26

Cincinnati prices at same period were as follows: Unwashed combing, 25 to 26, and 27 to 28 cents. Showing that California and Oregon wools, making due allowance for the larger amount of dirt, &c., compare very favorably as to quality with those of the best wool-growing districts of the country, and this corresponds with our own observations on the subject.

We subjoin extracts from one of the excellent tables of statistics prepared and courteously furnished us by the cashier of the Grangers' Bank of California, Mr. Albert Montpelier, whose important services to the agricultural interests of the State, in the annual preparation of reliable statistics, are, we hope, duly appreciated by the farmers of California.

According to these tables the total wool clip of California for eleven years, that is, for 1870 to 1880, both included, was 423,701,154 pounds. Total value \$78,652,830. The clip of 1880 is stated to be 46,074,154 pounds, valued at \$10,136,313. The largest clip was in 1876, to-wit, 56,550,970 pounds. The next year was about four millions pounds less, while in 1878 the clip was only 41,402,509 pounds.

On the whole, it would appear that the wool product of the State has doubled since 1870. The prices as given by these tables for the past eleven years average a fraction less than 20 cents per pound.

From what has been said as to the system of sheep husbandry in California, we are forced to the conclusion that, as respects its influence upon the fertility of the soil, it is as unfavorable as any system that could be devised. But there is no question as to its returns being highly remunerative. If it be true that pasturage can be had to keep sheep the year through for 3 cents per head per month, we may assume that the cost per year, excepting salt, attention, and shearing, is from 35 to 40 cents per annum. The total, we suppose, as these large flocks are usually kept, could not exceed 50 cents, while the wool at, say, 20 cents per pound, and 6½ pounds per head, would give us for the fleece alone \$1.50.

The value of the increase we shall not attempt to estimate. But if provision were made to guard against losses occasioned by storms and by failure of herbage, the value of this increase would be very great, as there is probably no climate where sheep are more healthy or more prolific.

#### SWINE.

California is not a hog-producing State, for the very obvious reason that these animals, for their prosperous growth, require corn and clover, which are cultivated here only in exceptionally moist localities, and to a very limited extent.\*

\*Excellent crops of corn are often produced on the coast, even when it has been planted after the cessation of the rains, and there is no obstacle to planting it six weeks earlier. The chief reason why it is not grown more abundantly is the limited demand, inasmuch as the temperate winters do not allow of pork packing to advantage. The latter industry is left to Oregon, and the production of pork in California, outside of the mountain districts, is practically confined to supplying the markets with fresh pork. One of the most extensive corn and pork growing districts in the State is the coast region of Ventura County, and the valley of the Santa Clara, lying back of the same—the Saticoy country.—E. W. H.

According to the department report for 1879, the number in the State in January, 1880, was 661,000; average price, \$3.97. In Oregon the number was 228,500; average price, \$2.60. In Nevada, Colorado and the Territories, the number is 170,000; average price, \$6.97. We do not understand why hogs are so dear in the mountain States and Territories. We suppose the expense of growing them must be very high.

Kansas had, at the same period, 1,208,700 hogs, valued at \$5.28 each. According to the report of the surveyor-general for 1880, Butte County had more than four times the number of hogs reported for any other county in California, the number being no less than 101,500, while the next highest, Los Angeles, had only 18,990, and Tulare and Sonoma had each over 18,000. Excepting Tulare, each of the above counties produce considerable crops of corn—Sonoma, 1,000,000 bushels; Los Angeles, 800,000 bushels; and Butte, 70,000.

#### QUALITY OF HOGS.

The hogs of California, so far as our observations extended, appeared to be of good blood and quality.

The breeds most in favor are the Berkshire, the Essex, and the Poland China, here called simply *China*, a designation certainly quite as accurate as the Poland China, first applied by a few speculators in the Miami Valley, in Ohio, where this excellent variety of swine originated from crossing the China hog with the Frazier, Berkshire, &c., but there is, we believe, no authority whatever for the assumption that the blood of any Poland breed was ever used in the Miami Valley, or elsewhere in Ohio.

The white hog is universally condemned in California; his skin does not seem to stand so much sunshine. Hence we found black the prevailing color in all parts of the State, and a large proportion are all black, like the Essex, and similar in form, though usually larger. But, as already stated, they are very generally of good quality. Of the long-legged, long-nosed and flat-sided sort, very few are to be found in California.

#### HOW THEY ARE KEPT.

Like all other stock here, the hogs are on the range or in open fields throughout the year. Those best cared for are on grain stubble or alfalfa pasture, and furnished with a little corn, pumpkins, and mill feed, and at the dairies they have the whey and buttermilk.

The alfalfa is very highly esteemed by many farmers for fattening hogs. Among other intelligent opinions of practical men we quote here that of Hon. T. B. Berry, of Sutter County, now Representative in Congress, who informed us that he frequently made hogs fat enough for market on alfalfa alone. This gentleman's farm is at the junction of the Yuba and Feather Rivers, where the lands are quite fertile and moist.

This branch of live-stock breeding is not increasing in California—is in fact much less now in proportion to population than it was in 1860, being then 600,000 against only 661,000 now.

#### GENERAL SYSTEM OF CULTURE AND METHODS OF FERTILIZATION.

In view of the account already given of the system of breeding and management of live-stock in California, it is scarcely necessary to add that in the great grain and stock growing districts *there are no methods of fertilization.*

The great and indispensable reliance of the farmers in all counties where advanced systems are practiced, is barn-yard manure.

It may be said that upon the great ranches where wheat is grown by the wholesale methods we have already described, there are few or no barns or barn-yards, and no manure heaps in store for the exhausted soil. Not only so, but it is not an uncommon thing to hear owners of these ranches argue that barn yard manure is useless in the climate of California; that it cannot be rotted, and if "plowed under will be an absolute detriment to the crops in dry weather." In San Mateo County we found Mr. Ashburne, the English tenant farmer, to whom we have referred before, with a large herd of first-class Shorthorns and a dairy, feeding his cattle in-doors, and saving all the manure, which was thrown into a manure pit in the barn-yard, as is the practice in England. From the pit it was carted off to the fields where roots and corn were grown to feed his cattle; the corn being mostly fed green, at about the stage the ears were forming, and sometimes when in roasting ears. And this practice, Mr. Ashburne assured us, was amply remunerative.

It should be observed that the manure pit is dug out in basin shape in the barn-yard, so as to hold the water falling in the rainy season, which, with the liquid excretions, furnished an abundance of moisture to rot the straw and other solids in the manure heap. The same economy was observed in the management of manure by some of the dairy-men in Marin and other counties in the Coast Range.

We could not learn that any experiments had been made to fertilize the soil here, by plowing under vegetable matter, as practiced in many of the States. Common red clover could not be grown for that purpose in California, except in the extreme northern counties, in some of which the clovers, with timothy and orchard grass, are grown with profit, as they are in nearly all parts of Oregon; and in consequence, live-stock and dairy interests are rapidly increasing.

#### PRACTICAL AND SUGGESTIVE OBSERVATIONS ON THE AGRICULTURAL PRACTICE OF CALIFORNIA.

Assuming that the space the department is able to devote in its reports to the publication of the data furnished by this commission is limited, it has been deemed expedient to confine this paper to the leading agricultural products, the prevailing practice in the cultivation, the methods of fertilization, and the animal industry of the State; leaving grape culture and all the various branches of horticulture, as well as such results of scientific research as may be appropriately submitted in connection with the subject, for the other members of the commission. Understanding the object of the department in creating this commission to be to obtain data to aid in determining the agricultural needs of this portion of the country, my purpose has been to confine these observations to subjects believed to be most important to that end.

While the investigations have been as extended as circumstances would permit, and conducted with a thoroughness and impartiality that should assure confidence in the conclusions reached, we have here condensed into as brief a compass as possible the statement of the results of these investigations.

From this brief survey of the agriculture of this great Pacific State, it appears that its leading products are wheat, cattle, horses, and sheep, estimated by the Department Report for 1879 to be worth no less than *one hundred million dollars*, to-wit, wheat, \$43,050,000; cattle, \$32,031,053; horses, \$12,607,140; sheep, \$12,387,816; to which the wool clip would

add, say, ten millions more, while all the other products, to-wit, barley, corn, oats, rye, hay, and potatoes, aggregate only \$29,874,238.

As has been shown, the methods of cultivation practiced by wheat growers in California are indifferent enough, and very seldom such as will secure crops equal to the productive capacity of the land, besides being about as bad as can be in their influence upon the fertility of the soil. Nor are the systems practiced in the rearing and management of cattle and sheep any nearer the general standard of the advanced agriculture of the United States.

These wholesale and wasteful systems originated with the owners of large landed estates, which are more common here than in any other part of the country. The title to these estates was originally acquired by grants from the Spanish and Mexican Governments, and in many of the better counties of the State, more than half of the most desirable lands are held under these grants, which usually embrace five or six to twenty and thirty thousand acres each, and in some instances as high as forty to fifty thousand. Many of the proprietors of these large tracts insist that, in California, wheat cannot be grown on small farms at prices to compete with the wholesale methods practiced upon the large estates. But from the testimony of a very large number of the most intelligent and practical farmers of the State, and from a careful computation of the expenses of the different methods we are satisfied that this assumption is altogether erroneous. Among gentlemen of experience with large estates of the best wheat-growing lands, whose opinions were obtained on this subject, may be mentioned Hon. J. A. Bidwell, of Butte County, whose estate contains no less than 20,000 acres, and appears to be most admirably managed in all its departments, including all the standard varieties of fruits, with grain, live stock, &c.

General Bidwell states that with the large force necessary to employ at special seasons of the year, in the cultivation of grain by thousands of acres, besides the fact that the cultivation cannot be of the thorough character to insure the highest yield, there would necessarily be large losses resulting from the waste of time occasioned by various accidents occurring, and other causes which cannot be guarded against. There is also an unavoidable loss from neglect in taking proper care of tools, implements, and teams. Add to these items the great waste resulting from their wholesale method of harvesting the grain, and the fact that it cannot be done at the proper time, and it will be found that the methods elsewhere practiced upon small farms would give the most profitable results here also. Hon. T. W. Berry, member of Congress, residing in Sutter County, and Mr. Johnson, of Sacramento County, speaker of the State senate, and a large number of other practical farmers in different parts of the State, fully concurred in this opinion of General Bidwell.

But besides all this testimony we have the figures as to actual cost and receipts under this wholesale practice. The expense of the cultivation, harvesting, threshing, and hauling to store an acre of wheat, is about \$10, as was generally agreed by the advocates of the wholesale system. I think the expense in Ohio, under our practice, would not exceed this sum. The average yield under this system would not exceed 20 bushels per acre, worth, say, \$1 per bushel, which, it is claimed, would give \$10 per acre for the use of the land and the interest on other capital employed. But under this practice it is admitted that the soil is failing in productiveness, and that all the best farmers allow half their land to lie in fallow every year, which would give, in fact, only \$5 return per acre for the land and other means invested; and the rents of

good lands are lower than this, say \$3 to \$5 per acre. But in addition to all this, we were led to believe from what seemed reliable information that, as a general rule, the men who were farming these large tracts were in debt, some of them to very large amounts, and the opinion seemed very general that the business was hazardous; while the farming on smaller tracts was always safe, and the proprietors almost universally in prosperous condition.\*

Assuming that under the prevailing system of wheat growing in California, the soil is steadily decreasing in fertility, it would seem obvious that the enormous and constantly increasing area of the best land that is devoted to this crop cannot be otherwise than detrimental to the agricultural prospects of the State.

Notwithstanding the favorable conditions of the soil and climate for the production of large yields of the best qualities of wheat, there are some unfavorable conditions connected with this industry that are peculiar to the locality. The first is the distance from market, the enormous cost of transportation, and the time required between the shipment and the receiving of returns from the sale. Then we are to add to this unfavorable circumstance, as affecting the price of grain in the hands of the producer, the fact that the population, as compared with most of the other large wheat-producing States in proportion to the aggregate product, is far below the average; so that the home consumption is exceptionally small.

In 1880, while the population of California was 854,686, we find its wheat crop reported at 29,017,769 bushels; and Iowa, one of the largest and best wheat-producing of the new States, with a population nearly double that of California, reports for 1880 a crop of only 31,154,205 bushels; while in 1878 the crop in Iowa was reported at 30,440,960, and that of California at 41,990,000.

It is scarcely necessary to add that the California cultivation under the conditions above noticed is unfavorable to the increase of the rural population, and indirectly to that of towns and cities as well. From all which it seems plain that the most important of the needs of the agriculture of California is—

#### A GREATER DIVERSITY OF PRODUCTS UPON THE FARMS.

Whenever a change of practice in this direction is established, two results of the highest importance to the welfare and prosperity of the State will follow. First, a more rapid increase of population, especially in the rural districts; and, secondly, by the establishment of such a practice, with its indispensable feature of *rotation of crops*, the deterioration of the soil will be arrested and the foundation laid for the permanent maintenance of its fertility.

What are the changes required in existing methods to bring about this diversity of crops? In large measure, only to bring into general use methods that we find practiced in exceptional cases in every quarter of the State. An intelligent and industrious farmer on an estate of, say, one to five hundred acres, with suitable buildings, including barns

\* A very heavy item of expense to the large-scale wheat grower, not mentioned above, is its heavy prime cost, as well as wear and tear of the agricultural implements and working stock, of which, under the peculiar conditions of the California climate, especially the rapid maturing of the grain toward the end, there must be an unusually large plant in proportion to the area cultivated. Even thus there is a very heavy loss from the shelling of wheat, as is shown by the habit of "volunteer crops" the second year; and any accident to a header in harvest time involves a severe loss in many ways.—E. W. H.

and proper shelter for stock, the farm to be properly fenced and stocked with cattle, sheep, horses, pigs, and poultry, one-fourth to one-half of the land may be in grain—wheat, barley, oats, and corn—if the situation is favorable.

The farmer should grow, and can profitably grow, in any part of California, all varieties of vegetables needed for his own use; and if near markets, beets, cabbages, and potatoes may be profitably grown for sale. If planted at the proper time, and given the proper cultivation, good crops may be always expected. I do not refer here to the highly important horticultural industries of this State, further than to say that any farmer, under the exceptionally favorable conditions existing here for fruit-growing, should always produce, at least, a supply for his own family use. The rest of the land, after a proper allowance for timber, where practicable, should be devoted to grazing and the production of hay. It will be said by many that cultivated grasses, clovers, &c., cannot be grown in California, except in particular and limited localities. But I reply that there are abundant and incontestable facts establishing that in nearly every portion of the grain-growing districts, alfalfa can be and is profitably grown. It is valuable, as well for hay as for pasturage, and for all kinds of stock, including swine. Its cultivation is not more difficult or expensive than that of the common red clover, and it is probably as valuable as a fertilizer and as a restorer of exhausted soils. In many localities we have seen the rye-grass grown with the most satisfactory results. The variety here cultivated is called Australian rye-grass (*Lolium Italicum*). It is excellent for pasture, and makes the best of hay. It is, we believe, increasing in public favor here, and I have faith that it can be grown in many districts where it has not yet been tried, without irrigation. With irrigation, it will flourish in any part of the State. We could not learn that Hungarian grass (*Panicum germanicum*) had been tried in any part of the State, but see no reason why it could not be profitably grown here. It is an annual, producing a large quantity of seed, and germinates readily, and withstands drought wonderfully, remaining green when other grasses are dried up. It is a very rapid and rank grower, and does well on light clay soils. There can scarcely be a doubt but it would make a large crop of hay in almost any part of the State, if sown in early spring, without irrigation. A crop of this grass, after wheat, would clear the ground of weeds, and furnish what the English call a *shift*—a change of crops so essential to the maintenance of the fertility of the soil. After taking off the hay, the ground could be plowed for wheat in the autumn, and fertilized by the immense mass of fibrous roots which this grass sends into the soil.

The alfalfa would be still better as a renovator and fertilizer, and would be as profitable in the hands of a skillful man on a farm properly stocked with well-bred cattle, sheep, &c., as a grain crop, and would be followed by such an increased yield of grain, when the land should be again brought under tillage, that the result of the "shift," besides the benefit to the land, could not be otherwise than highly remunerative.\* And so the farmer under this system of mixed husbandry would be furnished at home with every agricultural product consumed by his family, or necessary for the subsistence of his stock. Instead of the system so generally practiced here, of selling everything that is grown upon the

\* One obstacle in the way of the proposed use of alfalfa in the manner suggested is the great difficulty of extirpating it when the land is once thoroughly stocked with it. Even with deep plowing it will reappear among the grain for several years, after turning under.—E. W. H.

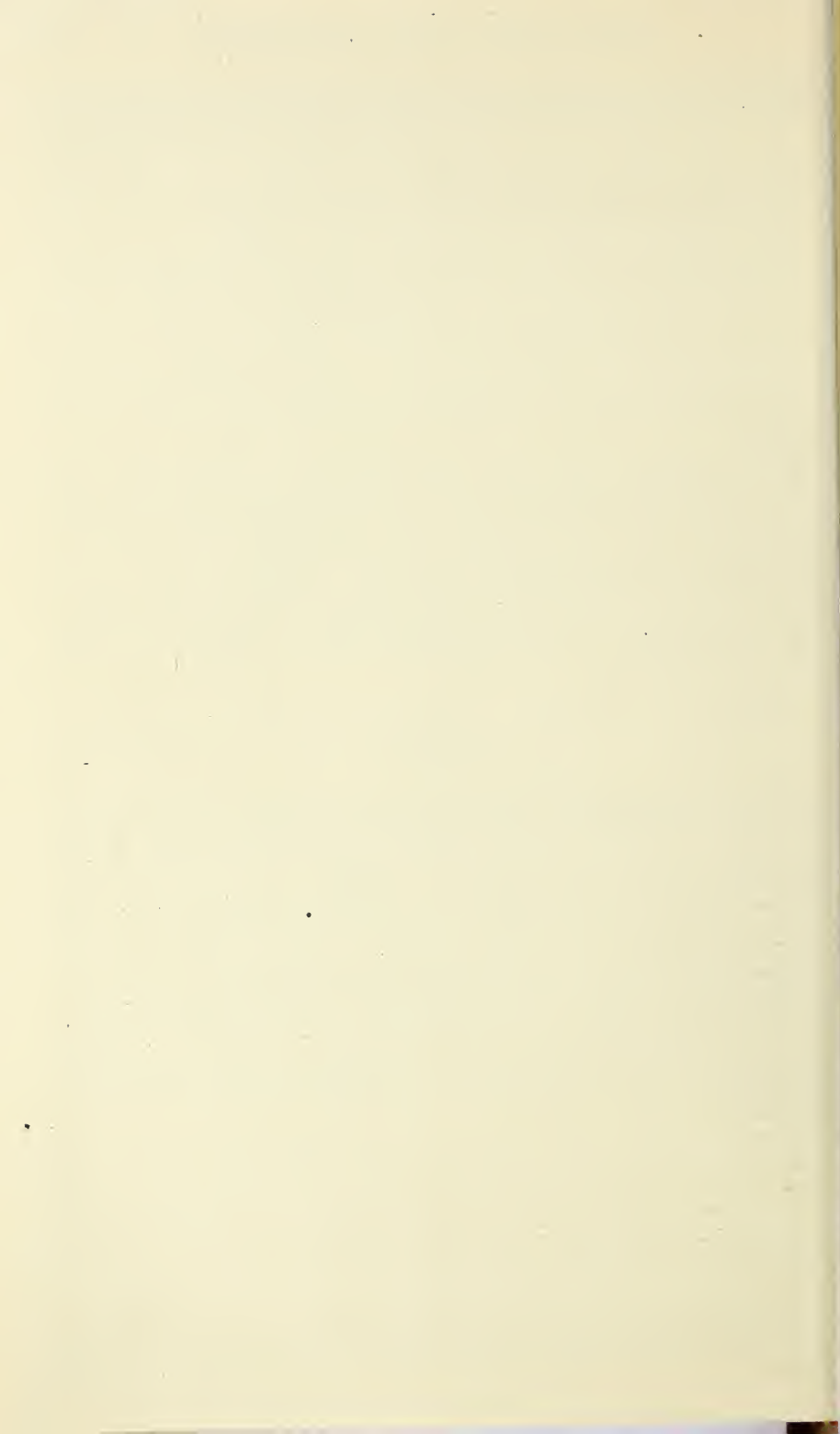
farm, and buying everything that the family consumes and a large portion of the feed for the teams, &c., there would be sold as *little* as possible of the crops in the raw state, converting, where practicable, the wheat into flour, the grass, barley, oats, roots, &c., into beef, mutton, pork, butter and cheese, and growing large fleeces of wool of the highest quality and in nice clean condition instead of the inferior, burry, and harsh and brittle staple so often grown upon *the ranges*.

This change of methods would also improve the quality of the beef and mutton; the flesh would be thicker, more juicy, and of improved flavor, and worth more money, as would also the milk and butter. Sheep for wool would still be kept upon the ranges that are not suited for cultivation; while improved mutton breeds would be kept in moderate numbers upon the well cultivated farms. And upon such farms the best and most profitable breeds of cattle, horses, and swine would be reared because these would soon be found to pay best under the improved system.

*How, it may be asked, are the best agricultural districts of the State, where so many large estates are now held, to be converted into farms of moderate size as here proposed?* The answer is, that so soon as proprietors become convinced of the necessity and practicability of the change in methods of cultivation, they will undertake to bring it about; and experience will teach them that it will be more profitable for them to divide up their estates into farms of convenient size, and either sell them or let them to good tenants, on long leases, than to undertake the management of "ranches" of such enormous magnitude, under the improved system of husbandry.

#### OTHER ADVANTAGES THAT WILL RESULT FROM A CHANGE OF METHODS.

The future prosperity of California must depend largely upon its agricultural population. Where the farmers' holdings are of moderate size, the work is done in large measure by himself and family; the men or women that may be hired are brought into intimate relations with the proprietor, and not regarded as inferiors. In such a community society is not divided into distinct classes of proprietors and laborers, as is the tendency in all countries where lands are cultivated in large tracts. It is not to be supposed that the liberal and patriotic landholders of California will be indifferent to considerations of this character, so directly affecting the welfare of the great commonwealth of which they are proud to be called citizens. Nor will they be unmindful of the beneficial influence of this diversified agriculture, in elevating the intelligence and promoting the happiness of the cultivators of the soil.



# MISCELLANEOUS FIELD CULTURES.

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BY E. W. HILGARD.

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## COTTON CULTURE IN CALIFORNIA AND ARIZONA.

Cotton has been more or less cultivated in California ever since agriculture took its place alongside the mining industry. Scattered patches of Mexican cotton were to be found in Southern California at an early date, but a home supply alone was the object of these. In 1868-'69 and succeeding years, energetic efforts to establish the culture on a large scale, and with improved seed from the cotton States, were made by the brothers Strong and others, in Tulare, Kern, Merced, and Colusa Counties, and the samples of these earlier crops remain to justify the statement then made, that the staple was of superior quality, both as regards length, fineness, and luster. The want of a market at home, and inability to compete with eastern cotton elsewhere, is apparently the sole reason why cotton has not, until quite lately, been counted among the regular and paying crops of California. A limited demand was maintained by the woolen mills for carding in with certain wools; and this demand was for four or five years supplied from three plantations in the bottom of the Merced River to the extent of from 400 to 500 bales per annum. Some agitation of the subject caused several experimental plantings to be made in 1880. Among these one of about 70 acres on Belleview ranch, near Bakersfield, in Kern County. The success of this, at least so far as quality was concerned, having called attention to the subject, plantings were made in other parts of the State also; among others one of 500 acres at Williams Station, Colusa County, and an experimental half acre in the bottom of Feather River, in Butte County. These two plantings in the Sacramento Valley are of especial interest, because the plant was grown without irrigation and with only a light spring shower after planting; therefore, practically without either rain or irrigation, while in the case of the plantations in the San Joaquin Valley, two irrigations at least have been used. The planting made in Butte County gave an excellent result both in quality and quantity, it being said by good judges that it would have yielded at the rate of 2 bales per acre. The 500 acres in Colusa County were a failure in so far as the variety planted was chiefly Sea Island, which had barely begun to bloom when the frost came. But a portion of the same field that had been planted in the uplands cotton, though much neglected, yielded a result proving that even there this crop would succeed under proper treatment, though far away from the river and in a heavy soil. Cotton has also for years past been grown at Chico by General Bidwell, merely for ornament, and has always fruited abundantly.

There can thus be little doubt that in a large part of the Sacramento Valley cotton can be successfully grown without irrigation, especially in the lighter alluvial soils near the rivers; while it is equally well established that with a moderate amount of well-timed irrigation, it is a pay-

ing crop in the San Joaquin Valley, always provided that a market for the staple can be found in California. The projected establishment of at least one cotton mill at San Francisco seems to promise that this state of things will not be long delayed; and, if so, it is probable that cotton will gradually encroach upon the area now planted in wheat, more especially where alkali prevails. As stated in the portion of this report treating of alkali soils, deep-rooted crops, requiring summer tillage, are especially well adapted to the utilization of such soils with the least amount of irrigation, while the wheat crop, especially when sown broadcast, is liable to suffer severely, both from drought and from alkali in the southern part of the San Joaquin Valley. For many reasons, it will before many years have to be replaced by crops admitting of summer cultivation, and less exhaustive to the soil. Among these cotton fulfills pre-eminently both conditions, for, as is now well known, the simple return of the seed to the soil will enable it to grow almost indefinitely without the use of manure on any naturally strong soil. There is, therefore, every reason to expect California to become a prominent cotton-producing State before many years.

In the coast region, north of San Diego, cotton fails absolutely. In the Los Angeles region cotton is not winter killed, and in San Diego, as well as Yuma, has fruited for three years in succession. A third year's staple grown at San Diego was rather short and harsh, seeming to confirm the experience of other countries as to the deterioration of the fiber after the first year. Yet it may be that the sample in question, as well as some others examined with a similar result, were from the neglected Mexican cotton, and that better varieties might be maintained in bearing, with good culture, for two years at least, thus saving the expense of planting for one year, and securing a very long bearing season during the second one.

The picking of cotton has thus far been done almost altogether by Chinese, who average about 75 pounds of seed cotton per day.

Excellent samples of cotton have been grown in Salt River Valley, Arizona.

Of other fiber plants, the ramie can be successfully grown almost throughout California, whenever the means of working this beautiful fiber shall have been sufficiently perfected. In the case of the ramie, as well as that of jute, the cost of labor will long stand in the way of profitable production, in competition with India and China, especially if Chinese labor should be excluded.

The hop plant is extensively cultivated in the middle portion of California, especially in the coast region north of San Francisco Bay, and the product is of very high quality. Here also the labor question is a critical point, all efforts to have the picking done otherwise than by Chinese having resulted unsatisfactorily thus far.

Beans, among them chiefly the Navy and Lima, are extensively grown in the coast counties south of San Francisco, and more or less all over the State, as a large scale crop.

#### SUGAR PRODUCTION IN CALIFORNIA.

The probabilities of profitable production of sugar were early considered in California, the more as several of the prominent sugar-producing plants were known to flourish in the different climatic regions of the State. Sugar cane was, and still is, a common crop on a small scale on the Mexican homesteads in the Los Angeles region, while beets, sorghum, and melons yield abundantly in the more northern portion. It was doubtless the scarcity of water, and the necessity for irrigation, that pre-

vented earlier efforts to cultivate the tropical sugar cane in Southern California, and left the initiative of the sugar industry to the humble beet in Northern California, between 1874-'75.

#### BEET SUGAR.

Beet-sugar factories were established in Sacramento, Alvarado, Santa Clara County, and Soquel, Santa Cruz County: and each of these produced excellent samples of sugar for a time. But owing to a variety of causes, chief among which seems to have been a speculative rather than well-considered technical basis of operations, they proved financially unsuccessful. The Sacramento factory was in active operation only a short time. Its machinery was, in 1877, transferred to Isleton, on the Sacramento River, where it had one season's fairly successful run, but has since been at a standstill, apparently from want of proper technical skill in management, not certainly from want of the best material.

The Soquel factory has continued in more or less vigorous activity until within two years past, when operations ceased for reasons not apparent to the public. About the same time, however, the Alvarado factory, which had been in abeyance for some years, was revived under new management, and with improved machinery, and since then has continued in successful operation, as shown in the report of one of the members of this commission.

It is not the province of the writer to discuss all the alleged and possible external causes of these early failures, which in the public mind were connected more or less with the interests controlling the Hawaiian sugar trade. It suffices for our purposes to show that the natural conditions in a large part of California are eminently favorable to the production of beet sugar, and that one factory at least is entirely successful. The data given below will substantiate these points, as also the fact that a good quality of beets, at least, can be grown in Eastern Oregon and Washington Territory.

Sorghum has thus far been grown chiefly for forage or sirup-making. But during the last two years experiments in sugar-making from the Minnesota Early Amber have also yielded highly promising results. Some data regarding these will be found below.

The true tropical sugar cane succeeds admirably in the region of Los Angeles and San Diego, and has also had fair success in the southern part of the San Joaquin Valley. The need of irrigation and the uncertainties of the sugar market have conspired to prevent any large-scale of experiments in this direction.

The facility with which enormous quantities of watermelons of extreme sweetness can be grown in the middle portion of the San Joaquin Valley gave hopes that the production of sugar, or at least of sirup from that source, would be found profitable. A special investigation undertaken by the Agricultural Department of the University of California proved that unfortunately these hopes are not well founded.

The results of this investigation also are given below.

#### INVESTIGATIONS OF BEETS FROM CALIFORNIA AND WASHINGTON TERRITORY.

1. *Beets from Isleton, Sacramento County, California.*—Sent by Mr. F. A. Roe, October, 2, 1877. Raised from California seed (from Mr. Gwyn

Soquel) on low tule land, burnt two years ago. Average of the crop on 14 acres, about 15½ long tons; on some land, 23 tons.

Specific gravity of the juice (by spindle).....	1.066
Amount of solid matter corresponding (if sugar).....per cent..	16.10
Amount of solid matter by direct determination.....do....	17.51
Percentage of cane sugar in the juice.....do.....	14.69
Purity coefficient.....do.....	84.00

Dried beet fiber, 4.1 per cent. of the whole beet; ash of fiber, 2.97 per cent. of its weight, or about 0.12 per cent. of the weight of the whole.

Total ash in the juice.....per cent..	0.58
Insoluble part of ash.....do....	0.21
Soluble part of ash.....do....	0.37

Alkalinity of soluble ash corresponds to 0.10 of sodium oxide, which, in evaporation, would render 1.10 per cent. of sugar uncrystallizable.

Constituents.	In 100 parts of solid ash.	In 100 of juice.
Oxide of potassium.....	43.25	.1666
Oxide of sodium.....	8.66	.0334
Chloride of potassium.....	12.81	.0494
Sulphuric acid.....	2.91	.0112
Phosphoric acid.....	9.73	.0374
Carbonic acid (by diffusion).....	22.64	.0720
	100.00	.3700

These beets are of exceptionally fine quality for sugar-making. Other determinations of the quality of beets from the same locality have been made in succeeding years, as follows:

2. *Beets from Isleton*.—Received in December, 1878. It was desired to determine the relative value of beets planted at different times during the summer. Specimen No. 1 was planted in June, No. 2 in July, 1878. The determinations gave:

Constituents.	No. 1.	No. 2.
Specific gravity of juice, by spindle.....	1.0535	1.035
Solid contents corresponding, per cent.....	13.17	8.66
Total per cent. of ash in juice.....	1.55	1.19
Per cent. of soluble ash in juice.....	0.32	0.38
Alkalinity of soluble ash corresponding to $So_3$ , per cent.....	0.46	0.54
Amount of sugar that would be destroyed by the alkali in evaporation per cent.....	3.24	3.57

The absolute cane-sugar percentage could not be determined on account of the instrument being out of order. It is, however, easily seen that these beets were both considerably inferior in quality to those previously tested, especially so as regards the sample planted in July, which, being immature, was inferior to the earlier planted, not only in the percentage of sugar, but also in containing a larger amount of total as well as of soluble ash. Practically No. 2 would be unworkable under ordinary circumstances. As to the possible causes of the inferiority of the beets grown that year I have no information.

3. *Beet from Isleton*.—Grown in 1879; received in October; weight 12 ounces; crisp and in good condition.

Specific gravity of juice, at 17 per cent.....	1.063
Corresponding amount of solid matter in solution.....per cent..	15.5
Per cent. of cane sugar by saccharometer.....do....	14.0
Hence purity coefficient.....	90.03

This, again, is a very high-grade beet, with which any sugar-maker would be pleased. Assays of beets worked at Sacramento are reported to have often run as high as 19 per cent. of cane sugar; and considering that the Isleton beets were grown on fresh land by inexperienced growers, there can be no doubt that beets of unusually high quality may be grown in the Sacramento Valley, and doubtless also in that of the San Joaquin. To seaward of the Coast Range, the results obtained have not been so favorable, probably from the absence of a sufficiently high summer heat.

The table below shows the results of the examination of three lots of sugar beets sent, grown by Mr. D. F. Newsom, in the bottom of the Arroyo Grande, San Luis, Obispo County, in 1877. In some portions of this bottom a little alkali is apparent. It was stated that three crops could be readily grown in one season in the region. Average size of beets, about two pounds.

No. 1 was beets ninety days from the seed; No. 2, one hundred and twenty days. Both were taken up the last days of July. No. 3 was eighty days from the seed; taken up about the middle of September. The flesh of these samples was somewhat soft and flabby.

*Composition of soluble part of beet juice, No. 1.*

Constituents.	1.	2.	3.
Specific gravity of juice, by spindle .....	1.051	1.057	1.053
Solid matter corresponding .....	12.6	14.0	13.0
Cane sugar, by polarimeter .....	8.44	10.0	9.85
Purity, coefficient .....	67.0	71.0	75.7
Per cent. of ash, total .....	1.36	1.14	1.17
Per cent. of ash, soluble .....	(*)	1.04	*

\* Not determined.

*Composition of soluble part of beet-juice ash, No. 2.*

Constituents.	In 100 ash.	In 100 juice.
Potash .....	22.34	.232
Soda .....	14.59	.152
Phosphoric acid .....	6.25	.065
Sulphuric acid .....	3.50	.036
Chloride of potassium .....	36.52	.379
Carbonic acid and loss .....	16.80	.175
Total .....	100.00	1.039

A simple discussion of these results leads to the conclusion (which was verified by the alkalimetric method) that after clarification of the juice of No. 2 with lime, nearly a quarter of one per cent. of caustic soda will be present in the juice, which amount, according to the best experiments, would, in the evaporation, render eleven times that amount, or 2.75 per cent. of the sugar present, non-crystallizable, thus leaving only 7.25 as the best possible result of manufacture. This is economically out of the question.

The analysis of No. 3 seems to indicate that beets of the same age are richer in sugar when grown later in the season, probably on account of the higher temperature then prevailing on the coast. Nevertheless, both Nos. 2 and 3 are below the desirable average in respect to sugar percentage, and near the lower limit as regards the purity coefficient.

In both, the ash percentage, and the alkalinity of the ash, are so great as to render them an undesirable material for the sugar-maker. No. 1 is altogether below the admissible standard, in respect to sugar percentage, purity, and ash.

It seems necessary to conclude, therefore, that at present the Arroyo Grande bottom will not produce beets adapted to sugar manufacture, although it may do better after longer cultivation.

*Beets from Guadalupe, Santa Barbara County.*—Sent by Mr. James Morse. Having been three weeks on the way, they had sprouted leaves and fibrous roots into the soil, and were slightly wilted. The following is a summary of the results from the three specimens sent:

Constituents.	No. 1.	No. 2.	No. 3.
Specific gravity of juice (by spindle).....	1.0412	1.065	1.6295
Amount of solid matter corresponding (if sugar).....	10.2	15.8	7.66
Amount of solid matter by direct determination.....	10.68	17.06	.....
Total ash percentage in juice.....	1.185	1.23	2.47
Insoluble ash in the juice.....	0.115	0.15	0.11
Soluble ash in the juice.....	1.07	1.08	2.36
Percentage of coagulable albumen in juice.....	0.834	.....	.....
Alkalinity of soluble ash neutralizes sulphuric acid (So <sub>3</sub> ).....	0.43	0.30	0.56
Per cent. of sugar destroyed in evaporation.....	3.60	2.50	4.60

These beets differ widely in their composition and value for sugar-making. No. 3 contains so little sugar—probably not over 6 per cent.—and so large an amount of soluble and very alkaline ash, as to put it entirely out of the question. No. 1 contains an adequate amount of sugar, but also more ash than is deemed admissible, especially as it is very alkaline; moreover, it contains a very large amount of albuminous matter. No. 2 is a very good beet, containing so much sugar—probably about 14 per cent.—that even its somewhat large ash percentage would not render it unacceptable, the ash not being very alkaline.

It would have been interesting to know just in what locations and under what circumstances these beets were grown, but I have been unable to obtain the data. As the record stands, it proves only that from the same seed very different qualities of beets may be grown, but these differences may be largely due to imperfect maturation, as in the beets No. 2, from Isleton, of 1878 (see above). In the widely different climates of California, it will be necessary to determine not only the proper soils, but more especially the proper times of planting for each location, before the best possible results can be obtained, the higher temperature then prevailing.

The following results were obtained in the assay of beets of the crop of 1879, grown by Mr. J. M. McElhany, of San Luis Obispo. These beets were somewhat shrunken, but otherwise in good order. One had the reddish color of a common beet, the other less red, and more like a regular sugar beet.

A portion of each was taken, and the two samples mixed for analysis.

Fresh beets from San Luis Obispo:

Specific gravity of juice.....	1.071
Solid contents of juice.....	17.0
Percentage of cane sugar.....	13.0
Purity coefficient.....	76.5

These figures, it will be noted, agree very closely with those obtained from the beets grown by Mr. Nadeau, near Los Angeles, given below. It should not be forgotten that almost all have been grown on comparatively fresh soils, on which the best results of sugar-beet culture are rarely obtained.

## SUN-DRYING OF THE SUGAR BEET.

That, in general, sugar beets of unusually high quality can be successfully grown in many regions of California, has now been sufficiently proved by the tests made up to this time, as well as by the practical working of the manufacturing establishments that have been managed with a reasonable degree of business tact and technical skill. That the profitable production of beet sugar depends on a great many conditions besides that of the quality of the raw material is too well known to need discussion. The beets will not bear transportation to any distance, and in order to render them available for sugar making their successful growing must, within a limited area, be coupled with cheap fuel, good and abundant water supply, and reasonably cheap and reliable labor.

It has often been attempted to free this industry from some of these restraints by rendering the beets transportable and capable of being kept all the year by drying. But to do this by artificial heat is so costly an operation that it can be made to pay only under peculiar circumstances; hence, as a matter of fact, this expedient has been thus far but little resorted to.

The dry summer climate of the interior of California, however, seems to offer unexceptionable facilities in this direction; for where raisins can be made successfully, cut beets can be dried without artificial heat. So far no raisin-making country has attempted the beet-sugar manufacture, hence the conditions offered here are entirely new.

At the suggestion of Mr. Ernest Th. Gennert, the well-known beet-sugar expert, who has been chiefly instrumental in introducing this industry east, experiments in the drying of beets in the open air were carried out in Southern California, and some of the beets so prepared were sent to the department for examination—one lot from near Santa Aña, Los Angeles County, by Mr. W. H. Spurgeon; the other by Mr. H. J. Rudisill, of Riverside, San Bernardino County. The following record of the progress of the drying process is given by Mr. Rudisill:

## EXPERIMENT IN DRYING BEETS.

*First experiment with "Mangold Wurtzel," from Santa Aña, Los Angeles County.*

Date.	Temperature, Fahrenheit.			Weight of beets at 12 m.
	6 a. m.	12 m.	6 p. m.	
September 29 .....	°	76	68	Pounds, 100
September 30 .....	58	82	73	46
October 1 .....	60	85	75	20½
October 2 .....	65	90	.....	15

NOTE.—The first day the beets were spread upon a cloth on the ground, when I found they did not dry as rapidly as upon a scaffolding, or platform, a few feet above the ground, where the air can circulate freely.

*Second experiment with "Sugar beets" from Northern California.*

Date.	Temperature, Fahrenheit.			Weight of beets at 12 m.
	6 a. m.	12 m.	6 p. m.	
October 16 .....	°	°	°	Pounds, 100
October 17 .....	55	85	74	29½
October 18 .....	55	85	.....	25½

NOTE.—A light north wind set in on the morning of the second day, and continued during the experiment.

Of the drying at Santa Aña, done about the same time, Mr. Spurgeon reports that 100 pounds were in twenty-four hours reduced to 29½ pounds, they having been sliced crosswise into disks, about one-half an inch thick, and spread simply on boards. These slices when received here were dry, but pliable, and retained 20.6 per cent. of moisture, while those sent by Mr. Rudisill contained only 10.6, and would evidently have kept indefinitely, like well-dried apples. The results of their examination are given in the following table, the sugar percentage being stated both for the absolutely dry substance and for that containing 10 per cent. of moisture, as will be the case on an average in practice.

Varieties.	Sugar in sugar beets absolutely dry.	In beets dried with 10 per cent. moisture.			Ash in juice residue, per cent.
		Sugar, per cent.	Total organic matter, per cent.	Ash, per cent.	
Sugar beet, Riverside .....	68.0	63.0	86.09	3.91	5.411
Santa Aña (Mangold) .....	64.0	58.15	86.25	3.75	4.779
Santa Aña .....	62.1	55.92			5.218

Not having received any of the fresh material, I am unable to state precisely the original sugar percentage in the fresh beets; but a test made by Mr. Gennert gave somewhat over twelve per cent. Taking this as a basis, it will be seen that the weight of the raw material has been by drying reduced to one-fifth, thus, of course, diminishing the freight expenses in a corresponding ratio. It is obvious that a material containing from fifty-six to sixty-three per cent. pounds of sugar in the one hundred will bear shipment to any moderate distance; thus rendering it possible to locate the manufactory at whatever point may, on the governing considerations, appear most desirable.

During 1880 experiments in beet drying were carried out on a large scale in Los Angeles County, partly under the direction of Mr. Gennert, who hoped to be able to work the sun-dried roots by an abridged process that has proved feasible with fire-dried beets. The slicing machine followed the laborers digging the roots in the field, and for some time the expectations raised by last year's experience as to the facility of sun drying were realized. Foggy weather, unexpectedly setting in, retarded the operations, and as the sequel showed materially damaged a portion of the stock that was too hastily stored. Moreover, it was found that the sun-dried beets, not having been subjected to as high a temperature as in the case of fire drying, work like fresh beets, requiring the use of charcoal filters. Notwithstanding partial failures recorded from this year's experience, I am still of the opinion that it only requires a little more experience in the management of the drying process to render the dried-beet crop quite as certain and safe, as to quantity and quality, as any other now grown.

The failure of the apparatus successfully used for the manufacture of sugar from fire-dried beets, to accomplish the same object in the case of the sun-dried article, places the latter simply on a level with the fresh beet, so far as the purity coefficient is concerned; always provided that the drying process has been properly conducted under reasonably favorable atmospheric conditions. That this is really so is proved by the

assays made of dried beets furnished by Mr. Gennert and Mr. R. Nadeau, of Los Angeles (the latter one of the parties most heavily interested in the enterprise), which are given below.

This assay is not as easy a matter as that of fresh roots, in which case the juice can be pressed and its quality ascertained in a very short time. In that of dried beets the substance has to be extracted with water; and according to the quantity and temperature of the latter, the results, especially as to the purity coefficient, may vary materially, the latter being usually depressed.

After a number of experiments, the following general method was determined upon and adhered to. Thirty grammes of dried beets were finely "hashed," and then allowed to soak over night in an amount of water sufficient to swell them to their natural bulk, and cover them over. In the morning the swelled beets were placed in a displacement apparatus, and water kept to 50° centigrade was allowed to pass through slowly, so as to amount to six hundred cubic centimeters, more or less, by three o'clock in the afternoon, by which time the extract had ceased to show any sugar in the polarizer. The residue was then pressed for the last portions of the juice, and the extract immediately treated in accordance with the usual methods pursued in the case of fresh juice.

The results given in the table, with the exceptions noted, were obtained according to this process. In judging of the variations, it must also be kept in mind that the amount of moisture contained in the sample, at the time the test was made, was not in every case determined. The average commercially assumed is about 10 per cent., but in small samples exposed to the air it may vary from about seven to twelve and more. This, of course, produces an apparent variation in the sugar percentage, which, however, is unimportant for the present purpose.

No. 1.—Sliced and dried beets received from E. Th. Gennert, Los Angeles, September 20, 1880. Grayish-white, uniformly brittle. Under the microscope show on the surface abundant brownish crystals of cane sugar. Taste, that of fresh beets; color of the extract same as fresh juice.

No. 2.—Sliced and dried beets received from the hand of R. Nadeau, of Los Angeles, October 5. Aspect, color, &c., about the same as in No. 1; color of extract the same; sugar crystals on surface not quite so abundant.

No. 3.—Two fresh beets, sent from Alvarado sugar factory, said to come from R. Nadeau, Los Angeles, and presumed to represent the quality of the beets dried by him. Slightly wilted when received, October 31, but otherwise in good condition. Each was separately assayed.

Sample.	Specific gravity of juice or extract.	Solid contents of juice or extract.	Percentage of cane sugar.	Purity coefficient.
No. 1. Dried beets, from E. Th. Gennert :				
A .....			51.33	.....
B .....			50.00	.....
C .....	1.0165	2.69	56.34	79.92
No. 2. Dried beets, from R. Nadeau :				
A .....			42.07	.....
B .....	1.0100	2.56	46.05	68.40
C .....	1.0108	2.77	46.87	69.9
No. 3. Fresh beets, from R. Nadeau :				
A .....	1.070	17.14	12.8	74.9
B .....	1.071	17.14	12.3	71.5

Determinations A and B, No. 1, were made before the regular process above detailed had been adopted, and are affected by incomplete extraction as well as by a high percentage of moisture. The same is true of A, No. 2. The last determination in each case I consider the true standard of comparison, the others being simply corroborative and minimal. It will be seen that in the case of Nadeau's beets the fresh and dried beets accord in regard to purity coefficient quite as nearly as is commonly the case with different samples of fresh beets. *If there has been any lowering of this important factor by the drying process, it has been insignificant.* Moreover, the percentage of sugar in the dried sample is almost precisely what it should be, in the accepted proportion of four parts by weight of green beets to one of dried.

The conclusion is, that green beets of proper grade for sugar making do not lose their usefulness for this purpose, in any sensible degree, by a *carefully conducted* process of sun drying in the climate of Los Angeles. This is abundantly corroborated by the results obtained from the sample furnished by Mr. Gennert, evidently made from a beet of higher sugar percentage than the average (which seems to be about 12 per cent.), and also of high purity coefficient. No sugar maker could desire a finer material to work upon.

In the face of these facts, which only confirm the reasonable supposition of any one familiar with the subject, and with the climatic conditions of Southern California, the statement, somewhat industriously circulated, that the whole scheme is a failure, appears rather premature. There certainly has been a failure of success in treating the sun-dried beets like those dried at a higher temperature, and it is greatly to be regretted that this important point was not ascertained before heavy investments in beet drying were made. In addition, there has been a partial failure to manage the drying process so as to secure a uniformly good product, and this, as might be expected, has carried with it a failure to produce from the resulting material such average of sugar as might have been justly expected from the quality of the green beets, as well as from the assays above reported.

My attention was drawn to this fact by a communication from Mr. E. H. Dyer, superintendent of the Alvarado sugar factory. He stated that the sugar obtained from the working of five tons of Mr. Nadeau's dried beets had yielded only 20 per cent. of manufactured sugar, and sent at the same time a sample of dried beets, stated to be similar in quality to the lot used in the experimental manufacture.

This sample of dried beets differed very obviously in appearance from those furnished by Mr. Gennert and Mr. Nadeau. Its aspect was darker, and inspection, as well as microscopic examination, showed it to consist largely—to the extent of about one-half by bulk—of brown, soft shreds, with but few sugar crystals on the surface. Some of these showed on the cross-cut a white center streak within the brown covering. The lack of sweetness and the difference of taste was noticeable at once. The different portions of the sample, moreover, differed in the proportion of the sound, white fragments intermixed with the brown.

The following assays have been made at the California Agricultural College of beets received from parties in Washington Territory, desiring authentic information as to the quality of the beets thus far produced by them on a small scale:

No. 1.—Beets grown by Mr. S. M. Wait, of Dayton, Washington Territory; one weighing about 17 and the other about 12 ounces; crisp and in good condition when received.

No. 2.—Sugar beet grown by Mr. E. Meeker, Puyallup, Washington,

Territory; sent at the request of Mr. M. G. Marsiliot, of the United States revenue steamer Wolcott, Port Townsend; weight about 16½ ounces; somewhat bruised and wilted when received.

Constituents.	No. 1.	No. 2.
Specific gravity of juice .....	1.065	1.058
Percentage of cane sugar .....	12.38	12.68
Purity coefficient .....	78.3	90.5

This is a very fair showing for the Washington beets, but it is probably not the best that can be done. No. 1 was decidedly immature as yet, as was shown by the peculiar behavior of the juice. A few weeks' more growth would doubtless have greatly raised its purity coefficient and also its sugar percentage.

The high purity of the juice of No. 2 is very encouraging, and if similar in the roots grown in Eastern Oregon and Washington, the sun-drying process would probably be found as applicable there as in Southern California. The frequent summer rains of the Puyallup region would forbid the use of this method there.

So far as known, no attempt to cultivate the sugar beet has as yet been made in Arizona, or in the interior Territories.

The following table shows the results of assays of this sample, the first two being taken from different portions of the mass, the third representing the average of the whole:

Constituents.	Dried beets from Alvarado.		
	A.	B.	C.
Specific gravity of juice or extract .....		10.13	1.0065
Solid contents of juice or extract .....		3.09	
Percentage of cane sugar .....	23.29	34.15	26.24
Purity coefficient .....		51.46	47.00
Moisture, per cent .....		11.50	

A comparison of these results with those recorded on the previous table shows an enormous difference, not only in the sugar percentage (nearly two to one), but also a depression of the coefficient of purity, which renders the material altogether unfit for the purposes of the sugar-maker. In the interest of a promising industry it cannot but be a matter of regret that the only large scale attempt to manufacture sugar from sun-dried beets should have been made with half spoiled stock, which, by a little attention and technical understanding, could have been readily recognized as such and rejected. While it proves nothing at all against the feasibility of such manufacture, it has engendered a prejudice in the public mind which it may take some time to overcome. It is not unusual that such mistakes are made in the infancy of a new industry or improvement, or that manufacturers and others, having their regular routine and established interests, should assume a negative attitude toward it. It may even, for a time, be dropped altogether; but if intrinsically sound, as I fully believe the beet-drying industry will prove to be, it will, in time, find its place among the recognized branches of California agriculture.

It would thus seem that in California, if anywhere, the beet-sugar industry may look forward to a prosperous future; the only possible danger being the open competition of the sugar cane, both at home and abroad, with which, having the advantage of a purer juice, obtained with little trouble and expense, and yielding a merchantable sirup as its by-product, it would seem impossible for the beet to compete. It has done so elsewhere, mainly under the protection of a tariff, or (as between the East and the Sandwich Islands), under that of long transportation. While this is true, it is also indisputable that, both in California and in the East, the beet-sugar manufacture has proved remunerative whenever conducted under proper management and good natural conditions; and when the drying process is brought in, enabling the manufacturer to run throughout the year, as against the sugar-cane process, which is crowded into a short harvest season almost everywhere (save in the Hawaiian Islands), enabling him also to boil juices even more concentrated than that of the sugar-cane, by the use of the maceration process. The balance of advantage may readily, after all, be found on the side of beet-sugar industry. It seems probable at this time that this question will soon be practically tested, perhaps not only in California, but also further north, the high prices of sugar and their frequent and apparently arbitrary fluctuations having called popular attention strongly to the subject.

# REPORT ON THE STANDARD SUGAR REFINERY, ALVARADO, CALIFORNIA.

BY R. W. FURNAS.

The commission, under special instruction to "particularly investigate and report the present status, operations, capabilities, actual productions, and future prospects of the 'Standard Sugar Manufacturing Company,' at Alvarado, Cal.—the operations of this company embracing its means and efforts in raising beets, as well as the results of its manufacture of sugar"—report a visit to the manufactory on October 18, 1881, and found it in charge of Mr. E. H. Dyer, general superintendent, who cheerfully afforded every means for obtaining desired information.

The system in use is known as the "Roberts Diffusion." Operations were first commenced in the year 1870. Over a quarter of a million dollars were sunk or lost before any profits were realized. The original investment was a fraction over \$200,000. The present (second hand), \$135,000. The working season is from September to February. During that time, 1,239,503 pounds of sugar were made in 1880-'81, as shown by the books of the company. The quality of the product ranks high, and, where it is not known as beet sugar grades with Cuba brands. Sold under its true name, however, it commands a small fraction less, say one-eighth to one-fourth of a cent per pound. Eighty hands are employed in the factory proper. Skilled labor is paid \$3 to \$3.50 per day; the "boiler" \$6 per day. Unskilled labor the same as in other industries in the locality. Common laborers, principally Chinese. "In fact," says the superintendent, "we cannot get along without Chinese labor."

Experience shows that 16 per cent. saccharine matter in the beet juice will yield 13 per cent. of sugar; 20 per cent. of saccharine matter, 18.9 sugar. The last is considered an extra quality and yield.

The capacity of this factory is 100 tons of raw beets per day; 12,000 tons are worked up during the season. About twenty-four hours are consumed from the time the raw beets enter the washing-machine until the perfect sugar is produced. The company principally contracts with farmers for beets delivered, paying from \$4 to \$4.50 per ton, as they come from the field, topped. The average yield is 15 tons per acre. Medium-sized beets are preferable in all respects. The most profitable and desirable variety of beet is the White Silesian. The company has 100 acres of its own in beets. Land in this vicinity, suitable for beet culture, is valued as high as \$300 per acre. Land rents for \$20 per acre.

The commission, before visiting, was advised that there existed in the public mind a strong suspicion that, even in the management of the Alvarado Factory, there were interests adverse to successful sugar-beet manufacture in the United States, and hence failure was preferable to success. After careful investigation, the commission do not share in such suspicion, as regards this establishment at least, but are of opinion that good faith has been exercised, and everything possible done to

render the enterprise a success: and this, we further believe, has been accomplished. Mr. Dyer has been connected with the effort from the first, is still a party in interest, and quite elated over the final result in securing a prime article of sugar, with fair marginal profit.

That the sugar-beet industry in the United States is now an established fact, your commission entertain no doubt, and think that the importance of encouraging it cannot be overestimated.

The wise policy of France, Germany, and other foreign countries, with natural advantages not superior to ours, has made them exporters of beet sugar.

Without attempting argument on this point, we are free to advise, at least, such aid, both national and State, as will remove any and all obstacles that may stand in the way of successful prosecution of individual efforts now being made or hereafter to be made. We learn a leading existing obstacle to be the inability to utilize all the products of sugar beets—what is known in business parlance as “low products.” After investigation, thought, and conviction as to the particular point involved, we cannot more plainly state the case than to use the words of Superintendent Dyer in presenting the matter:

In the manufacture of beet-root sugar, we have a large quantity of molasses that is unfit for domestic use, and can only be utilized profitably by distilling into alcohol. This is done in Europe, and is a source of income.

This alcohol cannot be converted into whisky, as it has an unpleasant taste and odor, and can only be made useful in the arts or for mechanical uses. But in consequence of the heavy internal-revenue tax, distillers here claim that they cannot afford to pay us but about the cost of cooorage and freight, and we are obliged to run the beet molasses to waste.

In consequence of this we lose an important source of income. In Europe, after the molasses is distilled, the salts remaining are all profitably utilized in the manufacture of different chemicals. We are deprived by this tax of all these sources of income. We ask Congress to grant us relief from this loss, by permitting alcohol to be distilled from beet-root molasses and be exempt from paying an internal-revenue tax.

Proper safeguards can be devised to prevent fraud. No molasses should be allowed to be distilled until after at least three products of sugar have been extracted. There still remains a large percentage of sugar that is uncrystallizable on account of the salts and other impurities which always remain in the molasses.

In conclusion, the commission join in a desire that Congress aid this great enterprise in such manner and to such an extent as in its wisdom will best secure the interests of the American people, believing that in so doing an industry will be developed second to no other in the United States.

#### SUGAR CANE AND SORGHUM.

The culture of sugar cane has not, as yet, been carried on on a large scale in California. But numerous experiments on a small scale have shown that it succeeds well and is of good quality in Los Angeles, San Bernardino, and San Diego Counties. Whenever grown on irrigated ground there can be little doubt that it will also succeed in a large part of the San Joaquin Valley, as, according to Mr. W. H. Sanders's experience, it does in Fresno.

The extension of its cultivation will, I think, depend more upon commercial than climatic considerations; although probably the “bay climate,” as well as that of the immediate coast southward, is probably too cool to develop the saccharine juice to perfection.

Not so with the sorghum, which succeeds well from San Diego to Oregon, though probably with great variations as to its sugar percentage. Several varieties of sorghum have for some years past been grown on the experimental grounds of the Agricultural College at Berkeley, and

the results of the assays of some of the samples so grown are given below. In the great valley of California, sorghum has long been grown for forage, to a greater or less extent; but the introduction of varieties specially adapted to sugar making is of comparatively recent date. Assays of Early Amber cane, grown from seed received from the Department of Agriculture at Washington, at Bakersfield, Kern County, and on the Lower Sacramento, are given in the table below. Excellent samples of raw sugar, rudely made from sorghum juice, have also been received from Bakersfield. The samples grown on the Sacramento were intended to be worked into sugar at the Isleton beet-sugar factory, but the result has not transpired.

It is apparent at a glance that the showing for sugar-making purposes is considerably better than the average shown by the experiments made at the Massachusetts Agricultural College, and quite as encouraging as the results obtained in the Western States during the past seasons.

Doubtless the climate and soil have a great influence on the absolute and relative amounts of the several kinds of sugar, and actual experiment can alone determine whether or not in any particular region the quality of the juice can be made such as to render sugar making profitable. The fact that the Amber cane juice was of such good quality even in the bay climate, would seem to render it probable that in the warmer climates in the interior much better results could be obtained, as is actually shown by the assay of the Bakersfield samples.

An assay of sugar cane grown and cut late in December serves for convenient comparison both as to sugar percentage and purity.

*No. 1.*—Amber cane grown on the agricultural grounds of the University of California; cut during the first week in October, 1879, grain being in dough. In 1880 the cold, foggy summer was a drawback to the development of the saccharine juices, and the results have probably been as little favorable as they are ever likely to be.

Samples of sorghum, grown during that season, were received from Bakersfield, Kern County, from Mr. J. W. Brooks, secretary of the Kern County Improvement Association, under whose auspices seed was distributed last spring.

*No. 2.*—Early Amber, from Bakersfield, was considerably wilted when worked. Received October 5, 1880.

*Nos. 3 and 4.*—The Imphee and Minnesota Amber canes from Bakersfield were rather wilted, but not so dry as *No. 1.* Received November 15, 1880.

*No. 5.*—The Amber from University grounds was worked the same day it was cut, November 16, 1880.

*No. 6.*—Cuzco corn, grown by Mr. Chabot, of Fruit Vale, near Oakland. Fresh and very succulent. Received in October, 1880.

*No. 7.*—Grown and sent by Charles A. Wetmore. Received and assayed January 6, 1881.

*No. 8.*—Grown on Sacramento River, six miles above Rio Vista. Forty-two days' growth; cut on August 5; received and assayed August 12, 1881. It was somewhat dry, as it had been exposed to the air after being cut. Sent by Maximilian Taubles.

*No. 9.*—Grown at Isleton; planted May 15, 1881; cut August 22; average height of stalk 9 feet 6 inches, and thickness 1 inch. Assayed August 24 (sample from four stalks). Sent by Mr. Taubles.

*Assays of California sorghums and sugar cane.*

Varieties.	Specific gravity of juice.	Solid contents of juice.	Percentage of cane sugar.	Purity coefficient.
1879.				
No. 1. Early Amber, University grounds.....	1.0605	14.8	10.1	68.2
1880.				
No. 2. Early Amber, from Bakersfield.....	1.082	19.87	15.15	76.75
No. 3. Imphee, from Bakersfield.....	1.095	22.60	9.30	58.80
No. 4. Dark Early Minnesota Amber, from Bakersfield.....	1.100	24.60	14.03	58.02
No. 5. Early Amber, University grounds.....	1.076	18.55	13.67	76.39
No. 6. Cuzco cornstalk, Oakland.....	1.050	12.61	7.05	64.00
1881.				
No. 7. Early Amber, Sacramento County, immature.....	1.072	17.59	4.32	24.56
No. 8. Early Amber, Sacramento County, mature.....	1.067	16.41	10.87	66.24
No. 9. Sugar cane.....	1.076	18.4	16.09	92.09

It appears from the above table that the Early Amber cane, even in the past unfavorable season of 1880, has, in Kern County, attained a sugar percentage almost equal to the average of Louisiana sugar cane, with a very satisfactory purity coefficient, between seventy-six and seventy-seven; and even in the cool bay climate, and under the summer fogs of the Golden Gate, it has reached  $13\frac{2}{3}$  per cent., with an equally good purity coefficient.

The "Dark Early Minnesota Amber" has rather too low a purity coefficient for sugar making, at least at the time when tested. It seemed a little past the best condition.

The Imphee is very far inferior to the Early Amber, and, as the sample stood, would not even have made very good sirup.

The stalk of the Cuzco corn, though having a somewhat higher purity coefficient than the Imphee and Dark Amber, would also serve for sirup only; and considering its low percentage in the juice, and smaller production on the same area, there can be no reason to prefer it to the Amber cane. The latter seems, therefore, decidedly *the* crop to select for sugar, making, unless, indeed, the true sugar cane should yield a much better result than there is reason to anticipate, considering experience in the Southern United States. The rapid growth and early maturity of the Early Amber alone recommend it highly, as against the tardy maturity, and frequent damage from frost that proverbially render the culture of the true sugar cane in Louisiana a matter of thirteen month's work, and very liable to accident.

The continued interest in the subject of sugar production at home, as well as the desire for a greater diversification of crops, has induced numerous experiments in the growing of sugar-producing plants during the past few seasons. This has especially been the case in the Upper San Joaquin Valley, Kern, Tulare, and Fresno Counties.

## SUGAR FROM WATERMELONS.

The practicability of manufacturing sugar from melons has often been discussed, and varying opinions on the subject have been put forth, based, doubtless, upon the varying results obtained in different climates and soils. Both watermelons and muskmelons have been actually used

for the manufacture of sugar in Western Europe; but the fact that the industry has never assumed important proportions seems to indicate that it is subject to special difficulties. On the whole, it is well understood that the sugar contained in fruits is predominantly of the non-crystallizable kinds, viz., grape and sirup sugars rather than cane sugar; yet the latter is very generally present, and in varying proportions, according to circumstances, even in the same fruit.

The facility with which watermelons especially may be grown in the warmer portions of the State, their fine quality and great abundance, so as to be frequently a drug in the market, forcibly suggests that, if it be possible to use them in the manufacture of sugar or sirup, it might be a profitable industry, since it could be carried on on a small scale by farmers, with very little outlay for appliances, for the juice of the watermelon is easily obtained, and is so nearly free from the impurities which render the working of beet juice troublesome and expensive, that little, if any, purification (defecation) would be likely to be needed before evaporation.

Upon a suggestion made in August of the present year, through the columns of the *Rural Press*, by Mr. H. Hutchins, of Lodi, San Joaquin County, a full investigation of the subject was determined upon, and the material therefor was furnished by Mr. Hutchins, in the shape of a crate of fine melons, about the middle of September. The melons were of two varieties—one long, with thin rind and yellow seeds, red-fleshed and very sweet; the other, roundish and short, with thicker rind and firmer pulp, not quite so sweet to the taste.

Seven melons altogether were examined, a record being kept of their respective weights, form, degree of ripeness, &c., and in Nos. 1 and 2, considered as representative samples, respectively, of the long and round varieties, the proportion of the rind to pulp and kernels was determined.

*Melon No. 1.*—Long, thin rind, white seed, fully ripe.

*Melon No. 2.*—Short, roundish, thick rind, moderately ripe, black seed.

*Melon No. 3.*—Like No. 1, black seed, slightly over-ripe.

*Melon No. 4.*—Like No. 2, smaller, very ripe.

*Melon No. 5.*—Like No. 3, but quite under-ripe.

*Melon No. 6.*—Like No. 2, but fully ripe.

*Melon No. 7.*—Like No. 1, smaller, rather green.

*Table of results of examination of watermelons.*

I.—JUICE.

	Weight of melons.	Specific gravity.	Solid matter.	Cane sugar.	Other sugar and impurities.	Total ash.
	<i>Kil.</i>		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	
No. 1.....	*13.0	1.039	9.75	2.71	7.94	.27; .09 soluble; .18 insoluble.
No. 2.....	11.75	1.035	8.8	4.823	17.977	
No. 3.....	5.30	1.0388	9.75	11.97	17.78	
No. 4.....	7.50	1.0387	8.7	11.4	17.3	
No. 5.....	7.50	1.036	9.0	2.07	6.93	
No. 6.....	11.20	1.0345	8.625	2.42	6.205	
No. 7.....	10.60	1.038	9.5	3.46	6.04	

\* The kilogram is nearly 2½ pounds.

† It is probable that the cane-sugar determination in these cases was too low, in consequence of an error in manipulation, and should be thrown out in averaging the results.

## II.—WHOLE MELON.

	Per cent
No. 1, consisting of—	
Seeds .....	1.20
Pulp .....	48.796
Rind .....	50.000
No. 2, consisting of—	
Seeds .....	1.35
Pulp .....	35.68
Rind .....	62.97

## III.—MELON PULP AFTER PRESSING JUICE.

No. 1.—Ash .....	.345
Organic matter .....	6.891
Water .....	92.764
No. 2.—Ash .....	.275
Organic matter .....	4.43
Water .....	95.294

## IV.—JUICE OF MELON RIND.

	Per cent.
No. 1.—Specific gravity .....	1.022
Solid matter .....	5.7
Cane sugar .....	.328
Other sugar and impurities .....	5.371

## V.—PRESSED PULP OF RIND.

	Per cent.
No. 1.—Ash .....	1.169
Organic matter .....	6.708
Water .....	92.123

## VI.—SEEDS, FRESH.

	Per cent.
No. 1.—Ash .....	1.54
Organic matter .....	48.66
Water .....	49.8
No. 2.—Ash .....	1.278
Organic matter .....	41.8
Water .....	56.922

## VII.—NO. 2.—SEEDS, AIR DRIED.

	Per cent.
Husks .....	66.042
Kernels .....	37.958

## VIII.—KERNEL HUSKS, AIR DRIED.

	Per cent.
Ash .....	1.442
Organic matter and water .....	98.958

The hulled kernels, by drying and extraction with boiling ether, were found to be of the following composition :

## IX.

	Per cent.
Water .....	11.212
Oil .....	43.15
Extracted kernels .....	45.638

On burning the extracted kernels, they yielded 9.61 per cent. of ash, and therefore contained 90.39 per cent. of vegetable matter.

From the data given in tables seven and nine, it appears that the air-dried melon-seeds contained 15.4 per cent. of oil. This oil is pressed in the south of France and used for the table.

As to the main point in question, it appears from table 1 that the aver-

age amount of all kinds of sugar and solid matter in watermelon juice is a little over nine (9.1) per cent. on an average, but that of this amount only 2.66, or not quite one-third by weight, is cane sugar. This is far too little, in proportion to the other substances, to be made available for the manufacture of cane sugar, and the proposition to use the watermelon for this purpose is thus effectually disposed of in the negative.

Nevertheless, it appeared probable that a bright and palatable sirup, not liable to granulation, could be advantageously produced from the watermelon, especially since the amount of ash in this juice is so insignificant; but on making the experiment it was found that whether the juice be evaporated by itself, and purified only by skimming, or whether it be defecated with lime, as seems most desirable, the resulting sirup was always of so very dark a tint, although pleasant to the taste, and therefore well enough adapted to home use, it would scarcely be accepted in the general market. I hope yet to devise means practicable in the family for obviating this unexpected difficulty. It is, of course, readily overcome by filtration through bone charcoal, as is done in sugar refining, but this operation is too troublesome, lengthy, and costly on the small scale to be resorted to by housekeepers in the country.

The darkening of the sirup is obviously due to the influence of the air on some organic substance (oxidation), and not to any action of the ash ingredients, whose amount is scarcely one-half of what is found in the best beet juice.

#### GRAPE SIRUP.

It has already been stated that during the period of greatest depression of the wine interest in California, other modes of utilizing the grape were sought for by the grape-growers, and among these was the conversion of the fresh juice into sirup. A large scale experiment in this direction was made in 1876 by Mr. Weinberger, of Saint Helena, Napa County. The must was clarified with lime, and then evaporated. While it is not likely that the temptation to thus dispose of the grape crop will occur again, the results obtained should be put on record.

The specimen was furnished for examination as to the possibility of preventing the separation of the grape sugar, whereby the whole becomes solid, or at least a thick paste. In this condition it is not considered a very merchantable article. When received the sample had but a slight sediment of grape sugar, but after some weeks the whole appeared solid. The color was light brown, taste pleasant, but without any distinct grape flavor. The sirup dissolved in water perfectly clear, and addition of alcohol gave no precipitate either of gum or albuminoids.

Specific gravity.....	1.335
Water remaining, per cent.....	20.80
Amount of ash, per cent.....	1.014

This ash consisted mostly of phosphates of potash and soda, the rest being phosphates of lime and magnesia.

The sirup is slightly acid, to an extent corresponding to the presence of 0.56 per cent. of tartaric acid. The sample being small, the nature of the acid was not determined. It would be interesting to know whether it was a remnant of the natural acidity of the grape, or formed in the evaporation after the clarification.

As regards the means of preventing the solidification of the grape sugar, it should be kept in mind that, in the usual mode of preparing grape sugar from must, it is prescribed to "neutralize" the acid of the juice with lime in order to prevent its action on the grape sugar, by

which the latter is gradually (or in boiling more rapidly) transformed into "sirup sugar." The more acid the juice can be allowed to remain, consistently with proper clarification, the less liable will it be to solidify afterward. The color of sirup made from *acid* juice will, as a rule, be darker, but its taste and flavor will nevertheless be more agreeable than when boiled from juice completely neutralized by lime.

It is, however, scarcely to be supposed that the objection of the consumers to the pasty condition of well-flavored grape sirup will be permanent when the quality of the article is once well understood, and a taste for it established; both consistence and color are likely to be disregarded in this, as they are in so many other articles of diet.

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## HORTICULTURE AND VITICULTURE.

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### LEGISLATION REGARDING HORTICULTURAL INTERESTS.

The importance of general fruit-growing in California is being fully appreciated by the people, and they are acting accordingly. The State has been liberal in provisions and appropriations by legislative enactment. The industry is divided into two classes or departments, designated as viticulture and horticulture. For each the State is districted, with commissioners for each district, which together constitute a State board.

The viticultural districts are seven in number; one commissioner for each, and four commissioners for the State at large, all appointed by the governor.

Each county constitutes a horticultural district, with three members of the board, appointed by the county supervisors, on petition of five resident fruit-growers. The powers conferred are ample to render labors practical and efficient, being substantially those of a board of health.

The viticultural districts are:

*Sonoma district.*—Including Sonoma, Marin, Lake, Mendocino, Humboldt, Del Norte, Trinity, and Siskiyou counties.

*Napa district.*—Including Napa, Solano, and Contra Costa counties.

*San Francisco district.*—Including the city and county of San Francisco, and the counties of San Mateo, Alameda, Santa Clara, Santa Cruz, San Benito, and Monterey.

*Los Angeles district.*—Including Los Angeles, Ventura, Santa Barbara, San Luis Obispo, San Bernardino, and San Diego counties.

*Sacramento district.*—Including Sacramento, Yolo, Sutter, Colusa, Butte, Tehama, and Shasta counties.

*San Joaquin district.*—Including San Joaquin, Stanislaus, Merced, Fresno, Tulare, and Kern counties.

*El Dorado district.*—Including El Dorado, Amador, Calaveras, Tuolumne, Mariposa, Placer, Nevada, Yuba, Sierra, Plumas, Lassen, Modoc, Alpine, Mono, and Inyo counties.

County boards of horticultural commissions, at date of this report, exist in Sacramento, Yolo, Solano, Santa Barbara, El Dorado, San Bernardino, Santa Clara, Santa Cruz, San Joaquin, Amador, Alameda, Contra Costa, Nevada, and Placer.

## GENERAL REMARKS ON VITICULTURE AND FRUIT-GROWING IN CALIFORNIA.

The history and results of grape-growing and wine-making in California is interesting, and, in addition, singular. Of course for years those engaged in attempts to manufacture wines fitted for market were the merest novices. When experts even came into control of manipulations, there were still objections to California wine. It was too this, too that, and the other. Soon, however, there was a foreign demand for it. After a round trip across the ocean, it was found, even in California markets, disguised under foreign labels, and pronounced by connoisseurs all the most fastidious palate could demand. There are many "old settlers," even in California, who still adhere to the fashion of calling for "French wines" in preference to their own. The writer was an eye-witness to instances where experts, with such preferences, were called upon to decide, when labels were "mixed." In each instance award was made to the California product, although the prejudice of the individual deciding was the contrary. It is now an established fact, in the opinion of the commission, that as good wines *can* be produced in California as elsewhere. If California fails to obtain the credit which in reality is due her, she alone is to blame.

While producers were dependent on green-fruit markets, fruit culture was soon overdone. Many who engaged in it early abandoned the enterprise for this reason. Now the improved modes of drying, "desiccating," and of canning fruits, and wine and brandy making, being in successful operation in almost all parts of the State, and good prices paid, a new impetus is given to fruit raising and the fruit trade.

After full and careful examination of this industry, I am convinced that the conditions for successful fruit culture in California are unexcelled. The climate and soil combined are specially adapted to the culture of wine and raisin grapes, pears, peaches, plums, apricots, and prunes. Not as much is claimed for apples as for the fruits above named. And yet, at several points, as fine apples were seen, both on trees and on exhibition, as before noted anywhere. Quality was often questioned, and but few claimed keeping character equal to those from Oregon, or the more northern regions of the State itself.

In the appropriate place in this report I present statistical facts relating to fruit products. Orchards were visited in person in various representative districts in the State; also, some of the most extensive canning, packing, and desiccating establishments, and wine and brandy manufactories in the northern, middle, and southern regions.

A peculiar characteristic of California fruit trees is that they bear younger and are more prolific than elsewhere. Often two or three year old trees in nursery rows are full to breaking down. When in full bearing they are more regular bearers; that is, bear well, as a rule, successive years.

There are wonderfully diversified producing and climatic characteristics found in California. The extent of territory from north to south gives climates almost from one extreme to the other, with extensive intermediate, or medium, areas. A line drawn through the center of the State, following the curve of its western boundary, north and south, will measure nearly 800 miles, the average breadth being, say, 250 miles. The surface consists of mountains, valleys, and plains. Two great mountain ranges traverse the State north and south—the Sierra Nevada on the east and the Coast Range on the west, with intermediate ranges less pretentious. Almost any climate desired can be had, from perpetual snow-clad and ice-locked peaks to scorching Sahara. In the south-

ern half of the State nearly all semi-tropical fruits are grown successfully. In fact, I saw fine oranges growing in Marysville, north of Sacramento, and was told they are found still further to the north.

While it is not contemplated giving full and detailed statistics of the State, or even localities, relative to different factors of the fruit industry, a few representative results are given, merely to show what has been and can be done.

The vine was among the culture plants earliest introduced into California by the Catholic missionaries. It was found growing around the old missions by the early American emigrants, and hence received the name of "Mission" vine, which it still retains. It is a rapid grower and very productive; the grape is very juicy, rather small, light colored, bluish black, round, in straggling bunches, very sweet, with very little acid, and no definite flavor. It therefore produces a fiery, light-colored wine, of little body and no appreciable bouquet, deficient both in acid and tannin.

In the beginning of grape culture in California, it was exclusively planted, and the indifferent wines made from it alone, and brought into market in an immature condition, created the impression that no better wines could be produced in California, a prejudice which has but lately been definitely abandoned, in consequence of the appearance on the market of large quantities of excellent wines made from other varieties of the European grape, of which at this time there are but few prominent ones unrepresented in California.

Until quite recently, grape varieties derived from the American stocks were represented in California only as experiments or curiosities. The appearance of the phylloxera first called serious attention to the American varieties as resistant stocks for grafting the desired European grapes; but of the large quantities of cuttings introduced in consequence of this demand, a considerable proportion will also be grown for their own fruit, and will thus afford opportunities for combinations and blends never before tried on a large scale. At the same time the coming and employment of more professionally qualified wine experts will materially aid in correcting the errors heretofore committed, and in producing the best results attainable from the great variety of materials at command.

The cultivation of the European grape varieties has been altogether unsuccessful in the United States outside of California, Southern Oregon, part of Arizona, and New Mexico, and perhaps a part of Southern Texas. Hence wines similar to those now commanding the world's attention can be produced only in these regions, rendering it probable that there the American varieties will always be regarded more as auxiliaries for blending than as prime factors in the production of wines. In addition to this, the adaptation of the climates of Middle and Southern California and Arizona to the manufacture of raisins, so far made only from the European grape varieties, renders a continued preference for these still more certain. Even the appearance of the phylloxera is not likely to interfere in any material degree with this programme, since the pestiferous insect evidently labors here under special disabilities, which render its presence much less formidable—and its inroads comparatively easier of control—than is the case either in the Mississippi Valley or Europe.

The period of greatest depression of the grape-growing industry was reached in 1875-'77, when the prices of grapes were so low, and the stocks of wines on hand unsold so great, that in some cases hogs, calves and turkeys were turned into the vineyards to harvest the crop, and other modes of utilizing the fruit were sought, such as the making of sirup from the clarified juice, as detailed in another place. From this depression there

has been a remarkable and almost bounding revival of prosperity, the first occasion of which was the alarm excited in France by the inroads of the phylloxera, and the search after some source from which the deficient vintages could be complemented so as to retain the world's trade in its own channels. Since then, the progress made has been rapid beyond all expectation, so that at this time—1881-'82—the demand for cuttings for the planting of new vineyards has outstripped the supply, and the additional acres that will have been put in in one season will be counted by many thousands. From this revival of prosperity there is every reason to believe there will be no falling back, unless it be by the most grievous fault of the wine producers themselves. As the depression was, beyond doubt, attributable chiefly to the hasty putting upon the market of immature and indifferently made wines, so the return of prosperity has been, in a great measure, the result of steady improvement in the quality of the wines marketed, such improvement being partly due to the introduction of grape varieties better adapted than the Mission grape to the production of wines suited to the taste of wine-drinking nations; partly to a real improvement in the methods of treatment, and their better adaptation to the peculiarities of California-grown grapes. Doubtless much remains to be done yet, especially in the latter respect, before the best possible results are produced; for heretofore the vintners of each of the five wine-growing nations represented in California have followed their native habits and methods of treatment, the outgrowth of the experience of each country under its peculiar circumstances of climate, soil, temperature, &c. It is rather to be wondered that so much good wine has even thus been produced in California as to overcome the prejudice engendered by the first crude products marketed, and on account of which most of the California wines have heretofore been sold under foreign labels.

Grape culture has also been introduced to a limited extent in Southern Oregon, where the European grape seems to succeed perfectly alongside of the American varieties. No wines made in that region have come to public notice; but reliable reports from competent persons state that the wines made resemble those of the Lower Rhine and Moselle, being much less heady and alcoholic, and more aromatic, than those of California. There is no obvious reason to doubt this statement.

#### DETAILS AND STATISTICS REGARDING THE WINE AND BRANDY INDUSTRY.

The total value of the grape crop of California for the year 1880, it is safe to say, from most reliable information, will fall but little, if any, below four millions of dollars. In round numbers the vintage for the same year reached over thirteen million gallons.

The following actual figures were obtained:

9,800,000 gallons dry wine, at 25 cents .....	\$2,450,000
800,000 gallons sweet wine, at 60 cents .....	480,000
500,000 gallons brandy wine, at \$1.20 .....	600,000
75,000 boxes raisins, at \$2 .....	150,000
Green grapes, estimated.....	320,000
	\$4,000,000

The estimate for green grapes includes those shipped, canned, dried, home consumption, and worked up by small wine makers, of which there is no record. It is far below the actual amount.

Wines received in San Francisco during the year 1880, 3,860,000 gallons; brandy, 233,000 gallons.

Wines shipped out of the State, 1880: By sea, 1,845,000 gallons; by rail, 1,250,000—total, 3,095,000 gallons.

Brandy: By sea, 98,200 gallons; by rail, 94,320 gallons—total, 192,520 gallons.

While the commission was unable to obtain exact data as to number of acres of vineyards in the State, to place it at fifty thousand acres will not be considered an overestimate.\*

Basing an estimate of increase for 1881 on personal observation of what had been done, and that being done during investigation, I would add not less than twenty-five per cent.

The whole of Sonoma County, except a narrow strip on the immediate coast, is well adapted to grape culture. From the southern to the northern extremity of the county the grape flourishes, and good, sound, salable wine has been produced.

A very interesting and successful experiment of William Bihler, in Lower Petaluma Valley, below Donahue Landing, has conclusively proven that the vine flourishes on the level with tide-water, as well as upon the red volcanic soil of the interior uplands. In view of Mr. Bihler's success it may be justly claimed that the grape district of Sonoma County extends from the shore of the bay of San Pablo to Cloverdale, and from the summit of the Mayacmas Range, the eastern boundary of the county, to within 40 miles of the sea-coast—a length of territory of 60 miles, with a breadth of 25 on the average. Within this area there is a great variety of soils and marked climatic differences, producing everywhere good wine, though varying in essential qualities, as in the delicacy of bouquet and in color. There are in the county about 7,000 acres of bearing vines, and at least 3,000 not yet bearing, of which 2,000 acres have been set during the past year.

From the best information obtained the wine product of this county for the year 1880 is as follows:

	Gallons.
Sonoma Valley.....	1,400 000
Gnillicos.....	150 000
Bennett Valley.....	100 000
Santa Rosa.....	200 000
Windsor.....	75 000
Knight's Valley.....	25 000
Sebastopol.....	20 000
Healdsburg.....	150 000
Geyserville.....	40 000
Cloverdale.....	30 000
Total.....	2,190 000

While there has been much damage by the phylloxera in some vineyards in Sonoma Valley, it is gratifying to note that there is an unusual product of wine for the year, and it has proved fatal only in the shallowest soil in the locality. A careful examination has shown that the insect has not appeared anywhere in this county, outside of Sonoma Valley proper, and there the extent of the injury, as proven by this year's product, is much less than heretofore supposed.

\*The figures here adopted by Mr. Furnas are those given by the report of the State board of viticulture for the year 1880. The returns of the census for the same year differ so widely as to the product that no compromise is possible, the figures being on an average in the ratio of three to one. Total product, 10,600,000, according to the State board; 3,144,166, according to the census.

I cannot doubt that the census returns place the product too low; but leave the explanation of the discrepancy to the two parties concerned in making out the details of the returns. From the fact that there is little difference in the vineyard acreage as returned in both cases, while the acceptance of the statements collected by the enumerators would place the product per acre at only about seven-tenths of a ton, instead of the minimum of two tons notoriously harvested as an average between young and old vineyards in the State, the probability is that the board's estimate is nearer the truth.—E. W. H.

Any attempt to give the varieties of grapes grown in this county, in the confused condition of grape nomenclature, would be useless. The old vineyards are mostly of the Mission variety, while those more recently set out are in the main the Zinfandel, Rieslings, Golden Chasselas, Traminer, Burger, Flame, Tokay, and other popular foreign varieties. This county was among the first to introduce and is perhaps more noted for wine industry than any other in the State.

At present but little attention is given to grape growing and wine making in the counties of Marin, Mendocino, Humboldt, Siskiyou, Trinity, Del Norte, and Lake. It is claimed that Lake County, particularly, is well adapted to vine growing, by reason of both soil and climate.

Some advantages for obtaining detailed information and data in Napa County were presented, and, as that and adjacent regions are regarded as more representative in vine interest than any other portion of the State, these advantages were utilized.

In Napa County there are nearly four hundred vineyards, ranging from 1 acre to 400 acres. There are over 11,000 acres in vineyards, 5,000 of which are in bearing. The number of vines in the county are 11,230,950.

There are 52 wine cellars, the product of which ranges from 1,000 gallons to 300,000 gallons each, making a total of 2,857,250 gallons. The brandy product of the county is reported at 60,000 gallons. Green grapes shipped from the county, principally to eastern States, amounted to 350 tons.

Solano County produced in 1880 175,000 gallons wine, and 15,000 gallons brandy. In addition large quantities of green grapes were shipped to San Francisco and the East.

In Contra Costa County but little is done. Mr. King thinks that 20,000 to 30,000 gallons of wine were made, and no brandy that he has any knowledge of. Here, too, we found phylloxera. The use of bisulphide of carbon has been found efficacious. The Riparia type of vines from Missouri, Kansas, Nebraska, and Texas are being planted, being considered phylloxera proof. It is claimed, and generally conceded, that the soil in this portion of the State is of the highest class for vineyard purposes, owing to the decomposition of lava and other volcanic rocks.

The number of acres planted to vines in the counties constituting the San Francisco district are:

	Acres.
San Mateo .....	225
Alameda .....	540
Santa Clara .....	1,451
Santa Cruz .....	430
San Benito .....	315
Monterey .....	125
Total .....	3,086

Nearly all these vines are in bearing, and are principally of the finer foreign varieties. The wine yield for the year 1880, so far as data could be obtained, was:

	Gallons.
San Francisco (from grapes bought) .....	250,000
San Mateo .....	9,000
Alameda .....	270,000
Santa Clara .....	584,000
Santa Cruz .....	172,000
San Benito .....	60,000
Total .....	1,345,000

The small wine makers, from whom no statistics were obtained, worked up large quantities of grapes in addition.

The quality of wines is all that could be desired. The varieties preferred for wine making are grapes belonging to the Burgundy class, such as Pinot, the Chabono, the Grenacke, Miller's Burgundy, &c.; and, if we are to judge from the quality of red wines produced from them, these grapes are possibly the best that could be planted in the counties of Santa Clara and Santa Cruz, where the peculiar soil brings out their characteristics in quite a remarkable degree. Beyond this these grapes—all maturing early, being excellent bearers, and giving a deep color to the claret they are made into, when properly handled—are just suited to the climate of these counties, which is cool, and where, therefore, the vintage would necessarily be late.

A number of vineyards in the district are suffering severely from a form of fungoid disease which checks the growth of the vine, causing it to languish and become unproductive.

Prices paid for grapes in the district have varied somewhat; those nearer the wine makers and their presses realizing the best, varying from \$18 to \$25 per ton.

There are only a few large wine-making establishments in the district, the smaller ones being the rule. From all sources I hear of renewed confidence in this pursuit, which has not only proved satisfactory during the last two seasons, but even quite prosperous.

Little opportunity for personal observation was afforded the commission in the greater part of the Sacramento district, from which grapes are very largely shipped to the East, as well as to home markets. The following data are furnished by the census of 1880, regarding the acreage and wine product of the counties included within it:

Counties.	Vineyards.	Wine.
	<i>Acres.</i>	<i>Gallons.</i>
Sacramento .....	1,938	44,895
Yolo .....	757	21,789
Sutter .....	169	8,335
Colusa .....	14	.....
Butte .....	570	28,666
Tehama .....	39	72,300
Shasta .....	113	1,770

The products and acreage of these counties have doubtless been largely increased during the two succeeding seasons. In Tehama County alone a vineyard of about 1,000 acres has been established by Ex-Gov. Leland Stanford, in 1881-'82.

Much interest is being manifested in fruit culture in the San Joaquin district. The county of San Joaquin is generally level, with the lower foot-hills of the Sierra Nevada on its eastern border. It is estimated to contain 900,000 acres, fully one-half of it suitable for the growth of the grape. The price of the best vine land varies from \$25 to \$125 per acre, the highest price being for land in the immediate vicinity of the city of Stockton. The general character of the soil is clay and sandy loams, underlaid with marl, the water coming within 10 to 20 feet of the surface.

Most of the land can be irrigated or submerged, either from natural or artificial sources. The San Joaquin, Tuolumne, Stanislaus, Calaveras, and Mokelumne Rivers and their numerous tributaries, furnish abundant natural supplies, while artesian wells have been successfully sunk to the depth of 900 and 1,000 feet, respectively, at a cost of only \$2 per foot, affording a copious supply of water for irrigating large areas of land.

So far, few viticulturists have deemed it necessary to resort to irrigation during the summer months, but a few have submerged their vineyards in the winter, thereby largely increasing their production, and securing immunity from the phylloxera. The climate of this county seems particularly adapted to the growth and health of the vine. The northwest wind during the summer prevents mildew and sunburn.

The first planting in this county was in 1850. Vines in full bearing range from 5 to 10 tons per acre, and sell at from \$16 to \$35 per ton. The annual cost of producing an acre of grapes does not exceed \$10; gathering, \$1.50 per ton.

Stanislaus County, like San Joaquin, is nearly level or slightly rolling land, upon its eastern border. It contains 800,000 acres, a large portion of it good vineyard land.

The acreage in vines is placed by the census at 99 acres in 1880. The grapes grown compare favorably with those of other localities, the largest vineyards being in and around Knight's Ferry. Good grape lands are worth \$15 to \$50 per acre, according to location and easy access to market. Nearly all the vineyards are irrigated by means of ditches or canals. H. B. Pentland, of Knight's Ferry, reports 25 to 30 acres in vines, and large quantities of suitable land in that vicinity. All varieties do well when irrigated, and no diseases trouble the vines. Joseph Dominici and V. E. Bangs report the same, in substance, except that they do not irrigate.

The Red Mountain Vineyard contains 70 acres, two-thirds of which are of Mission, the remainder of Muscat and Zinfindel, all producing large crops. Large quantities of land, with good facilities for irrigation, can be bought in this locality for from \$10 to \$20 per acre. The grapes ripen early, and are seldom injured by late frosts. Pasturing sheep in the vineyard to keep down insects, especially the vine hopper, is recommended by Mr. Shell.

Fresno County is one of the largest in the State, embracing an area of 5,200,000 acres, mostly a sandy loam, a large portion of it arable, and at least 871 acres in vines. The natural facilities for irrigation are numerous and excellent, and artesian wells, bored to the depth of 150 to 300 feet in many places, supplement the water supply. A great number of colonies dot the county with settlements devoted to fruit and grape culture, the Central Colony being especially devoted to raisin culture. All irrigate, and the industry promises great developments in the near future.

Dr. F. T. Eisen commenced planting in 1873; has 179 acres in bearing, mostly wine grapes, comprizing the Zinfindel, Riesling, Hamburg, Malvoisie, Muscat, and Fisher Zagos varieties. T. C. White, of the Central Colony, has a vineyard of 30 acres, all of the Muscatella and Gordo Blanco, which are devoted exclusively to raisins. W. B. Banister, Central Colony, has five acres in Muscatella. Miss M. F. Austin, of the Hedgerow Vineyard, Central Colony, cultivates 30 acres in Muscats, Gordo Blanco, and Seedless Sultana. Thousands of acres can be obtained in that vicinity at \$5 to \$50 per acre.

Dr. Eisen is quite extensively engaged in wine and brandy making. His product for the year 1880 was 50,000 gallons wine, and 4,000 gallons of brandy. Besides his own grapes he purchases, paying \$20 to \$25 per ton. His products are disposed of at San Francisco mainly. Prices obtained: For sherry, 75 cents per gallon; port, 60 cents; and claret, 40 cents. No brandy yet sold.

Merced County, in topography, soil, and climate, greatly resembles the counties above named. The area embraces 1,000,000 acres, nearly all susceptible of cultivation, and much of it adapted to the growth of the grape. The number of acres devoted to its culture is about 178, according to the census of 1880.

The El Dorado district comprises near the entire Sierra Nevada range in the State. The soils are nearly the same—what may be classed as second and third rate. The eastern portion of all the counties, embracing more than one-half of the area, is unfitted for the vine from climatic disabilities; but the western portion of all these counties, or what is commonly known as the "foot-hills," is particularly adapted to the vine. It varies from a gray sandy, a volcanic brick color, to a brown slaty, the shallowest being 2½ to 3 feet, the deepest 8 to 10 feet, in depth.

In El Dorado County there are between 1,000 and 1,200 acres now in bearing vines—1,415 in all, according to the census. The average number to the acre is 800. These produce on an average of two tons to the acre of grapes. The proportions and kinds growing—taking 100 as the sum—are as follows: Mission grape, 68; Catawba and Isabella, 10; White Muscat, Muscatella, Malaga, 6; Tokay, Black Morocco, Malvoisie; 1; Zinfindel, Riesling, 2. The other thirteen are made up of numerous other varieties, such as Sweet Water, Black July, Hartford Prolific, Cloantha, and Concord, and some others.

One thousand four hundred and fifteen acres of vines have been planted in El Dorado County, according to the census of 1880. The Mission or the wine grape is the most prolific bearer. The number of gallons of wine produced will not fall short of 350,000; brandy, about 150,000. There are from 75 to 150 tons of grapes used for raisins. Grapes for wine sold at a uniform rate of \$15.50 per ton, table grapes at from 3 to 8 cents per pound. The vine throughout the district is healthy. Investigations prove that vines upon shallow, clayey, adobe, and black soils are infested with phylloxera, but to no considerable extent; in fact, the presence of this pest is barely noticeable.

In Nevada, Placer, Amador, Calaveras, Tuolumne, and Mariposa Counties the conditions of soil and climate are about the same as El Dorado. In Nevada County the number of acres of vines, taking small with larger growers, is about 400. In Placer there are about 850 to 900 acres; in Amador County, about 600 acres; in Calaveras, about 400 acres; Mariposa, about 500 acres, as near as I can learn; Tuolumne, about 400 acres.

The varieties of vines grown in these counties are about the same as in El Dorado, as well as the average yield, and the amount of wine and brandy made is about in the same proportion to the number of acres planted as in El Dorado. The phylloxera has also made its appearance in the vineyards of Placer, Nevada, Amador, and Calaveras. In Yuba, Sierra, and Plumas Counties there are many of the healthiest vineyards in the State, though small in comparison. Inyo, Modoc, Mono, Alpine, and Lassen have not given much attention to this industry, although the soil and climate of many portions of all these latter counties are susceptible and fitted to vine growing. There are hundreds of thousands of acres of the very best vine-growing land in the State that can be had for the taking. Improved lands, in bodies of from 100 to 300 acres, where from three-fourths to four-fifths of the whole are suitable for vineyards, can be purchased at from \$10 to \$30 per acre, in many cases with a vineyard of from 5 to 10 acres already planted. The physical qualities of the soils exerted upon by the atmosphere above, subterranean water currents below, taken with the physical properties of the soil and its rich chemical constitution, from experiments already made, make the "foot-hills," with the cheapness of the lands, the most desirable and advantageous outlook for California's future vineyards. The "foot-hill" grape is said to have a superabundance of sugar for a superior quality of wine, but this is shown to somewhat decrease with cultivation. It is desirable in planting vines to avoid shallow clay and bed-rock soils, to seek the sandy, porous, and easily pulverized ground, with the vine fair to sun during the whole day.

The whole country composing the Los Angeles district, except at and close by the old Missions—Los Angeles, San Gabriel, San Bernardino, San Diego, and Santa Barbara—may be called new. Nine-tenths of vine-growing to date is found in Los Angeles and San Bernardino Counties. The wine and brandy manufactory of Stem & Rose, in Los Angeles County, I take as representative of these industries in the district. Beside their own vineyard, consisting of several hundred acres bearing, they handled, as their books show, 1880, over 12,000,000 pounds of grapes. In round numbers, the wine produced was 400,000 gallons, and brandy 100,000. I found them in the mid-season of this year's operations, and therefore could only learn that it would be largely in excess, in all respects, over the year past. As an evidence of increase in vine-planting, I mention, as obtained from the foreman, that from Mr. Rose's vineyard there

were sold for planting, 1881, over 800,000 grape cuttings. They were paying \$20 per ton for grapes, the yield averaging four tons per acre.

In former years Los Angeles had the reputation of being especially adapted for making port, angelica, sweet muscat, and brandy; but in light wines the county stood last on the coast. The writer never shared in that belief, for, if the Mission grape attained a higher and more perfect maturity, and made a wine of the best quality for which it was adapted, I could not see why other varieties of grapes, which were suited for other kinds of wine, should not, also, when ripened in our genial, pleasant climate, make a wine—a light wine—characterized by a bouquet of the best quality. It is now an admitted fact that no country, no difference how well adapted for growing grapes of the best quality for making the most superior wines, will make equally good wine from all kinds of grapes. In order to make the best quality of wine, such localities must also have those varieties of grapes that make the best quality of wine. Johannisburg, without the Riesling, would soon lose its reputation for its fine quality. Plant Chateau Lafitte with the Mission grape, and the time would not be long when its name would drop out of existence as a locality for fine clarets.

Perhaps there is no locality in California which is so little understood as to climate as Los Angeles and other southern counties. Summer heat is much less, and nights much cooler, than at either Stockton or Sacramento. Here they have but little hot weather, but a more even temperature, warmer winters, and a longer season. As this is the home of the orange, lemon, and other like fruits, the mistake is a natural one, but they excel in raising these, not because they have a greater summer heat, but because of a warmer winter and a more even temperature the whole year. It is no longer an experiment whether they can make a light wine of the best quality. It is a fact accomplished, a fact which all viticulturalists who have tried their wines admit. Mr. Rose says he can show wine in quantities which only carries seven per cent. of alcohol, and can be drank with pleasure when one is dry to quench thirst, and leave no dullness of the mind behind. Of course this cannot be done with the Mission grape, and the verdict founded on that grape has been a just one, which said that we could not make a light wine, and that all our wines had a sherry flavor. The planting of other varieties of grapes, however, tells a different tale. The Blanc Elbea, Burger, Zinfindel, and Charboneau changes this verdict, which was based upon wine of every kind and variety made from our grape, viz., the Mission.

In San Bernardino County there are vineyards owned by Dr. Barton, Mr. Crafts, Mr. Pain, Dr. Edgar, and Mr. Pishon, amounting to about 200 acres. There is also an awakening to viticultural interest in Ventura and San Diego, all of which are buying the finer varieties of grape cuttings for planting. Riverside has many small vineyards, planted generally with Muscat of Alexandria, and Muscatella Gordo Blanco, from which a very fine quality of raisins is made.

There are about three hundred parties engaged, somewhat extensively, in grape-growing in Los Angeles County. Among them I had the honor of meeting General Stoneman, the cavalryman of late war notoriety. He has 200 acres in grapes and 20 in citrous fruits. J. De Barth Sherb, president of the Southern Horticultural Society, is largely engaged in grape-growing and wine-making. E. J. Baldwin, of San Francisco, has 300 acres in bearing vineyard, and 700 acres more planted, not yet bearing. His books show 150,000 gallons wine made, 1880, and 25,000 gallons brandy.

Lands range from \$10 to \$200 per acre. The "foot-hills," or mountain slopes, range the lowest, and yet for grape culture are regarded of high degree.



## CALIFORNIA WINES AND BRANDIES.

By E. W. HILGARD.

NOTES ON THE REPORT OF A COMMITTEE ON CALIFORNIA WINES AND BRANDIES, EXHIBITED AT THE FAIR OF THE MECHANIC'S INSTITUTE, SAN FRANCISCO, IN 1878.

Owing, in part, to depression of the wine interest, native wines for several years formed no prominent part of the exhibits at the several fairs in the State. At the twelfth exhibition of the Mechanics' Institute of San Francisco, in 1877, no wine was exhibited. In the following year (1878), at the suggestion of Rev. Dr. J. I. Bleasdale, of Australia, an invitation was issued by the managers to wine-producers, to send samples of their best products for adjudication by a committee of experts appointed for the purpose. This committee consisted of the following gentlemen: Dr. J. I. Bleasdale, of Melbourne, Australia; Drs. H. H. Behr, Charles Bertody, and Wm. Hammond; Messrs. B. H. Redding, and Adolph Herbst, of San Francisco, and myself. The diversity of national and individual tastes thus represented seemed to insure an impartial consideration of the intrinsic merit of the native wines. It was agreed from the outset that the unmistakable peculiarity of all California-grown wines (what is often called their "earthy taste") should be taken for granted, and their quality determined, not with reference to any particular standard of foreign wines, but upon their own merits, as much as the preformed tastes of the judges would allow.

Forty-three samples of wines from various parts of the State were sent in, and not only tasted, but also subjected to distillation and various other tests, by Dr. Bleasdale, whose painstaking investigation of Australian wines, in an official capacity, had specially qualified him for this examination. Five sittings were held by the committee, and the results published in tabular form, in the official report of the thirteenth exhibition of the Mechanics' Institute, in conjunction with a highly valuable treatise on the whole subject of wine-making, by Dr. Bleasdale. In this he considers especially the treatment of wines in Portugal, as the climate most nearly alike to that of California, and calls attention to a number of points of importance heretofore, in a great measure, overlooked by California wine-makers.

In classifying the various wines, it was agreed by the committee that the labels of all bottles should be effectively covered until after the vote was recorded. That the highest number of marks allotted to any wine should be 20; that all wines falling between 17 and 20, on averaging the marks of the several members, should be classed as No. 1; all those similarly falling between 14 and 16, inclusive, should be classed as No. 2; and those between 10 and 13, inclusive, as No. 3. Those falling, in the judgment of the committee, below 10, should be excluded from consideration. The points recorded separately by each member were the following:

1. Date of vintage.
2. Color of the sample.
3. Condition.
4. Flavor.

5. Bouquet, both as to quantity and quality.
6. Body—light, medium, or full.
7. Acidity felt by the palate.
8. Value of the sample, in numbers.

The absolute acidity of the samples and the proportion of tannin contained, were also simultaneously demonstrated by chemical tests. The general results were as follows: Of the forty-three samples examined, thirty-two were placed in the first class; one only, however, receiving the maximum of 20 marks, almost unanimously; eleven were placed in the second class, on the average of marks; none in the third class; unanimously, none in the fourth class.

It should be added that the favorable results were a surprise to most of the members of the jury, who had, it appears, not generally come in contact with native wines of this quality, and hardly believed in their existence. This circumstance adds to the value of their decision.

The following table shows in part the results of the labors of the committee:

*Classification of samples by the jury.*

Name of district and locality.	Name of grower.	Number of samples sent by exhibitor.	Name of wine.	Color.	Date of vintage.	Classification by the judges.		Retail selling prices in San Francisco.		
						Second.	First.	Per gal. lon.	Per doz. en.	
Mission San José...	Mr. Keene,..... (Exhibited by Mr. Woods.)	.....	Burgundy.....	Garn et red.	1876	.....	1	.....	.....	
			Zinfindel.....	Purple..	1877	.....	.....	.....	.....	
Stanislaus County.	Mr. Palmer, San Francisco.	2	Malvoisie.....	Red.....	1876	.....	1	.....	.....	
			Frontignan.....	Amber..	.....	.....	1	.....	.....	
Calistoga (Schramberg).	Mr. Schramm...	2	Port.....	Red.....	.....	.....	1	\$2 50	\$5 50	
			Schramberger white.	White..	1874	.....	.....	.....	2 50	5 50
Upper Sonoma Valley.	Kohler and Frohling.	.....	Schramberger red.	Garn et red.	1875	.....	.....	.....	.....	
			Port.....	Garn et red.	.....	.....	1	2 @ 4	5 @ 10	
Sonoma.....	Mr. Gundlach..	8	Tokay.....	Brown..	.....	.....	1	1 50	5 00	
			Angelica.....	Amber..	.....	1	.....	2 00	6 00	
			Riesling.....	Straw..	.....	1	1 25	4 00	.....	
			Zinfindel.....	Purple..	.....	1	1 25	4 00	.....	
			White wine.....	Amber..	.....	1	1 00	3 50	.....	
			White.....	Yellow..	.....	1	1 00	3 50	.....	
			Gutedel.....	Golden..	1870	.....	1	.....	7 00	.....
			Gutedel.....	Golden..	1875	1	.....	1 25	6 00	.....
			Claret.....	Purple..	1874	1	.....	1 50	4 50	.....
			Young claret.....	Garn et red.	1876	1	.....	1 50	4 00	.....
Napa and Saint Helena.	Mr. Groezinger.	8	Riesling.....	White..	1875	.....	1	1 25	6 00	
			Traminer.....	P a l e white.	1874	.....	.....	1 50	6 00	
			Another sample..	White..	1874	1	.....	1 50	6 00	
			Riesling.....	Yellow..	1874	.....	1	1 50	6 00	
			White wine.....	White..	1875	.....	1	1-1 25	3-3 50	
			Claret.....	Ruby..	1875	.....	1	1-1 25	3-50-4	
			Angelica.....	Straw..	.....	1	.....	2 00	4 50	
			Another bottle.	Golden..	.....	1	.....	.....	.....	
			Sherry.....	White..	.....	1	.....	2 00	4 50	
			Zinfindel.....	Red.....	1874	.....	1	1 25	3 50-4	
Sonoma (four miles from the town of Sonoma).	Col. G. F. Hooper.	11	Sherry.....	White..	1874	.....	1	2 00	4 50	
			Traminer.....	White..	1875	.....	1	1-1 25	3 50-4	
			Table claret.....	Purple..	1876	1	.....	0 45	.....	
			Table claret.....	Ruby..	1874	.....	1	0 65	4 50	
			Table claret.....	Purple..	1876	.....	1	0 45	.....	
			Zinfindel.....	Purple..	1877	1	.....	.....	.....	
			* Claret.....	Ruby..	1874	.....	1	0 65	4 50	
			Mission.....	Golden..	1873	.....	1	1 00	6 00	
			Tokay.....	Yellow..	1874	.....	1	1 00	6 00	
			Light claret.....	Ruby..	1875	.....	1	0 55	.....	
Chablis.....	White..	1874	.....	1	1 00	6 00				

## Classification of samples by the jury—Continued.

Name of district and locality.	Name of grower.	Number of samples sent by exhibitor.	Name of wine.	Color.	Date of vintage.	Classification by the judges.		Retail selling prices in San Francisco.	
						Second.	First.	Per gal. lon.	Per doz. ch.
Sonoma.....	Col. G. F. Hooper.	11	Medium claret ...	Purple..	1876	1	.....	\$0 45	.....
		Landsberger & Co.	12	Young claret .....	Purple..	1877	1	.....	.....
	Mission .....		White ..	1866	1	.....	.....	.....	
	Mission .....		Golden ..	1869	1	.....	.....	.....	
	White Zinfandel..		White ..	1876	.....	.....	.....	.....	
	Riesling .....		White ..	1876	1	.....	1 00	\$5 00	
	Noble wine .....		Golden..	1875	1	.....	.....	.....	
	Young Zinfandel		White ..	1877	.....	.....	.....	.....	
	Mission and Blendsfit.		White ..	1876	1	.....	0 75	3 50	
	Do .....		White ..	1876	1	.....	0 75	3 50	
	Do .....		Garne t red.	1877	1	.....	0 60	3 00	
	Do .....	Straw... ..	1869	1	.....	.....	.....		
	Eclipse cham-pagne.	White ..	1869	1	.....	Qrts. Pts. \$14 00	\$15 50		
Port.....	Ruby... ..	1874	1	.....	1 50	6 00			

\* This wine is the only sample that received the full number of 20 marks.

The following points were noted by the committee, although they were not made a special matter of official record :

The wines were in nearly all cases rather heavier—richer in alcohol—than is usual in the wines in daily use in wine-drinking countries. This is more especially true of the wines made from Mission grapes, which at the same time are deficient in the “bouquet,” and only acquire it to some extent by age. The red Mission wines are, on the whole, decidedly superior to the white; a circumstance easily accounted for from the fact that the Mission grape is remarkably poor in acid, which is necessary to the development of the bouquet, and of the higher qualities of wine generally.

I have heretofore suggested that this peculiarity might, in a measure, be modified by not allowing the grape to become as “dead ripe” as is now usually done. This would tend to increase the acid at the expense of the sugar, which is in excess at best, thus producing the excessive headiness for which Californian wines are thus far noted. The vintners object to this course on the ground of the European precedent, according to which every additional day of sun is accounted so much gain to the quality of the wine. But what is true in the cloudy climate of Europe is not, therefore, necessarily true in sunny California. To suit the taste of the wine-drinking nations, we must aim to produce not the fiery, but relatively flavorless wines of Southern Spain and Italy, but something more like the universally accepted wines of Middle and Northern France; and this cannot be done under the glowing sun and cloudless sky of the interior of California, unless the nature and treatment of the grapes and wine are correspondingly modified.

A correct appreciation of this necessity has led to the introduction on a large scale of the tart, acid, and highly colored Austro-Hungarian “Zinfandel” grape—the opposite extreme as compared with the Mission. Even under the fervid sun of California, the pure product of this grape remains too harsh for most palates; but its mixture with the Mission (before fermentation, of course) produces an admirably blended product, in which the faults of both have become virtues; and among such blends were some of the finest red wines sampled and tested by the committee. Of course, the combination of the acid and body-yielding Zinfandel with grapes of higher quality than the Mission may be made to produce still finer results. It remains to be seen whether in succeeding generations, under the influence of the Californian climate, the foreign grape varieties will not themselves gradually become modified in the same direction as the Mission grape. At all events, the committee were satisfied that one of the most important points to be more fully studied by California wine-makers is the proper blending of the several grape varieties in the must as well as subsequently in the cask. The objections sometimes made to this process are, of course, a pure matter of sentiment, and as such are scarcely ever taken into account by intelligent wine-makers, who are well aware that even the best grape will rarely produce a palatable wine unless

intelligently treated, and that, with few exceptions, the best wines in the world are judiciously made blends, whether of different grape varieties or of the product of vineyards differing in the peculiarities they impart to the product.

It follows from the above considerations that wine-making, like any other technical process of manufacture, requires special training, and in a measure a natural ability, as regards taste, to produce the best possible results from under given circumstances. Hence the establishment of large wineries, conducted by persons specially qualified, would tend to improve the quality of wines, as against the practice of establishing a costly plant for each small vineyard, whose proprietor is not versed in the difficult art of wine-making.

Again, it has been the practice to put on the market, under the names of port, sherry, &c., wines whose only resemblance to their prototypes consist in a superficial resemblance of color, sweetness, and alcoholic strength, but lacking both the body and flavor of the originals. It should be distinctly understood that the production of these wines is dependent both upon the peculiarities of the countries and the localities where their prime materials grow, and upon definite processes of manufacture, without which their character cannot be reproduced. Especially as regards port, the defects of the Californian practice are very clearly set forth in the treatise of Dr. Bleasdale, mentioned above. There is especially one point of radical importance, namely, thorough aeration of the must by the treading process, which evidently exerts a decisive influence upon the product. The aeration can, of course, be effected otherwise than by treading, but without it neither port nor sherry is likely to be produced anywhere, and the labeling of weak imitations with their names can but depress the public estimate of California wines.

The same point, namely, aeration, will probably need attention in connection with other, especially white wines, whose keeping qualities appear to be frequently injured by "overfining," practiced evidently for the purpose of improving an unsatisfactory condition (as to clearness or "brightness"). The removal of the tannin, resulting from this process, is a most serious detriment to the keeping qualities of the wine, as well as to its palatableness. It was also noticed that the use of inferior corks had, in a number of cases, injured the flavor of otherwise excellent wines.

Finally, it was a matter of remark that but few of the wines examined were of sufficient age to have developed their best qualities, and that in not a few cases the promise of the sample, under proper treatment, considering its juvenile age, would have placed it much higher than its present condition would warrant.

#### CALIFORNIA BRANDIES.

While in Northern California brandy has thus far been chiefly made of the pressed pomace, producing a somewhat rank-flavored liquor, that of Southern California is mostly made from unpressed pomace, or crushed grapes from which the "first run" only has been taken, and is therefore on the whole superior, although made almost entirely from the Mission grape. A few wineries in Northern California also distill their lower-grade wines, in part at least made from foreign grapes, and put into the market excellent products. One establishment only, thus far, has made a specialty of making high-grade brandies from wines specially prepared for the purpose from grapes known to be adapted to this end, viz., that of General H. M. Naglee, of San José. The brandies so made contain, of course, the minimum amount of the rank and fusil oils supplied by the pomace, which so materially heighten the deleterious effects of excessive use attributable by their action on the brain.

After the conclusion of its labors on wines, the committee above mentioned held several sessions for a comparison of samples of grape brandies, most of which were furnished by General H. M. Naglee, of San José, while others were procured in the general market.

General Naglee, after a study of the processes of brandy manufacture in the various districts of France noted for their product, concluded that it was possible to manufacture in California better brandies than those of Cognac; the increased value of wines having almost entirely done away with their distillation for brandy in France. He has, therefore, for nine years past, distilled brandies from young wines made from various kinds of choice grapes, such as Charbonneau, Folle, Blanche,

Riesling, &c., using therefor a still specially devised, by means of which he frees the distillates from the fusil oil to any degree desired, and thus produces a liquor as nearly free as possible from all but the finer flavors, and therefore better adapted to *bona fide* medicinal use than any other spirits now attainable in commerce, and capable of replacing advantageously the too frequent use of opiates in ordinary cases. The price of such products must of necessity always be too high to place it within the reach of many of those who make a daily beverage of strong liquor; and yet such spirits would be less injurious than those now in ordinary use, at least to the same extent that corn whisky is less fatal in its action brandies with those now usually obtainable under the name "Cognac" on the brain and nerves than "absinthe." A comparison of such pure will generally result in the rejection of the latter by any cultivated palate. The example set by General Naglee, in freeing the brandy as much as possible from the deleterious fusil oils, will establish for the Californian product the precedence over the much-doctored imported liquors.

#### COMPOSITION OF CALIFORNIA MUSTS AND WINES.

The subjoined tables show the results of analyses made in the viticultural laboratory of the agricultural department of the University of California of wines made in the laboratory itself, from grapes obtained in different portions of the State, in 1880. A similar and more extended series is being made of the vintage of 1881. These investigations have been made by Mr. F. W. Morse, viticultural assistant, and will be published with full discussion in the report of the college for the year 1882.

No. 1.—The first grapes used for making wine were the Mission grapes, sent by Dr. J. Strentzel, of Martinez, about October 10. They were picked when only just ripe, in order to compare them with grapes from the same place when fully ripe, and containing maximum amount of sugar. They arrived in good condition, and were immediately stemmed and crushed, and one-half made into red, the other half into white, wine. Fermentation began on the 14th of October, and on the 23d the red wine was pressed from the pomace. Both wines were racked off from their lees November 26.

No. 2.—Zinfandel grapes, from Mr. C. Krug, Saint Helena, sent October 22. They were very ripe and soft. They were treated in a similar manner to No. 1. Fermentation began on the 23d of October, and the red wine was pressed on the 31st. November 29 the wines were racked from their lees.

No. 3.—Malvoisie grapes, from Mr. C. Krug, Saint Helena, sent October 22. They were just ripe and in good condition. They began fermenting on the 29th, and the red wine was pressed on the 8th of November; on the 9th of December they were racked.

No. 4.—Pineau of Burgundy, sent by General H. M. Naglee, San José, October 30. They were packed in large barrels, and had been delayed on the road, so that when received they were in bad condition. The juice had run from the loose grapes so that it was impossible to determine the proportion of juice and pomace in the grape. The best ones were taken for making white wine. Fermentation began on the 1st of November; on the 11th the red wine was pressed, and on the 25th both wines were racked from their lees.

No. 5.—Burger grapes, from Mr. C. Krug, Saint Helena, sent November 4. The grapes were in a very bad condition; many had already soured and could not be used. Fermentation began on the 4th of November. The "red" wine was pressed November 13, and both wines were racked off November 28.

No. 6.—Mission grapes, fully ripe, sent by Dr. J. Strentzel, Martinez, November 10. They were in very good condition. Fermentation began on the 12th of November; on the 22d the red wine was pressed, and racked December 15.

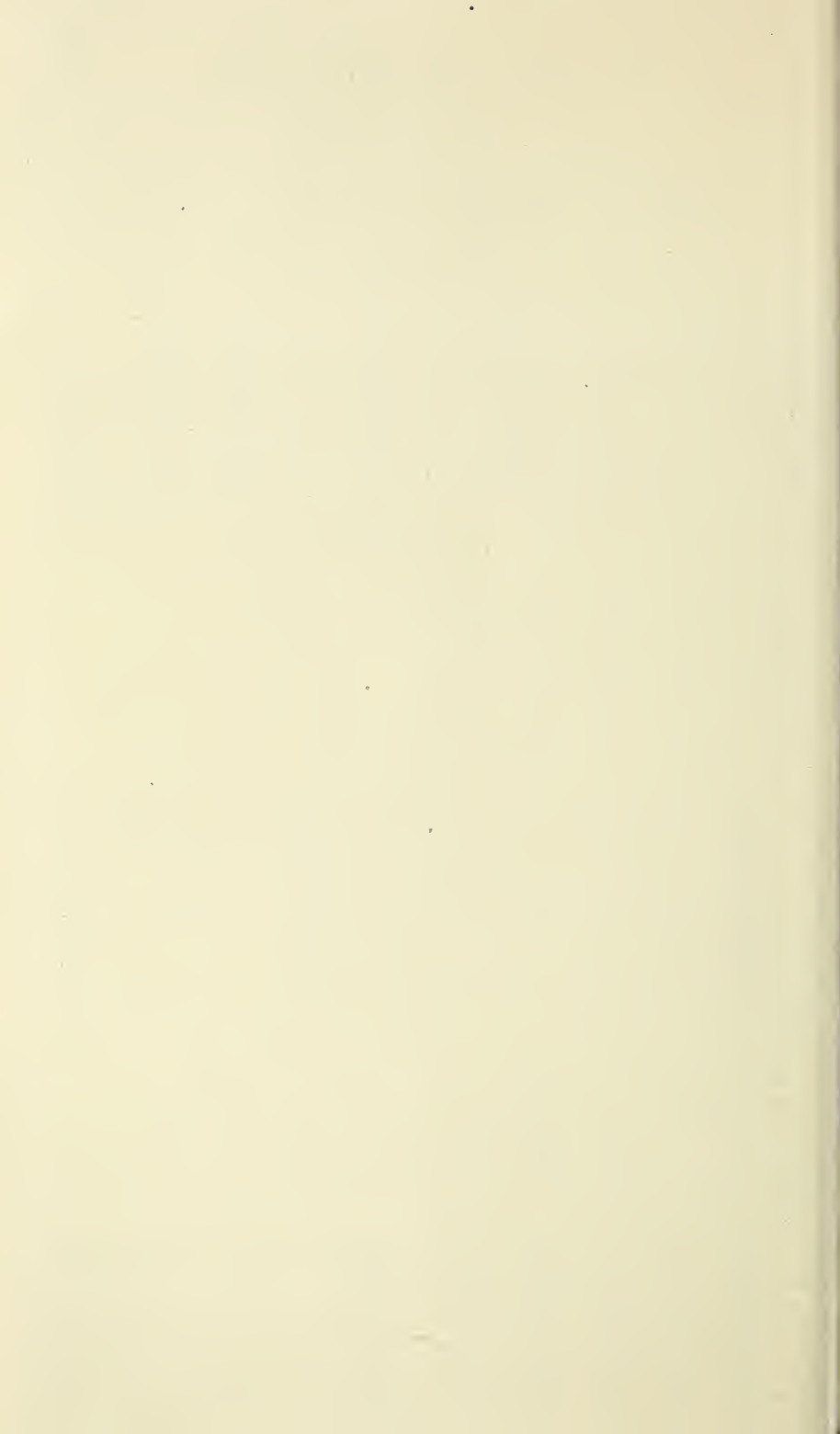
The must from some other specimens of grapes has been analyzed, but no wine was made from them.

Name.	Color of wine.	Total weight, in pounds.	Pomace, per cent.	St. ms. per cent.	Gallons of must.	Temperature of must.	Specific gravity of must.
Mission (just ripe).....	White.....	71.75	13.5	3.05	6.95	24	1.0665
Do.....	Red.....	106.5	18.3	3.75	9.2	13.5	1.085
Mission (fully ripe).....	White.....	101	11.63	3.96	9.4	16.5	1.100
Do.....	Red.....	84	27.3	5.75	6.2	18	1.088
Mission.....	White.....	126	13.4	5.55	11.2	22	1.060
Zinfindel.....	White.....	116	18.1	2.58	9.9	19	1.110
Do.....	Red.....	151	10.92	2.65	14.1		
Charbonneau.....	White.....	97	30.92	6.18	7.0	20	1.650
Do.....	Red.....	74	22.97		6.4	19	1.065
Burger.....	White.....	95	12.1	7.36	8.6		
Do.....	With skins.....						

Name.	Color of wine.	Solid contents, by spindle.	Residue by evaporation, per cent.	Grape sugar, by polarization.	Fruit sugar, by polarization.	Total sugar, by copper test.	Acid calculated as tartaric acid.	Amount of standard alkali solution to neutralize ten c. cm. of juice.
Mission (just ripe).....	White.....	16.2	16.32	6.55	10.22	16.77	.414	.552
Do.....	Red.....							.375
Mission (fully ripe).....	White.....	20.4	20.05	9.46	13.64	23.1	.458	.610
Do.....	Red.....							.480
Mission.....	White.....	23.75	23.68	7.54	16.15		.375	.500
Zinfindel.....	White.....	21.06	Lost	7.08	12.48	19.56	.405	.540
Do.....	Red.....							.322
Zinfindel (second crop).....	White.....	14.66	15.16	7.81	11.32	19.13	.756	1.008
Malvoisie.....	White.....	25.87	22.24	12.05	16.71	28.76	.338	.450
Do.....	Red.....							.303
Charbonneau.....	White.....	12.25	11.44	4.81	7.59	12.4	.657	.876
Do.....	Red.....							.750
Burger.....	White.....	15.83	13.28	6.51	9.06	15.56	.677	.903
Do.....	With skins.....						.75	1.000

Name.	Color of wine.	Specific gravity.	Specific gravity of dealcoholized wines.	Solid, by spindle.	Solid, by evaporation.	Organic matter, per cent.	Ash, per cent.
Mission (just ripe).....	White.....		1.055	1.375	1.228	.998	.230
Do.....	Red.....	1.000	1.005	1.25	1.638	1.320	.318
Mission (fully ripe).....	White.....	.995	1.0055	1.375	1.750	1.506	.244
Do.....	Red.....	.995	1.007	1.750	1.919	1.522	.397
Zinfindel.....	White.....	.9925	1.0055	1.375	1.548	1.362	.186
Do.....	Red.....	.9975	1.007	1.750	2.339	2.047	.291
Malvoisie.....	White.....	.990	1.005	1.625	1.751	1.435	.316
Do.....	Red.....	.995	1.008	1.200	2.619	2.282	.337
Charbonneau.....	White.....	.9975	1.004	1.000	1.325	1.121	.204
Do.....	Red.....	1.000	1.0055	1.375	1.855	1.536	.319
Burger.....	White.....	.995	1.005	1.250	1.505	1.335	.170
Do.....	With skins.....	1.000	1.0055	1.375	1.758	1.528	.231

Name.	Color of wine.	Alcohol, vol., per cent.	Alcohol, weight, per cent.	Total acid as tartaric acid.	Bitartrate.	Actual tartaric acid.	Sugar.	
							Degrees of polarimeter.	Per cent. by cop-per test.
Mission (just ripe).....	White.....	10.0	8.0	.537	.1550	.1550	.....	.....
Do.....	Red.....	8.5	6.3	.540	.0564	.0111	.....	.....
Mission (fully ripe).....	White.....	12.8	10.3	.349	.2300	.1776	.....	.....
Do.....	Red.....	13.3	10.8	.330	.1220	.0629	.....	.....
Zinfindel.....	White.....	12.6	10.2	.600	.1739	.0888	.....	.....
Do.....	Red.....	12.9	10.4	.390	.0470	.0370	.....	.....
Malvoisie.....	White.....	16.7	13.5	.427	.0517	.0592	.....	.....
Do.....	Red.....	14.5	11.7	.246	.0423	.0259	.....	.086
Charbonneau.....	White.....	8.1	6.5	.475	.1598	.1295	.....	.....
Do.....	Red.....	6.5	5.2	.442	.2068	.1184	.....	.06
Burger.....	White.....	9.0	7.2	.562	.0987	.1591	.....	.....
Do.....	With skins.....	9.2	7.3	.525	.0376	.0222	.....	.....



## RAISIN-MAKING.

BY R. W. FURNAS.

As raisin-making is comparatively a new industry in connection with vine-growing in California, and I may say a very important and successful one, I give the experience of R. B. Blowers, who has established a reputation as a raisin-maker, in his own words:

Raisins are made from the Muscatella, Gordo Blanco, and Muscat of Alexandria, preferably of the former; also a seedless raisin, highly esteemed, made from the Seedless Sultana. The grapes should be allowed to remain on the vine until quite ripe, showing a yellowish or golden color, and being more translucent than when too green. Then they should be carefully picked and placed upon a drying-tray (usually 2 by 3 feet in size), then exposed with an inclination toward the sun in some convenient place, generally between the rows in the vineyard or in some contiguous open land. After having been exposed a sufficient time to become about half dried, they are turned once in this manner, viz: two workmen, taking an empty tray, place it upon a full one, holding them together firmly, and with a swinging motion turn them over and replace the now turned grapes in their former position. The turning should be done before the dew is quite off the grapes, in the early morning; then, when the grapes have become so dry as to lose their ashy appearance, some being a little too green and some quite dry enough, they are, after removing those entirely too green, slid from the tray into large sweat-boxes, having a thick sheet of paper between about every twenty-five or thirty pounds of raisins; then they are removed to the storeroom, where they should remain two weeks or more. When ready to pack, it will be found that the too moist ones have parted with surplus moisture, which has been absorbed by the stems and drier raisins. The stems are now tough and the raisins soft and ready to pack. They are carefully placed in packing-frames made of steel or iron, the large and fair ones being placed carefully in the bottom of the frames, the surplus stems and imperfect berries cut away; then the average raisins arranged in and weighed, placing five pounds in each frame, then pressed enough to make them firm in the frame, but not enough to break the skin. They are then passed to an inspector, who examines the exposed side of the raisins, removing any imperfect ones; then placing the wrapper paper on the frame, holds it in place with a wooden or steel plate, turns it bottom up, drops the left end into the box, slides the plate quickly from under the frame, and it drops into the box; then pressing slightly upon the movable bottom of the frame, the frame is removed; the bottom of the frame is then pressed more firmly, to cause them to fill the space formerly occupied by the sides and ends of the frame; then it is removed, and the face of the latter is exposed; all imperfect berries or too wet ones are removed, and all vacancies or hollows filled by large loose raisins. The label of the proprietor is then placed on the face; the ends of the wrapper, and then the sides, are folded over, the box cover nailed on, and they are ready for market.

The complaint is sometimes made that the California raisins have too tough skins, too large and too many seeds, lose flavor in cooking, lose their bloom, and do not keep well. The most of these objections arise from an imperfect knowledge of the best varieties from which to make them. If Californians would confine themselves to varieties which centuries of experience have proved to be the best in Europe, there would be more satisfaction in the result.

Cultivation, irrigation, local climate, kind of soil, and exposure to sun all have an influence in modifying the characteristics of any one variety. Virgin soil and vigor of vine may make the seeds fuller, as it does in all cereals, but it should not, other things being equal, make skins thicker, but the contrary.

Soil for raisins, a rich, sandy loam preferred; climate, warm; soil, moist; winter irrigation in average years being quite as important as summer in our dry valleys. For safety against many kinds of insect pests, the phylloxera especially, a location is desirable where water is plenty and evenness of land surface permits winter submersion. In such favorable locations a larger berry, thinner skin, better yield, &c., will be the result. The vines are planted 8 by 8 feet in many locations, but growers of the

greatest experience prefer a greater distance apart; some plant 8 feet by 10, some 10 by 10 feet, thus giving greater vigor to each vine, enabling it to resist enemies of all kinds more surely.

Irrigation is a very important factor in the success of the fruit-grower, but if the situation is good in other respects, and no ditch water can be secured, it is found that in many parts of the State an unailing supply lies but a small way beneath the surface, in gravel ridges. Former water-courses having been filled with gravel, the surface stream diverted sometimes many miles away, leave quite a large flow of water in the gravel. This being tapped by a well, the only equipment needed is a straw-burner engine and rotary pump; and 100 or more acres can be irrigated with economy, insuring a good profit and a pleasant home.

In an experiment made recently in Yolo County, after having submerged the entire vineyard for nearly two weeks, such a well being on the place, the ditch water was shut off from twenty acres of the vineyard, and while the water still covered the entire surface to the extent of over 19 acres, the pump was run five hours, supplying the seepage and raising the water five-eighths of an inch over the entire surface, showing that in twenty-four hours 3 inches in excess of the seepage could be added to nineteen acres after the ground had been saturated.

Cost of planting and cultivating, irrigating, labor, subsistence, &c., including total expenses for first year, is from \$20 to \$25 per acre, if thoroughly well done; second year, \$15 to \$20; third year, many varieties if well cared for yield a profit; if not well attended to it may take a year or two longer. Nothing pays better than care, and nothing loses more surely than negligence in vine-growing. In pruning, the habit of each variety grown should be closely studied. In grafting great care should be taken to choose stock with wood of similar growth. If the variety desired is a coarse wood and large grower, a similar stock should be selected; if wood is of fine texture and slow growth, a wood of fine texture should be selected as grafting stock.

As the commission particularly desired data concerning the feasibility of raisin-making in California, I endeavored to give to it particular attention. As Mr. Blowers is regarded as an authority, and a representative man of the raisin industry, I endeavored to learn from him all there is of it. He has 40 acres of grapes in bearing. The gross proceeds from this has been as high as \$17,000 in a single year; expenses about \$7,000, leaving him a net profit of not less than \$10,000. His average raisin yield per acre runs from 180 to 200 boxes; 20 pounds to the box. His best yield was 4,800 boxes, from 20 acres. Mr. Blowers' raisins bring him an average of \$2.20 per box.

The famous and extensive raisin vineyard of Briggs is near that of Mr. Blowers, in Yolo County.

Miss M. F. Austin, at Central Colony, Fresno County, has 30 acres, young vines, in raisin vineyard, yielding 100 boxes to the acre, for which she receives \$2 per box.

Great attention is being given to the raisin industry at Riverside, in San Bernardino County, where they claim many superior characteristics. The specimens of raisin grapes and raisins made at Riverside were as fine as were found anywhere else in the State.

At Pasedana, Los Angeles County, the surroundings for successful raisin-growing is admirable, and already considerable attention given. Mrs. Carr, wife of Prof. E. C. Carr, former professor of agriculture in the California State University, I found making raisins on the Spanish plan of drying on the ground.

Over 100 tons of grapes were used in the year 1880 for raisins in El Dorado County. Principally, as elsewhere, they were dried in the sun; some few by artificial heat, in evaporators.

Dr. Conger, of Pasedana, gives the following account of his three-year-old grape-vines:

My vines are of the Muscat variety, and three years from cuttings, and without irrigation from the setting. Former care of the same has not been with the view of raisin-making; hence it is safe to assert that they have lacked the proper attention in some respects that would have been to their advantage. But such as it has been, I am now enabled to present the following as the returns for the crop just marketed:

Gross receipts from raisins, per acre, \$61.76; from grapes, per acre, \$13; from cuttings, \$13.98; total, \$88.74. Deducting the sum of \$25 per acre for the entire expense of care of vineyard and marketing crop, which includes everything connected with the work, and we have a profit of \$63.74

#### MODE OF MAKING RAISINS IN SPAIN.

As Spanish raisins are of high repute, and all information on this subject desirable in America, I extract from a paper by W. B. West, making it a part of my report:

Only a few years ago it was impossible to find any California raisins that were worthy of the name. We were groping in the dark; we knew nothing of the varieties to plant, how to cure them, or how to pack them. We knew nothing of localities suited to the raisin grape, and we had extravagant notions of the profits of the business.

We begin to understand the requirements of the business. We have also learned that to succeed we must have knowledge, patience, energy, and brains; that we must have the right kind of soil and climate for the true raisin grape. The Muscatella will not succeed everywhere, even in California. Many who rushed into the making of raisins a few years ago found that there was too much to learn, and gave it up after making a few tons of trash from all kinds of grapes, dried and packed in a slovenly manner. A few indomitable persons stuck to it: they had hard times; the price of foreign fruit was low; they had much to learn; but they persevered and are now nobly rewarded. They have taught us that only in certain localities can the business be carried on profitably. We are gaining information by these experiments every day, so that the future of raisin culture is more certain.

I believe in the future this business is destined to be carried on by small farmers. It is pre-eminently a matter of detail. It is such a business as will give employment to the family of the poor man—the one to make the little homestead in the hills a source of revenue. To these the Spanish method is well adapted. I propose, therefore, in this paper, to give their methods of cultivation and preparation for market. From a people who have cultivated the grape and made raisins for many generations we can certainly learn something, especially as we are only beginners.

#### THE SPANISH METHOD OF CURING.

In their mode of curing we may find something of advantage. As our grapes ripen nearly a month later than theirs, we have trouble to get them dried, and have resorted to many expensive methods to accomplish this purpose.

The climate in which the Spaniard cures his raisins in fifteen days is not any warmer than ours. It is a little more moist, and sometimes varied by showers; but his fruit being securely covered by boards remains perfectly safe, and by being covered at night to protect it from the dew, he is enabled to cure his raisins in the time stated, while we in California, who cure them on boards or canvas, are usually twice as long. Their grapes commence to ripen by the 1st of August and are usually gathered by the 15th of that month. They are not all picked at the same time; only those that are perfectly ripe. Much judgment is required in this matter, as unless the grapes are perfectly ripe they will not make good raisins. They are picked from the vines very carefully, taking care to handle them by the stems, and are placed upon willow trays and carried to the drying-floors. In every subsequent operation care is taken not to disturb the bloom, which is very important to the higher grades.

The drying-floors are constructed as follows: Where the country is a little hilly, as it usually is, advantage is taken of some slope with a southwestern aspect. When this is not attainable, an artificial slope is sometimes made by building a strong wall for the back and sides and filling in with dirt. Sometimes they are perfectly level. They like to have them with such an inclination as will allow the water to run freely from the covers. The length of these floors, which depends upon the inclination of the land, is usually about 45 feet where the angle is about 45°; where it is steeper they can be longer. The width is 14 feet. Between each bed is a path of 3 or more feet. Around the outside of these beds is a row of tile to prevent the water from entering from the paths. These are properly cemented, and it is very important that no water should enter. In the middle is a row of tile to support the center of the covering, which is of boards 14 feet long by 1 foot wide. They are laid across the bed, and are lapped one over another, so that no rain can get in. The bottom, upon which the grapes are placed, is of the natural soil, and is always loose and dusty, the vineyardists contending that the dust rather protects than disturbs the bloom. The grapes are placed quite closely upon this floor, but not so as to cover each other. Every one who has grown grapes knows that there is one side of a bunch of grapes that shows the stem more than the other. This side should be placed upward. The covers should not be placed on at night, until the grapes have shriveled a little, or in three or four days. At the end of eight days, if the weather is good, they will require to be looked over, to take out such grapes as have dried in advance of the

others, and these are clipped out with a pair of scissors. If allowed to remain they would become hard and worthless. A man commences at one end of the bed and selects those that are dry, or nearly so, placing the remainder back just as they were before, not turning them over, as is the universal practice here. The reason for this is that the side cured on the ground presents a more attractive appearance than the other.

At the end of the next seven days the raisins are fully cured. Here let me state that no substance has been found that will cure a raisin so well as the ground, and no plan have I ever seen that seemed to me to be more fitted to accomplish the object sought than the Spanish hill-side drying-floors.

Those made upon level ground require a few days more to cure the fruit, and are sometimes covered with cloth or corrugated iron. The superiority of this method over the ordinary California way of using boards or canvas is so marked that I hope some of our vineyardists will give it a trial. The necessity of covering fruit at night is not properly recognized in this State. I have found fruit in Spain warm and dry in the morning, whereas it would require at least two hours' sun to bring it to that state had it not been covered. The covers also protect them from any showers that might come up during the dry season. They are also useful in retarding the drying, as it sometimes occurs that the raisins cannot be packed as fast as they dry.

#### ASSORTING AND PACKING.

The raisins are taken directly to the packing-house, and assorted and packed immediately for market, not going through any sweating process. This sorting is of such a complicated nature, and requires so much skill, that it would be utterly impossible for us to follow it. They calculate that it requires a day's labor to select and pack a box of the best raisins. Another good reason is that the American market demands but few of the higher grades of fruit. The London layers and the loose Muscatella are the most sought.

The fruit is taken immediately to the place for assorting. A skillful workman takes each bunch in succession and grades them according to their size and condition. When a bunch contains two or more grades, as they usually do, it is cut up so that each can be put in its proper place. Each kind is carried to the workman who is packing that particular class. Although the raisins never hold out to the weight which they are supposed to represent, I noticed the workmen were careful to weigh each form as they were put in the box. They are packed in forms of six pounds each, using common paper, which is replaced in the warehouses by a more fancy article, at the option of the purchaser. The loose Muscatellas are those single berries which may be on a bunch of superior class, which their strict grading requires to be cut out; hence they are usually of a better size than their price would seem to warrant.

Mr. West further said, in relation to the raisin industry in California, what others who are engaged in it also informed me, that objections to or faults hitherto found with California raisins grew out of the fact principally that there was not care enough exercised in making them. They were made of all kinds of grapes that would dry. They were not evenly cured; not uniform in size, and too small. The latter was caused by permitting vines to overbear.

There is a future for the raisin industry in the United States, when we remember the demand for them, to supply which not less than 3,000,000 boxes are annually brought to us from foreign lands. It is demonstrated that California possesses all the essentials to supply at least all our home demand. I have given results from four different and distant portions of the State.

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## ORCHARD AND SMALL FRUITS.

### LOCAL AND CLIMATIC ADAPTATION OF FRUITS.

The commission was able only to visit personally representative regions. Dr. J. Strentzel, chairman of a committee appointed by the State Horticultural Society to condense all valuable information relating to adaptation of fruits to different parts of the State, has brought the whole matter into such concise and comprehensive shape that it is

adopted as part of this report, adding, in so doing, that personal observations, where made, suggest no change of the statements made by the doctor. His condensation is based on one hundred and fifty reliable and carefully prepared reports, some from each county in the State. He says:

To systematize these reports, adapting them to general view, it seemed most suitable to group contiguous counties subject to nearly the same climatic and topographical conditions, although it should be understood that, owing to manifold configurations of the land, alluvial or detrital soil, &c., an extreme variation exists in its productive quality, even on comparatively limited parcels of ground, so no rigid rules what to plant can be prescribed or made applicable to large bodies of land without closely discriminating the surrounding local conditions. Thus, for instance, in the central counties located around the bay, eminently adapted for the culture of the choicest fruits, some of the terrain is adapted to the growth of apples; peaches will not do so well, and *vice versa*. Some produce apricots and almonds to perfection where figs are nearly a failure. So we are restricted to noticing in each county as reported the predominant feature in fruit raising, following with a list of fruits of acknowledged excellence, adapted for export, for the use of desiccators and canning establishments, to secure permanent support to families distributed over small tracts of land, to multiply our resources, to prevent that rapid deterioration and exhaustion of the soil consequent upon the skimming process of grain production, to increase the esthetic taste of the people for the beautiful, and draw a rich usufruct from land heretofore producing at best a scanty pasturage.

## CENTRAL BAY COUNTIES.

*Alameda*.—The land along the San Lorenzo Creek is unsurpassed for small fruits, the currant leading; good plums, prunes, apricots, apples, pears, and almonds; rather too cool for the fig; peaches suffer with curl-leaf; olives grow well; crops are grown with irrigation.

*Contra Costa*.—Good for choice apples, pears, plums, prunes, cherries, figs, pomegranates, quinces; sheltered nooks for oranges, higher land for apricots and almonds; southwesterly slopes of the valleys are choice peach land; all the country around and at the foot of Mount Diablo is destined to be a continuous orchard; crops grown without irrigation.

*Santa Clara*.—Apples, pears, plums, cherries, and small fruits do well; peaches, apricots, and figs on high, sheltered land; olives produce well; curl-leaf and mildew very prevalent and injurious; irrigation partial.

*San Mateo*.—Apples, pears, plums, prunes, cherries, olives, and figs do well; peaches curl badly, scale bugs and aphid prevailing; fruit ripens one month later than in Santa Clara.

*Santa Cruz*.—Excellent for small fruits and berries, apples, pears, and plums; figs and cherries a failure; some mildew on pears, curl-leaf on peaches, coddling moth, woolly aphid, caterpillars damaging fruit; too much water in the ground, but the mountain above the fog-line is proven as choice land for the raising of all fruits of the temperate region.

*Solano*.—Around Vacaville and Green Valley fruit ripens earlier than in the adjoining counties; apricots, peaches, and figs do best, and are most profitable to raise; apples, pears, plums, and prunes do well; too hot for currants, raspberries, and walnuts; almonds not a sure crop; no irrigation.

*Napa*.—Apples, plums, prunes, pears, and quinces very productive; apricots, cherries, figs, almonds, and peaches require well-sheltered, warm spots; curl-leaf and mildew destructive to peaches; no irrigation.

*Sonoma*.—Apples, pears, plums, and prunes do exceedingly well; cherries, fair; walnuts and almonds, uncertain; apricots get frosted; peaches destroyed by curl-leaf and mildew; small fruits do well; no irrigation.

*Lake*.—Apples, pears, and plums very good; apricots, almonds, figs, and peaches require choice locations; cherries do not do well; no irrigation.

*Yolo*.—Apples unprofitable; pears and plums do well; few peaches raised, which suffer with curl-leaf and mildew; almonds and cherries uncertain; figs and olives do well; oranges frosted; practice irrigation.

## NORTHERN TIER OF COUNTIES.

*Mendocino*.—Apples, pears, and plums do well; too frosty for peaches and figs.

*Humboldt*.—Apples, pears, and plums; berries do well; no semi-tropicals.

*Del Norte*.—Similar to Humboldt.

*Shasta*.—Apples, pears, plums, and almonds do fairly; walnuts very well.

*Siskiyou*.—Apples, pears, and plums do well; peach apricots often frosted; May Duke and Oxheart cherries succeed well.

## INLAND COUNTIES.

*Colusa*.—Apples, pears, plums, prunes, peaches, and figs do well; seedling oranges mature.

*Tehama*.—Apples and pears good; figs and peaches extra good.

*Plumas*.—Apples and pears good; too frosty for peaches; irrigate.

*Butte*.—Apples, pears, plums, and figs good; peaches injured by curl-leaf; almonds, walnuts, oranges, and cherries do not do well.

*Yuba*.—Apples, pears, plums, and peaches do well; almonds and apricots unproductive; figs do not ripen well.

*Nevada*.—Apples, pears, peaches, and plums do well; apricots, almonds, walnuts, olives, and figs get frosted; chestnuts are splendid.

*Placer*.—Apples, pears, plums, olives, and figs do well; peaches curl and mildew; high ground preferred for orchard; irrigate.

*El Dorado*.—Apples, pears, plums, and peaches do well; apricot trees killed to the ground; irrigate.

*Amador*.—Apples, pears, peaches, and plums: soft-shell almonds, oranges, olives, pomegranates, and figs do well, subject to curl, codling moth, and untimely frost.

## RIVER COUNTIES.

*Sacramento*.—Apples, pears, plums, prunes, peaches, and apricots do well; of small fruits, blackberries exuberant; figs, A No. 1; almonds do well; irrigate upland; codling moth abundant.

*San Joaquin*.—Too warm for apples; pears do well; plums and prunes extra good; peaches subject to curl and mildew; apricots uncertain; almonds not reliable; cherries not favored; olives and figs do well; oranges frosted; sandy land requires irrigation.

*Stanislaus*.—Apples to be of any account must be irrigated; pears do better; peaches curl, but bear well; plums a failure; apricots very successful; cherries not good; irrigate.

*Tuolumne*.—Apples, pears, and plums do very well; peaches curl badly; apricots and cherries do well; almonds not reliable; figs excellent; oranges frosted; irrigate.

*Merced*.—Apples poor and wormy; peaches curl badly; plums, apricots, pears, and figs do well; cherries do no good.

*Fresno*.—Apples and pears do well; peaches, apricots, and prunes grow to perfection; almonds not reliable; too warm for figs; walnuts and oranges get frosted; irrigation indispensable.

*Tulare*.—Apples, pears, apricots, peaches, and almonds do well; walnuts not successful; oranges frosted; cherries not good; young fig trees frosted; codling moth and aphides plentiful.

## SOUTHERN COUNTIES.

*Monterey*.—Few apples and pears are raised; peaches curl badly; apricots and figs do well; almonds a failure; also cherries; too cold for oranges.

*San Benito*.—Apples, pears, plums, prunes, cherries, almonds, and figs do well; walnuts unsatisfactory; in some localities peaches destroyed by curled leaf.

*San Luis Obispo*.—Apples do well; pears, prunes, peaches, apricots and figs, tolerably well; all fruit does well in sheltered localities, out of the frost belt, without irrigation; oranges moderately good.

*Santa Barbara*.—Apples pears, few raised; young trees doing well; apricots, peaches, plums, walnuts, figs, and olives grow well; almonds not satisfactory; cherries do moderately well; oranges suffering from black smut and scales; curled leaf and insects annoying.

[NOTE.—No report was received from Ventura County. It is, however, well known that the valley of the Santa Clara River is an excellent fruit region, more especially for walnuts, chestnuts, almonds, and figs. Extensive orange and lemon orchards, also, have been planted near Santa Pania. Other valleys of the county, such as Ojai, are similar in character.—E. W. H.]

*Los Angeles*.—Apples, pears, and plums on clayey soil do well; cherries, almonds, and walnuts unsatisfactory; apricots and figs very good; oranges get frosted in some places, but attain great perfection, are of large size, and excellent flavor; irrigation required.

*San Bernardino*.—Apples, plums, cherries, almonds, do not thrive; apricots, olives, figs, walnuts, and oranges do well; peaches curl, but on high and warm lands they do well; oranges and raisins the prevailing culture; irrigate.

*San Diego*.—Apples perfect success; peaches do well; plums and almonds a failure; apricots and oranges a success; irrigate.

## DEDUCTIONS.

*Apples* require a cool location and richest of soil to produce fruit of full size and good flavor—low standard. Dusting the trees with a compound of ashes and lime during the rainy season is efficient in destroying insects, pests, and fungoid growths; by keeping the ground around the trees scraped smooth, with a cone of lime and ashes around the stem, codling larvæ will be deprived of shelter.

*Pears*.—Succeed almost everywhere in California, and respond most readily to the richest of soil; neither much injured by alkali nor swampy soil.

*Quince*.—There is a broad field to gain notoriety and rich reward by the production of a new superior seedling quince, free from black knot.

*Peaches*.—Most of the old white varieties are suffering with curled leaf and mildew; at their worst during cold and wet springs, when the excess of sap is not duly elaborated, for lack of solar heat, provide a ready food for the fungoid growth. No persistent efforts, so far as known, have been made to destroy it, although, judging from analogy, sulphur promises to do the service, in which it proves so efficient on the grape mildew. To infuse new vigor to the stock debilitated by the use of seed from budded trees, the sweet, hard-shell almond offers a substitute to bud the peach upon. Peaches to do well require a warm, sheltered ground, the richest of soil, and regular shortening in the process of pruning and thinning out the fruit.

*Apricots*.—The almost unlimited demand for the fruit and consequent great value of a productive apricot orchard suggest close attention to the requirements of the tree and shelter from spring frosts; an experience has to guide us in the selection of a location. A rising ground facing west is most eligible, although flats, near large bodies of water, appear to furnish the same exemption. The use of apricot and plum seedlings for stock to bud the apricot upon is nearly discarded, and peach preferred. The yellow varieties of more stocky growth should be used. The practice of rebudding old almond trees, if successful, may bring almond seedlings in demand.

*Almonds*.—The responses show the production to be limited, owing to late frosts; requiring close observation to conditions favorable to abundant fruiting, as the trees are very thrifty and the nuts valuable.

*Plums and prunes* for canning and drying are in great request, causing a corresponding demand for trees, not fully supplied, owing to scarcity of non-suckering plum stocks, which started the practice of budding the plum on peach seedlings, some plums requiring double working to secure well-jointed trees. The inadequate supply of our nursery-men will induce some to import trees from eastern sources, and with them the dreaded *cureulio* may be introduced. To avoid this calamity strenuous efforts should be made by the chief executive horticultural officer to provide an efficient quarantine and disinfection of such imported trees.

*Cherries*.—The superabundance of the Black Tartarian will require many trees to be regrafted with Royal Ann and other light-colored varieties; the responses disclose the fact of the limited area within which this fruit can be grown in perfection; the insect pest noticed last spring in some orchards should be closely investigated during the ensuing year.

*Citrus fruits*.—The experience of late years narrows the profitable culture of the orange to four counties as now constituted, still of sufficient extent to produce oranges, lemons, and limes to supply all the domestic

demand for said fruits and spare some for foreign export. The industry and sagacity of our people will brush off the scale and clean the golden fruit of its black incubus.

*Figs.*—Figs grow with but little trouble or care, and yield abundantly, and of most excellent quality in the greater part of the State. For some reason but little attention comparatively has been given to this fruit. Those who have manipulated them are quite well satisfied with results, and it is believed the time is in the near future when figs will be an important factor in fruit culture in California. The mode of preparing is simple, and the price fair. They are dried for a short time in the shade, then scalded, then fully dried, pressed, and packed in boxes. Thus prepared they will keep soft and fresh for a year or more. Good pressed figs are worth in the San Francisco market about 6½ cents per pound.

The *pomegranate* bears fruit abundantly, from the warmer valleys of San Francisco Bay to San Diego.

*Small fruits.*—With water and compost at command, one acre of land can be made to produce sufficient income for the sustenance of a moderately sized family planting strawberries, currants, raspberries, blackberries, &c. Strawberries are to be found in the San Francisco market during ten months in the year.

The above statement regarding citrus fruits hardly does justice to the demonstrated possibilities of the production of oranges, at least, northward of the Los Angeles region. The orange has ripened well, and with the best qualities of the fruit as far north as Marysville, and excellent fruit comes into market in small lots from several of the valleys of the Coast Range north of San Francisco. Singularly enough, such fruit is usually several weeks in advance of the oranges of Southern California; doubtless in consequence of the more intense heat of these valleys in summer as compared with the coast climates of the South. The same is true of other fruits, the cherries of Vacaville, in Solano County, for example, being nearly a month ahead of those of Santa Barbara, and the earliest in the entire State. Excellent oranges are grown within two miles of Martinez, Contra Costa County, about 15 miles east of north from San Francisco, in a sheltered valley of the Coast Range.

For the success of the citrus fruits in the more northerly region it seems absolutely essential that the trees should have been grown, at least from the graft, in the same climate. They thus become so hardy as to be injured only by extremely severe weather; at the same time, their growth is considerably slower, and of course the period before coming into bearing longer. Trees imported from Los Angeles to the Bay region are so tender as to be set back severely by frosting, if not actually killed, and thus are eventually longer in yielding fruit than those of northern growth. Orange culture in the San Joaquin Valley has hardly been fairly tested as yet, but there can be little doubt that it will be successful when properly managed.

Much has yet to be learned as regards the proper management of citrus fruits in respect to irrigation. As is usual, when the use of water has been secured in an arid country, irrigation has often been carried to excess, to the injury of the quality of the fruit, and often greatly to the detriment of the health of the trees. It seems pretty well established now that the minimum amount of irrigation compatible with full development secures the highest quality of fruit and the best health of the tree; but the exact measure of this amount is still the subject of

much discussion among the growers, and must evidently be determined separately for each location and soil.

It has been strongly insisted upon that the number of citrus trees already planted in California at this time is all that the market will carry, when they get into bearing. But it is difficult to predict what will be the changes wrought within that time by the establishment of new routes of communication, and therefore new markets.

The orange crop, being saleable only in the fresh state, is most easily overdone. That of lemons and limes, being available for the manufacture of citric acid and essences, will not easily be in excess of what may be utilized. So far, scarcely an attempt has been made to dispose of the inferior qualities or surplus in this way; nor has there been any attempt to manufacture the essences of the flowers, whose sweetness has thus far been wasting on the desert air.

The growers of citrus fruits will find, as they come more fully into competition with each other and with the rest of the world, that these minor industries connected with their product will oftentimes form the turning-point of the beam as regards profit and loss, and that they cannot afford to neglect them much longer. Miles upon miles of hedges of limes now annually waste their fruit on the ground for want of a market for the fresh fruit; lime juice has been made on a small scale, but was driven or kept out of the market by the article imported from Tahiti. All this will correct itself in time, but it is quite essential that the attention of those engaged in the culture should now be drawn to the dormant possibilities of their industry.

As to the quality of California fruits, they will doubtless be able to compete with any in the market, so soon as proper care is bestowed upon sorting and packing. It has been too much the habit of growers to ship promiscuous lots, large and small, sour and sweet—a practice of which disadvantages are too obvious to require comment. It is only quite lately that wrapping choice fruit has been begun in California; and it is very emphatically stated that it does pay.

The subjoined analyses of some California citrus fruits may serve as a basis for comparison with those produced in Louisiana and Florida, whenever data for the latter may become available.

#### ANALYSES OF ORANGES.

At the request of the South California Horticultural Society, through its secretary, Mr. L. M. Holt, the following analyses of oranges grown in 1879 were made for the purpose of obtaining data for comparison with the fruit of other countries. One specimen, a Mediterranean Sweet, grown by Mr. J. M. Asher, of San Diego, was somewhat under size, but with a very fine, smooth skin and high flavor. The other was a large and fine-looking fruit somewhat rough-skinned, but in flavor and sweetness very nearly the equal of the other, a seedling grown by Anson Van Leuven, of Old San Bernardino.

In the statement given below, the third column shows the data of the analysis of a Florida orange, variety not stated, made by Dr. J. R. Nichols, of Boston, and published in the Jacksonville (Fla.) Sun and Press; also in the Southern California Horticulturist for April 1879.

Constituents, &c.	Mediterranean sweet.	Van Leuven seedling.	Florida orange.
	Per cent.	Per cent.	Per cent.
Total weights of fruit..... grams..	149.7	233.5	246.5
Skin .....	10.487	28.738	23.33
Seeds .....	.941	.700	2.84
Pulp .....	89.172	70.55	73.83
The skin contained:			
Water .....	43.723	77.6169	78.00
Volatile oil.....	5.753	1.6775	21.36
Organic matter.....	49.505	19.812	.64
Ash .....	2.019	.8936	.....
Seeds contained:			
Water .....	55.630	53.09	50.00
Organic matter .....	42.941	45.32	48.64
Ash .....	1.429	1.59	1.36
Pulp contained:			
Water .....	86.446	86.982	90.99
Organic matter.....	13.121	12.572	8.68
Ash .....	.433	.446	.33
Sugars:			
Saccharose .....	7.57	7.33	3.3
Levulose .....	2.91	2.9	3.3
Total sugars .....	10.48	10.24	.....
Acid:			
Citric acid .....	1.43	1.284	1.00

About 30 grams equal one ounce avoirdupois.

The most striking point in the above comparisons is the fact that while in the California oranges the total amount of sugars is over 10 per cent., in the Florida orange it is only about 6½ per cent. This, of course, cannot be taken as a general truth until corroborated by still farther examinations of definitely-named varieties of Florida oranges. Moreover, the statement made by Doctor Nichols that *grape sugar* accompanies the cane sugar in the orange must, on the whole, be deemed improbable, unless confirmed by direct tests. The optical tests in the California oranges indicated altogether the presence of fruit sugar, or levulose, instead of grape sugar. The acid percentage seems to be smaller in the Florida orange in the same proportion as the sugar. As between the two kinds of California oranges the most striking differences are in proportion between the skin and pulp—a matter of the most vital interest to the consumer. The thin-skinned orange has nearly 19 per cent. more pulp than the thick-skinned variety, the difference being mainly due to the large amount of water contained in the skin of the latter, which is at the same time much poorer in volatile oil. In the quality of the pulp, however, there is little difference, so far as analysis can determine this point.

In March, 1880, six samples of oranges were forwarded by the executive committee of the Riverside Citrus Exhibition, with request for analysis. The subjoined table exhibits the results obtained, so far as the scanty supply of material would permit. It should be understood that for some of the determinations as many as four of the smaller oranges are indispensable.

The analyses of several other kinds are given in Nos. 7, 8, and 9.

- No. 1 (2 oranges). Naval orange (premium).
- No. 2 (2 oranges). Seedling (premium), Garcelon.
- No. 3 (2 oranges). Kona, Garcelon.
- No. 4 (2 oranges). Saint Michael's, Garcelon.
- No. 5 (2 oranges). Seedling, T. J. Wood.
- No. 6 (2 oranges). Bergamot, Garcelon.

No. 7. Mandarin orange, sent by Mr. A. B. Chapman, Los Angeles, received February 10, 1880.

No. 8. Japan oranges, presented by Mr. E. V. Cowell. They were considerably dried up when analyzed, and in spots somewhat decayed.

No. 9. Wolfskill's "XX lemon," grown by J. W. Wolfskill, Los Angeles, received March 15, 1880.

Number.	Total weight.			Specific gravity of juice.	Amount of solid matter.	Sugars.		
		Pulp.	Skin.			Acid.	Cane.	Levulose.
	Grams.	Per ct.	Per ct.		Per ct.	Per ct.	Per ct.	Per ct.
1	228.5	78.44	21.56	1.047	11.57	0.749	3.95	1.62
	234.7	78.46	21.54					
2	197.7	66.42	33.58	1.050	21.28	0.767	5.78	1.935
	223.0	70.05	29.05					
3	185.1	73.21	26.79	1.049	12.05	0.998	4.43	1.308
	143.0	81.82	18.18					
4	133.3	80.72	19.28			1.305	5.04	1.655
	192.8	75.52	24.48					
5	165.5	65.44	34.56			1.919	5.01	1.505
	85.5	66.32	33.68					
6	88.5	66.68	33.32			4.365		
	141.3	74.05	25.05					
7	108.6					0.920	6.01	1.34
	59.4	88.07	11.03					
8	133.6	88.97	11.03			0.691	7.24	2.14
9						7.31		

The extraordinary amount of acid in No. 6 creates a suspicion that it was not fully ripe, but the material was insufficient for a sugar determination. The acid percentage of the Wolfskill "XX" lemon is above the usual average.

#### ACID TESTS OF LEMONS.

In March, 1879, a request was received from the South California Horticultural Society for the communication of some method by which the acid strength of lemons and oranges could be determined, without too much of the chemist's appliances, by the committee on the subject, appointed on the occasion of the Citrus Family Fair held at Riverside at that time.

In response to this request a quantity of a carefully "standardized" solution of caustic potash was forwarded to the society, with directions for use; and the tests were carried out successfully by the committee, consisting of Dr. O. H. Congar, of Pasadena, and Mr. C. F. Heinzeman, druggist and chemist, of Los Angeles. The results obtained by them, originally published in the South California Horticulturist, for April, 1879, are here appended in a tabular form. It is to be regretted that the weights of the respective samples of lemons are not given, but this omission will doubtless be made good in the tests to be made the coming season.

The calculations are made on the assumption that all the acid of the lemon is citric acid, which, of course, is not rigorously true, as some malic acid is probably always present. Since, however, for most of the

uses of the lemon there is no difference in the value of the two acids, the tests are strictly correct for comparison.

No.	Name.	Amount of juice.	Per cent. of citric acid.	Amount of citric acid in lemon.
		Grams.		Grams.
1	Thorb's seedling, budded on orange stock .....	9	6.4	.58
3	Lisbon lemon, on lemon stock .....	10	7.0	.7
7	Lisbon lemon, on lemon stock (very large).....	12	9.8	1.18
8	Lisbon lemon, on China lemon stock.....	10	7.13	.713
9	Eureka lemon from original tree.....	8.5	7.3	.62
11	Seedling lemon, the "Olivia".....	5	8.8	.44
15	Eureka lemon, on orange stock .....	3	9.6	.29
17	Australian lemon, on orange stock.....	5	7.8	.39
20	Seedling, the "Riverside Knobby".....	6.5	10.0	.65
23	Thornless sweet-rind, on orange stock.....	3	6.0	.18
35	Eureka orange, on orange stock.....	7	7.13	.5
36	Lisbon lemon, on orange stock.....	9	7.5	.68

### EXAMPLES OF FRUIT PRODUCTION.

As illustrative, a few statistics are given as obtained in person relating to fruit-growing:

J. W. WOLFSKILL, *Los Angeles.*

This is the oldest orange-grove or orchard in California—110 acres. A portion of these trees were planted in 1841. Some I measured; body, 2 feet from ground, 3 feet 9 inches in circumference; 30 feet high. Trees planted 24 to 28 feet apart. Seedling trees commence bearing at seven to ten years old; budded ones at from three to four years. A ten-year-old tree will produce 500 oranges; at twenty years, from 2,000 to 3,000 each. Ground is kept clear, irrigated, and stirred often; almost constantly when not irrigating. Irrigates about six times in a year, by submerging ground between rows, in older orchards; in younger, immediately about the trees. Two hands will irrigate 6 acres a day. Cost of water, \$2 per day. This is far below the average cost of irrigation when water is purchased. In this immediate locality water is abundant and cheap. Freight: Los Angeles to Chicago, by rail, express, six to seven days, \$1,000 per car; two to three weeks, \$500. Three hundred boxes a car load; 150 oranges to the box, average size. Orchard principally seedlings. Is introducing, with success, improved foreign varieties. Few insect ills.

Since the official visit of the writer to Mr. Wolfskill's grounds, where he obtained the data given, the general superintendent of the Southern Pacific Railroad has given the fruit interests in the Los Angeles region more favorable transportation rates for January 1, 1882. For oranges, from Los Angeles to San Francisco in car lots, \$10 per ton. From Los Angeles to Kansas City, \$300 per car load of ten tons; Saint Louis, \$335; Chicago, \$350.

E. J. BALDWIN, *Rancho Santa Anita, Los Angeles County.*

	Acres.
Oranges .....	250
Lemons.....	10
English walnuts .....	6

Acres.

Almonds.....	30
Peaches.....	40
Plums.....	10
Miscellaneous fruits.....	20

Principally young trees, just commenced bearing. Almonds have not given satisfaction.

For Los Angeles County, I found complete record as to the status of fruit-growing, showing:

Orange trees.....	192,000
Lemon trees.....	30,250
Olive trees.....	3,000
Apple trees.....	20,500
Pear trees.....	13,345
Fig trees.....	7,325
Plum trees.....	3,125
Peach trees.....	24,375
Quince trees.....	1,900
Grapes.....	6,225 acres..
Miles irrigating ditch.....	345
Acres land irrigated.....	52,515

THOS. W. COVER, *Riverside.*

This gentleman has 10 acres good bearing limes, which yielded as high at 100,000 limes in a week, the value of which, at the orchard, was \$1,500.

California apricots stand high in the market as a canning fruit. Where they flourish, every one who can is planting. Such was the demand for trees this fall that about all stock of nurseries was exhausted. They bear early and yield well. Mr. George Crawford, Riverside, showed 1,200 trees, four years old, which yielded this season 11 tons fruit; sold for \$55 per ton. While the price realized is not up to the market, the income of a four-year-old orchard is thought worthy of notice.

Mr. Caldwell, near Petaluma, gives his experience and suggestion as to plum culture:

I have tested many varieties, observed the peculiarities of soil necessary for their growth, and the kind of stock to be used. The best kinds for pitting are the Columbia Gross prune and Washington; for prunes the Petite Prune de Agen, and the Yellow Egg for canning.

Almost any of our soils are good for growing prunes, but a clay subsoil is best. Twenty-five acres in plums will make a man a nice income in a few years. I have in my orchard two acres and a half in plums, and they pay me on an average \$500 a year.

If you set out two-year old trees, they will pay expenses the second year, and the third year you can realize a profit of \$50 an acre. Say, as an illustration, 100 trees to the acre, 25 pounds to the tree will yield 2,500 pounds of green fruit, which will make 500 pounds of pitted dried fruit, worth at 10 cents per pound \$50, which is a nice income on the investment. Of course, as the trees grow older the crop will become larger and more profitable. I candidly believe that the above-named quantity of land in plums will, one year after another, pay a greater profit than the best 300-acre grain farm in the county.

General JOHN BIDWELL. *Rancho Chico, Chico.*

General Bidwell has 1,000 acres bearing orchard—apples, peaches, plums, pears, apricots, blackberries, cherries, and almonds.

This season 15 tons green apples, bringing from  $\frac{3}{4}$  to  $1\frac{1}{2}$  cents per pound; 5 tons dried, 5 to 6 cents per pound. Pears, green, 5 tons, 2 to 3 cents per pound; dried, one ton, 8 to 9 cents per pound. Apri-

cots, green, 5 tons, 2 to 3 cents per pound; dried, 1,000 pounds, 14 to 15 cents per pound. Peaches, 60 tons, green, 1 to 2 cents per pound; dried, 50 tons, 10 to 13 cents per pound. Plums, 60 tons, green, 1½ to 2 cents per pound; dried, 16 tons, 11 to 13 cents per pound. Grapes, green, 15 tons, 3½ to 5 cents per pound; dried, 10 tons, 5½ cents per pound; 10 tons of raisins, 10 to 12½ cents per pound. Blackberries, green, 20 tons, 3 cents per pound. Almonds, 30 tons, 12 to 14 cents per pound. Also 50 fig, twenty-five each quince and olive, of which no account was taken.

Mrs. JEANNE C. CARR, *Pasadena.*

Mrs. Carr has planted 42 acres. Ground broken and first planting done 1877. Fourteen thousand grapes, principally raisin varieties, with an experimental vineyard of seventy-two varieties.

Non-irrigation thoroughly tested by watering ends of rows containing twenty-eight vines each, 8 feet apart; leaves the opposite end without water. Seven hundred orange trees, one hundred and fifty lemons, one hundred limes, irrigated between May and September. Three hundred apples, five hundred peaches, fifty each plums, nectarines, pears, and figs. Two hundred English walnuts, one hundred prunes, two hundred pomegranates, twenty to twenty-five each almonds, white walnuts, pecans, chestnuts, olives, cherries, guavas, jujubes, and Japan persimmons. Also, berberries, raspberries, and strawberries of many varieties. Several choice varieties mulberry for silk culture. Seventy species American forest trees along drives. Not more than one-half of all these have been irrigated since first year of planting.

In 1880 600 pounds of raisins made from vines planted 1878 and 1879. Sold 1,200 pounds apricots from trees planted 1878. Dried 800 pounds prunes and peaches, and sent to market large quantities of other orchard products, of which no account was kept.

Thirty varieties forage plants have been grown successfully in this small tract. Some with and others without irrigation. With slight protection, bananas grow in this locality. Altitude, 1,200 feet.

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SPECIAL REPORT REGARDING OLIVE INDUSTRY.

Olive culture has already become an important factor in the fruit industry of California. It succeeds in almost every part of the State, especially along the coast, south of San Francisco, and in Southern California.

Ellwood Cooper, of Santa Barbara, has, perhaps, given this industry more attention, with a view to thoroughly utilizing it, than any other person. From him the data here presented are obtained:

The common and preferred method is to plant the cuttings, taken from growing trees of sound wood, from three quarters of an inch in diameter to 1½ inches, and from 14 to 16 inches long. These cuttings should be taken from the trees during the months of December and January, neatly trimmed without bruising, and carefully trenched in loose, sandy soil. A shady place preferred. They should be planted in permanent sites from February 20 to March 20, depending upon the season. The ground should be well prepared and sufficiently dry, so that there is no mud, and the weather warm. In Santa Barbara, near the coast, no irrigation is necessary; but very frequent stirring of the top soil with a hoe, or iron rake, for a considerable distance around the cuttings, is necessary during the spring and summer. About three-fourths of all that are well planted will grow. My plan is to set them 20 feet apart each way, and place them in the ground butt-end down, and at an angle of about 45°, the top to the north, barely covered. Mark the place with a stake. By planting them obliquely, the bottom end will be from 10 inches to 1 foot below the surface.

All trees, as a rule, should be propagated from seeds. The roots are more symmetrical, the tree not so liable to be blown over, and the growth more healthful; but I have not been successful in germinating them, hence I recommend the cutting. If the trees are propagated from seeds, budding or grafting is necessary.

#### FRUIT BEARING.

Trees grown from cuttings will produce fruit the fourth year, and sometimes, under the most favorable circumstances, will give a few berries the third year. It is the habit of the tree to overbear, and as a consequence it will give but little fruit the year following a heavy crop. This statement is verified by the most reliable books published on the subject in the French, Italian, and Spanish languages. There are, however, exceptions to this rule in California. Mr. Davis, who had charge of the San Diego Mission orchard, in 1875, assured me that he gathered from the same tree, two years in succession, over 150 gallons of berries. I have also observed that some trees in my orchards have borne well in successive years. The fruit bearing can be controlled by the pruning. The cultivator will not forget that the shoots or branches must be two years old before they will give fruit, hence partial pruning every year will give partial crops. My oldest orchard was planted February 21, 1872. At four years I gathered from some of the trees over two gallons of berries; in 1878, over 30 gallons each off a few of the best trees, the orchard then being only six years old. In 1879, the seventh year, the crop was not nearly so large. I had planted several thousand cuttings in the spring of 1873, but these trees did not give, at six years, a result equal to the first planting. The present crop is quite good, the oldest orchard now being eight years, and I think I do not overestimate when I state that the yield of some of the best and fullest trees will be over 40 gallons. Trees large enough to give this quantity of fruit, planted at a distance of 20 feet, will occupy nearly all the ground, and therefore give all the fruit that can be produced on one acre.

An orchard bearing uniformly the quantity as above, would give the following result: One hundred trees to the acre, at 40 gallons each, 4,000 gallons. This would be an enormous crop, unprecedented, and far beyond any statistics given in European publications. The one-fourth of the quantity yearly would be a very profitable crop.

In estimating an orchard, the yield of isolated trees, or trees of great age, occupying considerable areas of ground, must not enter into the basis of calculation of the probable production.

The tree mentioned in the San Diego Mission orchard as yielding 150 gallons of berries was more than 50 feet distant from those surrounding it.

French cultivators give the quantity of oil contained in a given quantity of fruit as one-eighth, and in weight, one-tenth; that is 8 gallons of berries to 1 gallon of oil, and about 50 pounds of berries to 1 gallon of oil.

Olive trees grown from seeds are not removed from the nursery until about seven years old; grown from cuttings, they bear in Europe as early as they do in California.

The newness and richness of our soil will probably give, the first fifty years, double the best results given in those countries where oil-making has been the business for so many generations. Our climate is congenial to the habit of the tree; it blooms from the 1st to the 10th of May, and the fruit forms from the 1st to 10th of June. At this season we have our best weather, free from extremes of either cold or heat. Nowhere in the world are all the conditions so favorable to the perfect fruit bearing.

#### FRUIT PICKING.

The olive usually ripens in November. In some localities in Eastern countries, during favorable years, the fruit picking for oil begins as early as October, and for pickling, in September. In Santa Barbara, the crop of last year (1880), as also that of 1878, was unusually late in ripening, not being ready to pick before the middle of January, a delay of fully two months, the cause no doubt owing to the extraordinary rainfall of these two years. In 1878 we had, after the middle of February, and up to the middle of April, a rainfall of over 14 inches, and in 1880 over 18 inches, being more than our yearly average.

The fruit should be gathered as soon as it turns purple, and before fully ripe, as the oil will be lighter in color and more fragrant, but somewhat less in quantity.

In Europe the common method of gathering the berries is to knock them from the trees with poles: they are then picked from the ground by old men, women, children, and cripples. This plan has serious objections, the fruit being more or less bruised, causing decomposition, and the contact with the earth is liable to give the oil an unpleasant taste and odor. The more economical plan of gathering is to pick from the trees by hand, and by the aid of intelligent contrivances an active man can pick 400 pounds each day.

I have arranged on a ranch wagon, platforms, with ladders securely fastened, so that the fruit from the different heights of even large trees can be gathered from the

wagon, which is driven along the rows and one-half of the trees picked from each side. This plan obviates the necessity of moving ladders, climbing, &c., and relieves the pickers from the labor of carrying the fruit, as the sacks containing the same are always at hand on the platform. The leaves and imperfect berries are separated by passing the whole through a winnowing mill. This process leaves the fruit in the best possible condition, preparatory to manufacturing the oil.

#### MAKING OIL.

The berries are dried before crushing, as it is necessary to evaporate a portion of the water. If, however, they are left on the trees until shriveled, which is a proof that necessary evaporation has already taken place, no drying is needed after picking. This late picking is not best, as mentioned in a previous article. If dried by the sun, it requires about fourteen days. This plan cannot be depended upon in Santa Barbara, excepting in years when the fruit is early ripe and we have continuous sunlight, with moderately warm weather. By artificial heat, ranging from  $110^{\circ}$  to  $130^{\circ}$ , the drying can be done in less than forty-eight hours. The crushing and pressing should follow without delay; that is, the fruit taken from the drier in the morning should be cracked and pressed the same day. Long intervals or delays in the process from picking the fruit to expressing the oil tend to rancidity. To make perfect oil requires a perfect system in the whole management.

The capacity of the press, the crusher, the drier, and the number of pickers should correspond or be about equal; all fruit picked during the day should be in at night, cleaned the following morning, and go into the drier immediately after the previous day's drying is taken out. The heat or temperature of the drier ought to be so graded as to complete the work in forty-eight hours, and it is better that it should be under  $130^{\circ}$  rather than above.

The almost universal method of crushing the berries is by a heavy stone, similar to a millstone, which is rolled round on the edge in a deep circular groove or trough, and by its weight does the crushing. A beam passing through the eye of the stone, and working on a journal in the center of the circle, with a horse attached to the outer end of the beam, is the simplest way to do the work, and the plan that I have adopted.

The circumference of the trough depends somewhat on the size of the stone. The one I am using is 4 feet high, 6 inches thick, and the diameter of the trough in which it works, 6 feet; the length of the beam 15 feet. This crusher is amply sufficient for an orchard of one thousand trees, but too small for my purpose. It cost about \$50.

A stone 5 feet in diameter and 2 feet thick would crush in eight hours a sufficient quantity of berries to make 100 gallons of oil, and by working it night and day, the crop of ten thousand trees. It would be better, however, to have two stones half the thickness of the above, one following the other in the same groove. The horse should work on the outside of the building containing the crusher.

To make 100 gallons of oil each day would require two good presses. The one best adapted for the purpose, so far as I have seen, is that used for making oleomargarine. Such presses could, with very little expense, be worked by the horse-power used for crushing the berries, so that one man could do all the crushing and pressing.

The press I am using is an old-fashioned wooden beam press, such as used in the New England and Middle States for making cider.

The beam is 26 feet long, and, with a heavy box filled with rock suspended at the extreme end, the power can be increased to 150 tons. The press with the differential pulleys cost about \$150. Such a press cannot be improved upon for expressing the oil, but the additional labor, and the time lost in changing, is so much greater than what would be required for the oleomargarine invention, that the latter would facilitate the work and be cheaper in the end, besides taking up so much less room.

The crushed olives are put in the press in cheeses about 3 feet square, and 3 inches thick, with wooden slats between each cheese. Ten or more cheeses can be put in at each pressing. I use coarse linen cloth to contain the crushed olives.

The fluid that is expressed is put in large tanks, and left from sixty to ninety days, when the oil will separate, and being lighter will rise to the top, where it can be drawn off. The pomace after the first pressing is re-crushed, and by pouring hot water over it a second quality of oil is expressed. The refuse can then be used either for fuel, for feed for pigs, or for making, still, a third quality of oil; if for the latter, it is thrown in vats, boiling water poured over it, and left to ferment, when the oil still remaining will be liberated and rise to the top.

#### FILTERING OR CLARIFYING.

This is a very simple process. The most common method is to have a series of five or six boxes, one above the other, each with cotton batting in the bottom; the oil passing the sixth will be beautifully clear, and ready for market. I use cylindrical tin vessels holding about three gallons each, one fitting in the other in tiers of three, with fine wire sieves in the bottom of each. On these sieves I place two or three layers of

cotton batting. The oil is passed from one tier to the other until clear. The clarifying can be done by the sunlight; also it can be bleached and made much lighter in color, but not without injuring it. When it is adulterated, artificial heat is necessary in the process. When once heated it loses a part of the nutty flavor, and is liable to become rancid when exposed to the air. It should be kept in an ordinarily cool place, not exposed to the sunlight or heat, neither should it be handled any more than is absolutely necessary in the filtering and bottling, and should not be shaken after bottled. The mucilage contained in the oil will not separate for a long time after the oil is ready for use, and, as it does not injure it, is not, therefore, objectionable. It will sometimes form in the bottles like globules of water, or in films, settling to the bottom as sediment, and when shaken will give it a muddy appearance, which, with the common prejudice against all table oils that are not perfectly clear, renders it unsalable, as consumers consult more the eye than the taste. The oil is better when new and fresh, and what is gained in the appearance by its remaining a longer time in the tank is more than lost in its freshness and delicacy of flavor.

To sum up the cost of the machinery in the making of the oil, we have as follows: Drier, \$150; mill, \$250; two presses, \$500; two tanks, \$200; filterers, \$50; corker, tin-foiler, \$50; wooden building, \$400. Total, \$1,600.

### SPECIAL REPORT ON CULTURE OF ENGLISH WALNUTS.

The cultivation of English walnuts in California has become of sufficient importance to warrant a brief chapter in this report. Finding it favorably grown at many points visited by the commission, and being advised that Mr. Russell Heath, of Carpinteria, Santa Barbara County, had been longer engaged in the industry, and was likely to be more experienced than any other cultivator in the State, from him the following detailed data were obtained.

We premise that other experimenters agree with Mr. Heath in the belief that all early plantings of this tree were made too close at the Wolfkill orchard, near Los Angeles; many inner trees were dying out, apparently from being too much crowded, the distance being 20 by 20 feet.

You are doubtless aware that the nut commonly called English walnut, or Madeira nut, is in reality the Persian nut. In Spain it is called "the nut"; in France, the same; in the island of Madeira, where it was first planted, the Madeira nut, &c.

Upon examination I find that in Persia it comes in bearing the eighth year from seed. In Spain and the south of France in about fifteen years. In England in about twenty. The climate of Santa Barbara is as near the climate of Persia, where it grows to perfection, as perhaps any place on this continent. Here the trees come in bearing the eighth year from seed.

The mode of planting in this State is to prepare the land same as for any nursery. The nuts are placed in rows, about 5 inches apart, and covered with 2 inches of earth. If the weather is warm the nuts sprout in ten or twelve days.

With regard to length of time to leave trees in nursery there is difference of opinion. I have changed my views after years of experience.

At present I leave trees in the nursery rows until they have attained the age of bearing; say, the eighth or ninth year. I have been led to this course for the following reasons:

If the tree is removed when one year old it is so small (3 or 4 inches high) that too much care is required in cultivation, and no advantage gained over transplanting older and larger trees. If transplanted at two years you would lose the two years in the nursery, because the tree will not produce fruit until in orchard full eight years.

If transplanted when three, four, or five years old, the tree ought to bear its first fruits in five years; or, in other words, you would gain nothing but size by selecting the four or five year old trees over the three-year old.

Trees should never be taken from the nursery when six years old, as at the sixth year the tendency is to top and not to root.

When trees are taken when eight or nine years old the top is pruned close, cutting back to about 9 feet. The side branches should be cut back to two or three buds from the body. Such trees will ordinarily bear the third year after transplanting, or as soon as the head has time to develop itself. You see it is the saving of time from transplanting to bearing that I have been after.

The time of coming into bearing is based upon our climate of Southern California. In most favorable localities in the States, west or north (east of the Rocky Mountains)

I do not think they would produce under fifteen or twenty years from seed. How much they would be retarded if taken from the nursery at eight or nine years, from this State to the east, I am not prepared to say.

My first orchard was planted 30 feet each way. Have since planted at different distances, and think the best about 40 feet each way.

You ask me how many bushels a tree will bear at what may be called maturity. I have never seen a tree at such an age. I am informed, in Spain and South of France there are trees believed to be over three hundred years old, which bear 15 to 15 bushels each. On some of my twenty-year old trees, I had 3 bushels each. These trees come gradually into bearing; the first year seldom exceeding four or five nuts; the second year, from 2 to 5 pounds; the third year I have had trees produce 40 pounds. But such are exceptional. I should say from 10 to 15 pounds a good yield. Nuts, with us, commence ripening about the last of September. My process of gathering is to start my men after the nuts have commenced to fall, slightly jarring each tree that the ripe nuts still on the tree may fall, picking in baskets, then taking to the drying house. We take the orchard row by row. Usually, with a good gang of hands, ten or twelve days are required to go through the orchard once. As soon as the first round is finished the second is commenced. In four or five rounds we usually gather the crop.

At the drying house they are subjected to a heat of about 200° for six or seven hours, the nuts not being removed until they are thoroughly cured, when they will keep for years, without becoming sour or rancid, in an ordinarily dry place. This mode of curing does not injure them for use as seed. They are then ready for market. There is a pernicious practice, often resorted to, of bleaching nuts with sulphur, to make them appear a light color. Some customers demand this; but sulphurizing should not be indulged in if a good wholesome nut is desired. I never bleach except at the particular request of customers. I think it materially injures the flavor, and only gives an unnatural color. My market has usually been the States west of the Rocky Mountains, although some shipments have been made to Chicago, Boston, and New York with good results. Prices range from 10 to 15 cents per pound, according to quality. I have about six thousand trees in orchard, from nine to twenty-one years old. I consider the investment a good one. I do not regret the years and money invested in this industry. True, there are no returns of consequence for a number of years. The tree is of slow growth, and must attain age before producing. From the fourth year the orchard may be said to be paying expenses, and from that time troubles and anxieties need not alarm you. You have something that ordinary drought does not effect. Of pests, I absolutely have none. The trees are healthy and free from disease.

## FRUIT CANNING.

As the mode of utilizing green fruits by canning, jellifying, and desiccating is, comparatively, of recent introduction in California, and forms an important adjunct to fruit growing, efforts were made by the commission to obtain data from a few establishments, situated in various parts of the State, in order that at least an approximate understanding of this industry might be had. To this end the following places were visited, and the extent of operations copied from the books kindly furnished:

J. LUSK, CANNING COMPANY, *Oakland*:

During the working season employed five hundred hands, principally Chinese labor. Experience has demonstrated that no other attainable labor can be relied on in this business. Ship goods to States east, England, and Australia. Eleven-twelfths of product is consumed in the United States. Fruit is put up 2½ pounds to the can; twenty-four cans in each case.

*Put up for 1881 to date of visit, October 17.*

	Cases.
Tomatoes .....	51,000
Apricots .....	10,000
Peaches .....	22,000
Pears .....	17,000
Plums .....	19,000
Strawberries .....	1,750

	Cases.
Blackberries .....	750
Raspberries .....	1,230
Grapes .....	4,903
Asparagus .....	520
Pease .....	12,001
Cherries .....	3,102
Gooseberries .....	823
Currants .....	7,710
Beans .....	1,000
Nectarines .....	800
Quince .....	900
Jellies and jams .....	3,998

Raised their own tomatoes; had 220 acres; paid \$12 to \$20 per acre, land rent; other fruits purchased; paid for apricots  $3\frac{1}{2}$  to  $4\frac{1}{2}$  cents per pound; peaches,  $3\frac{1}{2}$  to 5; pears, 3 to  $3\frac{1}{4}$ ; plums,  $1\frac{1}{2}$  to  $3\frac{1}{2}$ ; strawberries, 5 to 6; blackberries,  $3\frac{1}{2}$ ; raspberries, 6 to 7; grapes, 2 to  $2\frac{1}{2}$ ; asparagus, 2; pease, 2; cherries, 5 to 7; gooseberries, 3; currants, 3; beans, 1 to  $1\frac{1}{2}$ ; nectarines, 4; quinces, 2 to  $2\frac{1}{2}$ .

Freights from Oakland to Chicago, by rail, \$1.50 per 100.

#### JOSEPH BLACK, *Santa Rosa*:

His first year, as an experiment, to date October 4, had put up—

	Cans.
Peaches .....	43,000
Pears .....	20,000
Blackberries .....	15,000
Plums .....	25,000
Tomatoes .....	4,000
Corn .....	25,000

#### Evaporated.

	Tons.
Peaches .....	15
Plums .....	5
Apples .....	10

Average prices about same as paid by the Lusk Company; some little variations; all shipped to San Francisco.

#### SAN JOSÉ PACKING COMPANY, *San José*:

To date October 11, had put up—

	Cans.
Tomatoes .....	400,000
Peaches .....	100,000
Apricots .....	150,000
Bartlett pears .....	150,000
Plums .....	150,000
Cherries .....	50,000
Blackberries .....	50,000
Currants, raspberries, and strawberries, each .....	20,000
	Tons.
Muscat grapes .....	30
Honey .....	100

Prices paid for green fruits range a shade higher than that of the Oakland house. Market, principally in cities east, largely Chicago and Denver; foreign trade—London and Australia—increasing; working season, May to October; use both American (female) and Chinese labor; “don’t blush to employ Chinese labor,” it being the most reliable; pay women and unskilled Chinamen \$1 per day, best skilled Chinamen, \$2 per day; Chinamen make cans and superintend cooking.

PACIFIC PACKING COMPANY, Colton (*San Bernardino and Riverside  
R. R. Station*):

To date September 17, had put up—

	Cases.
Apricots .....	100,000
Peaches .....	150,000
Pears .....	10,000
Nectarines .....	10,000
Tomatoes .....	20,000
	Tons.
Dried fruits .....	10
Honey .....	200
Beeswax .....	2

This is a branch of the San José house. Prices and other incidentals same; about as at parent house. There are a number of other packing houses in the State—at San Francisco, Los Angeles, Sacramento, Santa Barbara, Gilroy, Napa, and other points. The above four, representing different sections, will suffice for the purposes of this report.

The total shipment of canned fruits from California, to September 1, 1881, were 283,940 cases over 253,354 in 1880; showing an increase in one year of 30,586 cases. Besides shipments to the Eastern States, these goods go to China, Japan, Sandwich Islands, Mexico, Southern and Central America, Siberia, Sumatra, Java, and India.

Varieties of peaches most desired for canning, and bringing the better prices in the order named, Crawford's Early and Late, Heath, and Lemon Cling.

## NOTES OF EXOTIC FRUITS AND USEFUL PLANTS

ON TRIAL IN THE GARDEN OF ECONOMIC PLANTS, AGRICULTURAL  
COLLEGE OF THE UNIVERSITY OF CALIFORNIA.

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BY E. W. HILGARD.

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The subjoined data regarding some fruit-bearing and other economically useful plants that have been on trial for some years in the grounds of the University of California are mainly drawn from reports made on the subject by Mr. W. G. Klee, gardener in charge.

### THE DATE PALM (*Phoenix dactylifera*).

This, even as a young seedling, is perfectly hardy here; but, as most palms, a very slow grower the first years. This wonderful tree seems to have found another home on the Pacific slope, where the conditions of climate resemble most closely that of its Asiatic home, viz., dry heat and absence of rain during its fruiting season. Dates have been fruited in California all the way from the bay region to San Diego; but all having been grown from seed, the fruit has almost throughout been of very inferior quality. Yet well-tasting dates have been produced, as, *e. g.*, last year, 1881, in Solano County; sufficient to prove that this tree of the desert is adapted to this climate. It is very desirable that sprouts of valuable varieties should be introduced from the Old World for propagation here, the more as such trees thus grown bloom in one-third of the time required for seedlings. (See, also, remarks on "Timber Trees," above.) Excellent dates, however, are produced at several points in the peninsula of Lower California, whence they are regularly supplied to the market of Guaymas.

### THE CAROB TREE (*Ceratonia siliqua*).

This seems quite hardy in this region, as young seedlings resisted the frost of 1879. It is, however, a very slow grower the first season, until it becomes thoroughly established, after which it is comparatively rapid. A young tree with the best of care, has only made about 10 inches of growth during the whole season. In subsequent seasons the growth is quite rapid, shoots of 18 to 24 inches being made at the ends of the branches during the growing season. It has withstood without injury a temperature of 25° Fahr. In some localities it has been severely affected by the white scale (*Aspidiotus nerii*), which also infests acacias, oleander, pomentaceous trees, &c.

### THE CAPER BUSH (*Capparis spinosa*).

Seed of this shrub was procured from New York, but only two plants were raised from this; they were, however, increased by cuttings that

grew quicker than the seedlings. In the garden this has been of very slow growth. Early frosts this season (1881-'82) have killed all the young wood, but the plants will no doubt recover. It will doubtless be found hardy in all ordinary seasons in the Los Angeles region.

#### ZIZYPHUS VULGARIS AND JUJUBA.

Two species, furnishing the jujube paste, are both growing luxuriantly here. The first has fruited in Sonoma, but has not answered expectations. The latter may probably be superior. The leaves and young wood are killed here every winter.

#### CUSTARD APPLE (*Anona Cherimolia*).

This delicious fruit belongs really to the tropics, but may possibly find sheltered localities where it will do well. It is quite a rapid grower, making shoots 2 to 3 feet in a season outdoors, and twice that in the greenhouse. It is raised easily from seeds, but seems to be difficult to propagate from cuttings. It requires at least partial protection in winter here, but ought to be hardy farther south.

#### THE SOUR SOP (*Anona muricata*).

There is still less probability of rearing this tropical fruit out doors. Two plants set out in the garden at the same time as the *Cherimolia* died very soon after, and it has never made much growth even in the warmest place in the greenhouse.

#### ANONA, OR ASIMINA TRILOBA.

The Papaw of the Eastern States, and the representative of the custard apple there, has shown itself rather delicate in transplanting, but some plants have done comparatively well, and have reached about the height of two feet in three seasons.

The Calabash Tree (*Crescentia cujute*) has been fruited in Solano County.

#### THE TAMARIND (*Tamarindus indica*).

This tree seems very slow here. It has never progressed outdoors, and seems almost equally slow indoors.

#### THE JAPANESE PERSIMMON (*Diospyros kaki*).

This fruit, which seems destined to become of considerable importance to California, has ripened fruit in Berkeley, but of small size compared with specimens from Japan, and rather astringent. The variety, however, is doubtless of inferior quality, having been introduced three or four years ago, when the great difference of the varieties was not so well known. There is now on hand an assortment of twenty of the best varieties.

The persimmon is of moderate growth here, and the failure of a good many people, especially in this neighborhood, to make their trees grow, is probably only due to an omission to get their soil deeply worked, as the tap-root of persimmon is evidently intended to penetrate very deeply into the ground. The earth in the holes ought to be loosened two or three feet deep. Small consignments of the fruit, of excellent

quality and large size, have been received at San Francisco from the southern part of the State for two years past.

*Diospyros lotus*, of Southern Europe, is a rapid grower here, and a promising stock for grafting the Japanese persimmon. It has a tendency to continue in growth late in the season, so as to be caught by early frosts.

#### PERSEA GRATISSIMA.

The Aguacate (commonly mispronounced Alligator) pear of Central America has resisted surprisingly the severe weather of the present winter (26° F.), only the tenderest shoots at the ends of the branches being hurt. It is a rapid grower, and may prove valuable in the southern part of the State.

The pear-shaped "Guava" (*Psidium pyrifera*) has been cut down by the frosts of the last three years; hence must be considered a failure in the bay region. Favorable reports, however, have come from the southern part of the State, where it has been fruited. *Psidium cattleianum*, the Strawberry Guava, is, nevertheless, perfectly hardy with us, and promises well from here southward.

Excellent samples of ripe yellow guavas have been brought from Santa Barbara, and the same, as well as other varieties, have been grown near Los Angeles; but thus far no market has been found for the fruit, and not enough has been grown to encourage the manufacture of jellies.

#### MACADAMIA TERNATA.

This is a Queensland tree that produces a very finely-flavored nut. It is a near relation of the *Grevillia robusta*, known as Australian Fern Tree—a very ornamental tree of our gardens—but its leaf resembles more a holly. This tree is, doubtless, also perfectly hardy, but it is a slow grower during its first years. It was grown from seeds.

The *Japanese Chestnut* seems to excel even the largest Italian in size and flavor. It is easily grown from seeds, growing a couple of feet the first season. It is of slender habit, and is disposed to sucker; would seem to be adapted to the formation of hedges here. It is said to bear well already the fifth year.

#### CARICA PAPAYA (*the Melon Tree or Papaw of the Antilles*).

This tree grew well out of doors during the last summer, but succumbed to a frost of 28° F.: with some protection it would probably resist, as does its relative, the *Vasconcella hastata*, which, though a native of the West Indies, and apparently more soft and spongy in its stem than the "Carica," only suffered slightly at a temperature of 25° F. *Berberis heterophylla*, the edible barbery of Turkestan, is a hardy, deciduous shrub of rapid growth.

#### THE JAPAN VEGETABLE WAX (*Rhus succedanea*).

A Japanese tree belonging to the sumac tribe. Yields from the coating of the seed a substance similar to beeswax. The tree has been found to be a free grower here, making shoots several feet in length during the season, and is quite ornamental, resembling the Staghorn Sumac. *Rhus vernicifera* yields the genuine Japan varnish. It is a tree of similar habit as the Vegetable Wax. It has, though planted late, made a very fine growth. Both are deciduous and perfectly hardy.

## THE CINCHONAS.

Strong hopes have been entertained that some species at least of these valuable trees would succeed in California; and so far as the hardiest, which it has not yet been possible to obtain for trial, this hope may still be indulged. In 1879 a lot of seeds grown in India, and embracing the species and varieties *C. Condaminea*, *Calisaya*, *Succirubra officinalis*, and a *Hybrid*, were obtained through the courtesy of Sir Wm. Robinson, ex-lieutenant governor of Madras. In accordance with the suggestion of the donor, the seeds were at first sown in boxes kept at 75° with bottom heat; in these the *Calisaya* and the *Hybrid* sprouted in three weeks, whereas the others remained dormant for five months. They were then removed to a cold frame with a temperature of from 55° to 60°, where quite a number germinated.

Afterwards sowings were made in cold frames and good results obtained. A large number of seedlings were lost by damping off, probably under the influence of a somewhat objectionable spring water used in watering; and even well-grown plants showed a somewhat inexplicable tendency to sicken and lose their leaves when kept in the house continuously for a length of time. A number of each kind were set out in the open ground in the "Garden of Economic Plants"; the general result being that especially the *Calisaya* and *Succirubra* did well and grew rapidly, some reaching the height of 3 feet. Then came a season of violent, dry northers, which injured especially the large leaves of the *Calisaya*. The latter and the *Succirubra* survived the winter of 1880-'81 with a little protection, the tender ends only being killed, while the others were killed down to the ground, but being promptly cut off sprouted again in spring. The low temperature of the present winter (1881-'82), however, has finally killed all to the ground; and it must be admitted that where winter temperatures as low as 25° are likely to occur, these cinchonas cannot succeed. This, unfortunately, may happen even as far south as San Diego at long intervals, as was shown this season. The cinchona plants distributed last season to the southward have not as yet been heard from as to their resistance, but there is little reason to hope that they have survived the unusually severe winter, unless, perhaps, on Santa Rosa Island. There yet remains one species, said to be hardiest of all, viz., the *Cinchona pitayensis*, of which no seeds have thus far been obtainable. It would be very desirable to determine whether this specie will resist our winters, for it has somewhat unexpectedly been shown that the cinchonas do not require a very large amount of moisture at the roots, at least, as they have remained unirrigated for three months at Berkeley, and were injured only under the influence of a very severe "norther," but even then not materially.

## TEA PLANT.

The Tea Plant seems to be a complete failure all along the coast, but reasonably good results have been reported from the foot hills of the Sierra. Tea plants are unthrifty even in the propagating houses, and in private grounds under the best of care. They have almost invariably died out after a year or two of precarious existence. Of over a thousand healthy plants set out by Mr. Wm. Hollister, at Santa Barbara, but a few dozen were alive in 1880, and these very weakly. It seems improbable that practical success can be looked for anywhere in California in the cultivation of teas.

The hardier kinds of coffee seem to survive the ordinary winters of

South California, but any unusual cold is fatal to them. The limit of their existence is too nearly reached to render their culture at all promising, even in Southern California.

It is desirable that the culture of the *Mate* (*Ilex paraguayensis*) should be tried in California. Our efforts to procure its seed have thus far failed. The coca tree (*Erythroxylon coca*), whose leaves are now in demand for medicinal use, is very likely to be found hardy, both as regards drought and cold, in Southern California.

#### PLANTS WORTH TRYING IN CALIFORNIA.

[Report to the State Horticultural Society on Baron V. Müeller's "Select Extra-Tropical Plants," eligible for industrial culture or acclimatization, &c., with additions and comments by Herman Behr, M. D., and W. G. Klee.]

In submitting this report to the members of the society, we desire to state that neither our time nor opportunity have allowed us to investigate the matter as thoroughly as we might have wished to do; especially should we have liked to gather information relating to various plants which, there is reason to believe, have already been introduced into some part or another of this large State.

We concluded, however, that we probably would do the society and horticulturists at large greater service by offering the report, such as it is. We cherish the sincere hope that by doing so now the attention of horticulturists will be called to the desirability of co-operation, and mutual benefit result from interchange of experiences which should be the aim of the horticultural society. For, if persons who, perhaps, have tried one or several of the plants named, would communicate with us, stating their experience, some most valuable and more definite information might be gathered and published before the season for sending for seeds or plants. In regard to the arrangement of the plants enumerated, we have chosen to divide them according to their uses rather than to take them alphabetically, irrespective of qualities. We have commenced with the largest division, the plants yielding edible fruits, tubers, &c., and propose to give at an early date, in their order, medicinal plants, plants of technical value, shade and timber trees, trees and shrubs adapted for tide lands and alkali lands, forage plants, and, lastly, ornamental trees, shrubs, &c.

#### I. PLANTS YIELDING EDIBLE FRUITS, TUBERS, ETC.

*Arracacha Xanthoriza* (*Umbelliferae*).—Parsley family. Mountains of Central America, also Peru. The tubers of this plant are eaten. It would probably be hardy.

*Averrhoa Carambola* (*Oralideae*).—A native of the Himalaya Mountains. This is a small tree that is cultivated in the Orient for its fruit, which has a pleasant, currant-like taste. There occurs a sweet and acid variety.

*Argania Sideroxylon*.—The Argan tree, or iron wood of Western Barbary (*bumeliaceae*). The seed of this tree furnishes an oil, and the fruit is also used for cattle feed, while the wood is very hard, suggesting its name. The tree is on trial in the Garden of Economic Plants, at the State University. It may be propagated readily from cuttings, which has been done here.

*Aralia cordata* (*Araliaceae*) *China*.—The young shoots of this plant are used as asparagus. This plant is on trial at the Garden of Economic Plants, in Berkeley, where it seems to flourish; it is perennial, resembling the wild California species in habit.

*Adenostemon* (*Prunus nitidum* (*Laurineae*)).—South Chili; a laurel-like evergreen tree, with an edible fruit. Guelue, Nuble, and Aracua are in Chili various names for it.

*Brabejum stellatifolium* (*Proteaceae*).—South Africa, a beautiful evergreen tree, with an edible fruit, which, however is poisonous in a raw state. Seeds were donated to the university by B. Ferd. von Mueller, but failed to germinate.

*Benincasa cerifera* (*Cucubitaceae*).—Cucumber family. The fruit of this gourd yields a kind of cunic. Seeds of this are advertised for sale in James Thorborn's catalogue, of New York.

*Cajanus Indicus*.—Known as the Congo pea or catjang (a very desirable bean); deserves trial.

*Capparis spinosa* (*Capparidæ*).—The caper bush. The flower buds of this plant yield the caper of commerce. The shrub is on trial at the Garden of Economic Plants, at Berkeley, where it stood the test of last season well, but seems to be of very slow growth.

*Carum bulbocastanum*.—The tubers of this umbellifer are used as food under the name of earth chestnut. There is no reason why it should not succeed here.

*Chaerophyllum bulbosum*.—The parsnip chervil is a good addition to the kitchen garden, if not already introduced.

*Colocasia Antiquarum*.—This plant is well known as an ornamental foliage plant.

The variety "edulis" is the taro of the Polynesian Islands or tanya of the Southern States; it is cultivated for its tubers in almost all tropical countries.

It has stood the winter in the open air at Berkeley, and is now, in April, green, with large leaves. We believe that the cultivation of this productive plant has been tried with success in Alameda County.

*Corylus Columa*.—The Constantinople nut tree bears a well-flavored hazel-nut, and reaches a height of 60 feet, and is, on the whole, well worth introduction, as is also the Japanese hazel nut.

*Corylus heterophylla*.—*Diospyros lotus*, the Italian persimmon (*Ebenaceæ*), and *Diospyros virginiana* are both being tried in various parts of the State. We have found the latter (the American persimmon) to be of very slow growth here in Berkeley.

*Pueraria tuberosa*.—From South Asia, is a tall, woody climber, belonging to the pea family (*Leguminosæ*), the tubers of which are long, and rich in starch; it is perhaps the same species as *P. Sieboldii*, that in Japan furnishes a superior starch. This plant has been tried with success in the Garden of Economic Plants, in Berkeley, where it grows without irrigation, sending out vines 12 to 15 feet long in a few months.

*Soja hispida*.—The Soja bean of Japan and China. The catalogues of France and Germany are making considerable comment on this bean as something very desirable, the most nutritious bean, &c. It is said to yield well and succeed in North Germany. Seed of this bean received from San Francisco Bulletin resembles closely a bean introduced some two years ago from China and tried in the Garden of Economic Plants, in Berkeley; if the same, it is not to be relied upon as a sure crop in this locality, but indications are that it would yield a large crop in a little warmer locality.

*Guevina Avellana*, or *Quadria heterophylla*; *Proteaceæ*.—Ferd. von Mueller refers to this tree as one of the most beautiful in existence, and no one will deny this when he sees the tree, even without flowers. The pinnate large evergreen leaves are of a dark-green, glossy color, shining from afar, and the young purplish buds are clothed with a thick down; add to this snow-white flowers of the delicate structure peculiar to *Proteaceæ* hanging in profusion all over the tree, and you have a sight not easily forgotten. Besides its beauty, this tree is very useful; its fruit has an agreeable, nut-like taste, but is, like the Brabejum, poisonous in a raw state, and has given the tree the name of the Chilian nut tree. It has proved perfectly hardy in Berkeley, and of comparatively rapid growth when established. Though most easily propagated from seeds, this tree can also be propagated by cuttings, as has been done at the Garden of Economic Plants, in Berkeley.

*Maranta arundinacea*.—Is the true arrowroot of commerce. The culture of this plant is comparatively easy. It has, as far as we are aware, been cultivated with success in Fresno County.

*Dioscorea, yam*.—*Dioscorea hastifolia* is native of Western Australia; is recommended as very hardy. *D. japonica*, the Japanese, and *D. glabra* (*Batatas*) deserve trial. The latter has lately been distributed by the San Francisco Bulletin. *Dioscorea alata*, the Uvi yam, is a species that hails from the South Sea Islands, but has been grown successfully in New Zealand, and would most likely flourish in parts of California, where too early night frosts do not occur.

*Hovenia dulcis*, *Rhamnaceæ*.—Originally from India, but introduced to China and Japan, where it is cultivated for its fruit. It is a pretty deciduous tree, with a large linden-like leaf, and of comparatively rapid growth. This tree is also on trial at the Garden of Economic Plants, in Berkeley.

*Juglans Sieboldiana*.—A Japanese walnut, known in California as the Towerhouse walnut, being grown first by a Mr. Towerhouse, of Shasta County. It is a valuable addition to the nut trees, and deserves to be better known. *Juglans cordiformis* is a nearly allied species, probably also worth a trial.

*Macadamia ternata*.—The Queensland nut tree (*Proteaceæ*). Is a beautiful evergreen tree, producing a good size nut of a highly pleasant taste. This tree is easily raised from seed; is perfectly hardy in the milder coast climate. It is here in Berkeley a little slow, as is most of its relations, the first two or three years. As a number of seeds were imported last year, we will no doubt hear from various parts of California in regard to its adaptability.

*Maclura Mora*, a near relation to the Osage orange. Is a native of North Argentina; therefore probably hardy; the wood of this tall tree is valued for its toughness, while its fruit is edible.

*Mangifera Indica*, the mango.—This much-esteemed tropical fruit has, perhaps, been tried in California already; if not, it deserves it, for it is in many instances very hard to predict the adaptability of a tree. We know of more than one tropical tree that has proved hardy in spite of probabilities.

*Marlieria glomerata* (*Myrtuceæ*).—The *Cambuco* of the sub-tropical Brazil, deserves trial as the fruit is large and wholesome.

*Marlieria tomentosa*.—The Guaparanga, bears sweet fruit that are the size of cherries. Is found in the same region, and very likely also hardy.

*Melocanna bambusoides*.—The berry-bearing bamboo from Chittagong (India). This

bamboo deserves introduction and trial perhaps more than any other. It is of large growth (70 feet high), erect, and bears a fruit the size of an apple, the seeds of which are said to be very palatable. Combining this good quality with the usefulness of bamboos, it recommends itself specially, as it is said to grow on dry slopes of hills.

*Moringa pterygosperma* (*Leguminosæ*).—The horseradish-tree of India. Edible pods, with only almond-like seeds, from which a valuable oil, used by watchmakers, is pressed. The tree occurs in the mountains, and has been transplanted to various countries. In India there is a prevailing belief that this tree is a protection from lightning.

*Morus Nigra*.—The black mulberry and its improved varieties deserve planting more along the coast. It succeeds well with mild summer temperature and foggy damp weather. We are aware of a very old tree that for centuries has borne fruit on one of the smallest islands in the Danish waters. Though the weather here is often extremely rough and the soil very sandy and poor, the tree continues to flourish.

*Nephelium Let-chi* (*Sapindacææ*).—The fruit of this tree is the Lit-chi of the Chinese, well known as the Chinese nut. The tree would doubtless be hardy here; care, however, must be taken to procure fruits that have not been prepared for the market, as they have been heated to such a degree as to destroy the germinating power of the seed.

*Nephelium lappaceum*.—The Rambutan or Rambostan of India, is an Indian tree belonging to the same genus. It produces a similar fruit to the Let-chi. There is reason to believe that this tree would be hardy in sheltered localities.

*Parinarium Nonda* (*Chrysoalaneæ*).—The Nonda tree of North Australia, might perhaps be utilized in the more arid southern part of the State, where its plum-like but mealy fruit would be appreciated.

*Persea gratissima*.—The *Agual cate* of the Mexicans, or, as it is also called, the Alligator pear. This laurineous tree, so well known, from the tropics, will bear the open air with slight protection, in the locality of Berkeley, and should be tried more extensively. It is readily raised from seed.

*Peumus boldus* (*Laurineæ*).—The Boldo of Chile, undoubtedly introduced and distributed by the San Francisco Bulletin. Plants raised from this seed are yet too small to be judged. The wood of this tree is the most valuable part of the tree, but the fruits are also sweet and edible.

*Pistacia vera* (*Terebinthaceæ*).—This, the true Pistacia nut, was, as we have lately learned, introduced by Mr. Rixford in Sonoma some years ago. It will probably flourish in the greater part of the State. Seeds have lately been purchased for the Garden of Economic Plants, in Berkeley, and plants will in due time be used for distribution. Good seed can be obtained of Vilmorin, Paris.

*Pyrularia edule* (*Santalacææ*).—From Sikkin, Nepal, and Khasia; is a fine shade tree, the fruit of which is edible.

*Sechium edule* (*the Choco or Chayota*).—An Indian climber, of the cucumber family; has a starchy, edible root, and also good-size fruits, that are eaten. It is said to be very productive; comes to perfection in the warmer parts of the temperate zone.

*Solanum Quitoense*.—If this shrub would be hardy here, what is not unlikely, we would have a fine addition to our solanaceous fruits (tomato, egg plant, &c.). The fruit of this is the size of a small orange, of its color, and also of similar taste.

*Solanum Vesicum* and (*laciniatum*).—Yields the gunjang of the Australian aborigines, also an edible fruit that deserves trial. *S. Laciniatum* is hardy in sheltered localities in Berkeley.

*P. Sterculia Carthageniensis* (*Sterculiaceæ*).—All the sterculias are highly ornamental both for fruit and flowers. This tree produces seed with almond taste. There is also a Chinese species, *St. monosperma*. Both would probably flourish here.

*Telfairia pedata*.—A gigantic climber, belonging to the cucumber family. The flowers are most elegantly fringed, and lilac colored. The large fruit, attaining a size of 60 pounds, is edible in a cooked state, while the seed contains a large quantity of oil. The home of this plant is Mozambique, and it is perhaps doubtful that we could grow the plant, even in sheltered localities, out-doors, but it is certainly worth a trial.

*Terminalia Catappa* (*Combretaceæ*).—In mountain regions of India. Roxburg mentions this tree as the most beautiful, bearing seeds that are wholesome as well as of an agreeable taste. Mueller puts this, as well as the previous one, among the doubtful (hardy); but, as we have mentioned before, the home of a plant is not always a sure guide, only actual trial determining the constitution of a plant. We also recommend this tree.

*Vaccinium macrocarpon*.—Is the well-known cranberry of the Eastern swamps. Of the numerous species mentioned by Mueller, this is no doubt the most important. Though so well known, it is but of late years that cranberry culture has taken any proportion in California. We cannot urge the planting of this little bush too strongly, especially in localities subject to fresh-water inundations and with soil of a porous nature, such as is found on many of the islands of the Sacramento.

*Ximenia Americana* (*Olacineæ*).—This highly ornamental tree is found in many different countries; is also indigenous to Florida. Though the fruit perhaps is more ornamental than pleasant, it deserves trial, as it might be improved.

## II.—MEDICINAL PLANTS.

*Aloe ferox*.—One of the hardier aloes, deserving trial, as it yields one of the best Cape aloes.

*Barosma serratifolia*.—Rutacæ, also native of Cape of Good Hope, is a small bush, yielding the buchu of commerce. Judging from the number of Cape plants succeeding in California, we think it worth a trial, inasmuch as it might prove a very profitable culture.

*Cassia acutifolia*.—The leaflets of this species furnish part of the Alexandria senna. It is a perennial plant, much of the same habit as the Maryland senna, and might easily be protected from frost if not quite hardy. *Cassia fistulosa* is perhaps a hardier species. It is the pods of this that are utilized; besides its usefulness, it would be another very ornamental tree added to our gardens.

*Cinchona Calisaya*.—The source of the yellow or Calisaya bark, and also of part of the crown bark, is found in Peru, New Granada and Bolivia, at an altitude of 5,000 to 6,000 feet. The trees attain a height of 40 feet. There appear to be many varieties of this species; a Santa Fé variety ascends to 10,000 feet elevation. *C. Calisaya* has been and is being tried yet at the experimental gardens of Berkeley. Specimens which escaped the early November frosts at as low a temperature as 28° F. were killed afterward by the moist cold, which never was actually as cold by measurement as previously. Seeds of these were from Indian plantations, where this species thrives, but it would be very desirable to obtain the hardier varieties, as, for instance, the Santa Fé variety.

Vilmorin-Andrieux, of Paris, have seeds for sale of various cinchonas, among them *Calisaya*, var. *anglica*, which is supposed to be from India, and *Calisaya*, var. *Javanica*. The price is very reasonable, 6 francs for 10 grams of good seed.

*Cinchona nitida*.—The source of the gray or Huanaco bark is one of the largest growing of the Peruvian bark trees, reaching under favorable circumstances the height of 80 feet, judging from the locality (high elevation of the Andes in Peru and Ecuador). Von Mueller thinks this species one of the hardiest; we are not aware of this species having been tried in California.

*Cinchona officinalis*.—Andes of Peru and New Granada, at an elevation from 600 to 10,000 feet; yields the brown or crown Peru bark, besides part of Loja bark. This species is averse to a superabundance of moisture, and among its several varieties there will probably be found the hardiest of all cinchonas, the *Crispilla* variety; it is said to endure an occasional frost as low as 27°. The *officinalis*, and what perhaps is the same, *condaminea*, have both been grown from seeds in Berkeley. Like the *Calisaya*, they resisted the early frost of November and lived through the winter by a slight protection, but a decay of the stem set in late in the spring after they had commenced to start, from which they never recovered.

*Cinchona lancifolia*, Weddell.—Considered a variety of *officinalis*; grows in places where the mean annual temperature is that of Rome, with, however, less extremes of heat and cold. Seeds of *lancifolia* may also be obtained of Vilmorin-Andrieux, in Paris. Seeds from this source are now sprouting at propagation houses of the experimental grounds in Berkeley.

*Cinchona pitayensis* is another variety that in Upper India has brought some of the best results. It is a tree 60 feet high. Still another kind, *Cinchona kasskarliana*, may perhaps belong under *officinalis*, though the seeds are very much smaller—at least such is the case with samples of this kind procured from Vilmorin. This species has in Java proved very valuable, and deserves, like the rest, a thorough trial.

*Cinchona succirubra*, from the Middle Andine region of Peru and Ecuador, is a tree attaining a height of 40 feet; the source of red Peruvian bark. This species has in Berkeley borne out its reputation of being one of the hardiest of bark trees, being the only one of four species that has successfully survived the winter by a very slight protection, and it will probably be this kind that will be found to be the most paying here, as it seems to have been in other countries.

*Camphora officinarum*, or *Cinnamomum camphora*, *Laurineæ*.—The camphor laurel of China and Japan is one of the most beautiful of evergreens, the varied-colored hue of the foliage from purple to light green contrasting finely with yellowish branches. Apart from that, it may become of great value as the source of camphor. It should be planted in the garden, park, and promenades as a shade tree of peculiar beauty. It will most probably be found to be perfectly hardy in all the valleys of California, as it has been tried with success in various parts of the State. In Berkeley it has proved a fast grower, and the young foliage would seem even to be untouched by severe frosts. It is, on the whole, a tree that cannot be recommended too highly.

*Colchicum officinale*.—In the northern part of this State, where moist meadows occur,

this pretty perennial herb would flourish, and might be sold with profit to the drug stores.

*Dorema ammoniacum*; *Umbellifereæ*.—Is a tall perennial herb that yields a gum resin. Is a native of the mountains of Persia, and would be likely to flourish in the greater part of the State.

*Ecbalium elaterium*.—The squirting cucumber; *Cucurbitaceæ*; yields a powerful purgative. Being a native of a similar climatic region, the Mediterranean, it is apt to succeed in California.

*Eryngium sumbel*.—An umbelliferous herb from Central Asia; recommended as a remedy for various diseases. As far as hardiness goes, this plant must certainly be adapted to the climate. Seed is advertised for sale at Haage & Schmidt's, Erfurt, Germany.

*Ferula galbanifera*.—Another umbelliferous plant to be recommended for mountainous regions. It is a perennial, yielding the gum resin galbanum.

*Fraxinus ornus*.—The manna ash. Though this tree, known as the flowering ash, is cultivated in California, it ought to be planted more on the streets and in parks, being very ornamental, as well as the source of the medicinal manna.

*Gelsemium nitidum*, *Loganiaceæ*.—Is the false yellow jessamine of the Southern States, a climber of considerable importance in medicine. It will most likely succeed in California.

*Brayera anthelmintica* or *Hagenia abyssinica*.—The kusso is a tall, handsome tree, belonging to the rose family, and a near relation of our mountain mahogany (*Cercocarpus*). As the specific remedy for tape-worm this plant is of great importance, and being a native of the higher elevations of the Abyssinian mountains, is likely to flourish in the greater part of Central and Southern California.

*Helleborus niger*, *Liliaceæ*.—The Christmas rose, or black Hellebore, so well known on account of its time of flowering in midwinter, even in cold climates. It is perfectly well adapted to the cooler regions of the State. It is the root that is used medicinally.

*Hydrastis canadensis*, *Ranunculaceæ*.—The yellow puccoon, utilized in medicine, as well as for coloring, and would most likely thrive in the moist coast counties.

*Ilex Paraguayensis*.—The Paraguay tea, or mate. The leaves of this holly are used as a tea by millions of people in Uruguay, Paraguay, and many other countries throughout South America. Though it perhaps never would find much favor with people accustomed to tea, it deserves cultivation trial as the source of a highly stimulating product. Its nativity places it among the doubtful plants as regards hardiness.

*Illicium anisatum*.—The star anis of China and Japan, is a beautiful evergreen small tree belonging to the magnolia family. The star-shaped fruits are used in medicine. This species has small and yellow flowers, and should not be confounded with the *Illicium religiosum*, one of the sacred trees of the Japanese, that has pure white flowers.

*Krameria triandra*.—The ratanhia root is furnished by this polygalaceous herb. It is indigenous to Chile, Peru, and Bolivia, where it grows on sandy soil, and would most likely thrive in similar localities in this State.

*Pistacia lentiscus*, *Terebinthaceæ*.—The mastic tree is a tall evergreen bush, yielding the mastic resin; is a native of the Mediterranean region, and most probably well adapted to many localities in this State.

*Pistacia terebinthus* is also a native of the Mediterranean region; is a tall bush or small tree, yielding the fragrant Cyprian or Chio turpentine which is an exudation from the stem.

*Polygala Senega* (the Seneca snakeroot), *Polygalaceæ*.—It is probably well adapted to parts of California. It prefers a well-drained soil, and is generally found among rocks in its native home, the Eastern and Southern States.

*Rafnia perfoliata* and *amplexicanlis* are South African leguminous bushes, with sweet roots, the character of licorice, and possessing medicinal properties.

*Schaenocaulon officinalis*.—A near relation of the false hellebore (*Veratrum*), a native of Mexico's mountainous regions. It might doubtless be acclimatized in Southern California, and be made to produce its seeds, that are the sabadilla used in medicine.

*Smilax officinalis* of New Granada and *Smilax medica* of Mexico are among the many sarsaparilla-yielding species; two of the more important, and perhaps likely to flourish in sheltered localities.

*Spigelia Marylandica*.—The pink-root, *Gentianaceæ* or *Loganiaceæ*. As this plant possesses strongly medicinal properties and is a very showy plant, it naturally recommends itself.

*Styrax officinalis*, *Styraceæ*.—This shrub is a native of the Mediterranean region; is the source of the fragrant solid storax. Judging from its nativity and the fact that California itself is the home of a true styrax, we recommend it for trial.

*Swertia Chirata*, *Gentianaceæ*, is a perennial herb from the mountains of India, possessing febrifugal properties. It is also known as a fine tonic.

*Chrysanthemum (Pyrethrum)*, *Roseum*, and *Carneum*, insect-powder plants.—As the cultivation of the *Pyrethrum cinerariifolium*, or Dalmatian fever few, has been started on a large scale. It deserves notice that besides the named species, there are five others that are utilized for this purpose, viz., *tenuifolium*, *Wildenswii*, *persicum*, *corymbosum*, *macrophyllum*; and though some have settled on the Dalmatian, others may be equally or perhaps better suited to some localities than others. The difficulty that has been experienced in getting seeds of the various kinds is now passed, as Professor Riley has sent seeds of *roseum* to several places in the State, and the Stockton firm have decided to sell their seed of "*cinerariifolium*."

*Quillaya saponaria (Rosaceæ)*.—The Spanish bark or soap bark of Chile is the product of this tree. It reaches an enormous size. Seeds are very light and apt to be abortive. Due care should be taken to have them perfectly ripe for shipment, or they will not keep.

*Rhamnus chlorophorus (Rhamnaceæ)*, Buckthorn family.—From the bark of this Chinese tree a very superior green color is derived, utilized particularly for silk. *R. utilis* is another species used for the same purpose. The dye from these trees is called lokao.

*Rhus vernicifera, Terebinthaceæ*, is a medium-sized tree of Japan, yielding the true Japan varnish. This, and also its close relation, *Rhus succedanea*, are both well adapted to the climate around the bay, as trees grown in Berkeley show.

*Rhus coriaria*.—The tanner's sumac is a South European species, the foliage of which is extremely rich in tannin, and in great demand. This species can doubtless be grown with success on dry ground, as the plant not alone prefers it, but its product here is superior. The attention should be called to properties of the native California sumac that are very rich in tannin, *Rhus integrifolia* especially, an evergreen species abundant on the southern coast. The poison oak (*R. diversiloba*) might no doubt also produce a fine varnish, if the way of handling it with impunity could be found.

*Pogostemon patchouli*.—A labiate (mint-like) herb that produces the patchouli so much used as a perfume. It deserves notice that the seeds of *Hibiscus Abelmoschus (Abelmoschus)* by the Germans has been introduced to this country, the Department of Agriculture having twice received seed of this from two different sources. The true *patchouli* is a native of the mountains of India.

*Liquidamber Formoseana*.—From China, gives a species of sweet gum utilized for feeding a kind of silk-worm.

*Liquidamber orientalis*.—From Asia Minor, yields the vanilla-scented liquid storax, prized in perfumery.

*Nicotiana persica*.—The Shiraz tobacco, is recommended as adapted for more moist and cool climates.

*Vuhea florida, Apocynaceæ*.—A native of West Africa, but found up to 2,500 feet elevation. Is a beautiful climber, with white, fragrant flowers, the plant yielding caoutchouc.

#### OIL-YIELDING PLANTS.

*Gnizotia oleifera*.—From India, and perhaps Abyssinia; is the source of the Ramtil oil, utilized like the Bene oil (*sesamum*), for culinary purposes as well as in various industries. It is a yellow-flowered, coarse-looking composite herb, that seems perfectly adapted to the bay climate, maturing in Berkeley good seed, where the season is too cold for the Bene. The seeds of this plant are also known as Niger seeds in the London market.

*Madia sativa* grows as a common weed (tarweed) all over California. It would so much the more be successful under cultivation. The same is conspicuously true of the rape (*Brassica rapa*), which, under the designation of "wild turnip" or "white mustard," is everywhere obnoxiously familiar. In the valley and in Southern California the black mustard, *Brassica nigra*, is almost ineradicable, and ought to be made subservient to human uses.

The *sunflower* and *flax*, as well as the *castor bean*, succeed admirably.

#### PLANTS YIELDING WAX.

*Stillingia sebifera (Euphorbiaceæ)*.—The tallow tree of China; has been naturalized in some of the Southern States, and is probably perfectly hardy in the greater part of this State. A vegetable tallow is derived from the coating of the seeds; hence the name.

*Rhus succedanea*, the Japanese wax tree, has been referred to above. It grows like a native.

#### DYE PLANTS.

The various species of *Indigo*, *Indigofera*, *Anil*, and *tinctoria* are doubtless well adapted to the southern part of the State so far as heat is concerned, but with irrigation and consequent additional labor it is perhaps a question whether it could be produced at a figure low enough for competition.

The *Madder*, *Dyer's Weed*, *Safflower*, and other dye plants flourish, their successful production being purely a question of demand and price of labor.

## FIBROUS AND MISCELLANEOUS PLANTS.

*Maoutia Puya*.—Is a stingless nettle like the Ramie, utilized for its fine fiber. It is an Indian plant, found as high as 4,000 feet elevation.

*Fatsia (Aralia) papyrifera*.—Is planted for ornament, and seems perfectly hardy from San Francisco southward; as a source of the beautiful rice paper it might perhaps find more extensive use; it is the pith that is utilized.

*Fourcroya longavea*.—Is a near relation of the Century plant (*Agave Americana*) from the high mountains of Mexico, at an elevation of 10,000 feet. It reaches gigantic size, with a stem 50 feet high, and a panicle of flowers about 40 feet. The fiber obtained from this, as well as from the perhaps less hardy *F. gigantea*, is very strong.

*Stipa tenacissima*.—A grass found in South Europe and North Africa, known as the Esparto, or Atocha. Its principal use of late has been for the manufacture of paper, but as it is content to live in driest spots near the desert, it may prove valuable as a forage plant. The plant deserves special trial.

*Boemeria nivea (the ramie)*.—Although no machine, as yet, has solved the difficulty in regard to the preparation of this fiber plant, it is gratifying to know that it is perfectly hardy and well adapted to a greater part of California, as experiments in various parts of California have proved. As a paper plant it might perhaps find favor until the inventive genius of the Yankee has solved the difficult problem of constructing a ramie fiber machine.

*Boemeria tenacissima*.—Is, according to French and German seedsmen, the most valuable fiber plant, much superior to *nivea*; this, however, is contradicted by the report of the Agricultural Department, which says that the two are identical for all practical purposes.

*Bamboos*.—Under this head may be included all tree-like grasses, but especially those of a very hard and tough nature. Of the vast number of bamboos found in America, Africa, and Asia, we find some eighty different species mentioned as likely to succeed in sub-tropical countries. We shall mention a few, not because we think them little likely to succeed or of small importance; on the contrary, we subscribe fully to the eloquent plea of Ferd. v. Mueller, wherein he calls attention to their great usefulness for a multitude of purposes, and we believe that their importance can hardly be overestimated for treeless countries, where along the irrigating ditches they should be planted in every available spot. Our reason for naming but few is that the botanical names are generally not known in the countries where they are mostly cultivated, except in botanical gardens and their immediate surroundings. This is shown by the fact that even the government importations of last year are wanting in correct names. To give, therefore, a number of botanical names would be of little benefit to most people here, who have no means of procuring bamboo except by getting them from the natives and under the local name of the country, be it Mexico, South America, China, Japan, or India.

*Arundinaria falcata*.—Is the Ringal or Nigala bamboo; a native of the Himalaya Mountains, found at an elevation of from 3,500 to 10,000 feet; it rises to the height of 40 feet, with canes, however, of but 4 inches in diameter. The canes are strong and durable, and may be utilized for a variety of purposes. In the Garden of Economic Plants, in Berkeley, there is a plant of this species, raised from seed, but eighteen months old, that has, in three weeks, made canes nearly 6 feet long, and that without much moisture. This bamboo is, besides, perfectly hardy, even where it is beaten down with snow every winter. It is, furthermore, easy to increase by division and cuttings.

*Dendrocalamus strictus*.—Recommended as resisting great heat and cold; also for growing on drier ground than bamboos generally, attaining a height of 100 feet. Its strength and solidity make it very valuable. It is found in India, especially in Bengal. Seeds, donated by Baron Ferd. v. Mueller to the University Gardens, seem to require great heat to germinate.

*Bambusa vulgaris*.—Is the large unarmad bamboo of Bengal; grows to the height of 70 feet. It is, however, less hardy than any of the first named, though it will resist occasional frost, and might no doubt find many localities in the State to suit its requirements.

*Phyllostachys nigra*.—From China and Japan; is a very hardy, black-stemmed species, growing to the height of 25 feet. It is utilized for chairs and walking-sticks, as the canes are nearly solid.

In connection with these few named species, we must mention that in the Garden of Economic Plants, in Berkeley, are now growing five distinct species, derived from various sources, none of which we are able to determine. Three of these were imported by the Agricultural Department, and named *Bambusa metake*, *B. moso*, *B. tadake*. None of these are real botanical names, according to the best authority consulted on

the subject (General Munro's Monograph of the Bamboos), except perhaps *B. metake*, which, however, does not answer to the specimen on hand. All these are doing well. A fourth kind is also introduced, under the name *moso*, a slender species of rapid growth in Japan, utilized as greens, like asparagus. A fifth is a direct importation from Choofoo, China, planted right from a tub into the garden. It sent forth shoots that in less than three weeks have grown 6 feet. This species may possibly be *Bambusa vulgaris*. Before leaving the bamboos, we desire to repeat that we have the greatest appreciation of the importance of the bamboo for California, and would be very grateful for any information and local experience in regard to these plants.

*Jubaa spectabilis*.—The Coquito of Chile is one of the hardiest palms. In its native home it is utilized for the production of a sirup for which the tree is regularly tapped. It is said to be very productive. The young plant resembles closely the date-palm.

*Reutia sapida*.—The Nika palm of New Zealand, Chatham Islands, is a beautiful palm yet hardly known in this country. The unexpanded flower-stalks are used as palm cabbage.

*Plectocomia Himalayensi*.—Is one of the hardiest rattan palms.

*Salix purpurea*.—From Europe and Asia; is one of the better Osier willows. This species, as well as the real Osier, *S. viminalis* and *S. triandra*, should be planted along watercourses, instead of the native more or less brittle species. Cuttings of these could, in proper season, be shipped with the greatest safety.

#### FOREST AND TIMBER TREES.

*Quercus robur* (the English or German oak).—One of the most valuable of all timber trees; deserves trial, not alone as an ornament shade tree, but for its timber. In Berkeley this tree has made the extraordinary growth of 4 feet the third season, outdoing all other oaks; and from Australia comes the report that it withstands even the fiery winds of the desert.

*Quercus densiflora*, or the chestnut oak of California, better known perhaps as tan-bark oak. This beautiful tree, found associated with the redwood, is undergoing a wholesale slaughter, and maltreated as it is, it is no wonder that it never has attracted attention as a shade tree. In the redwoods this tree is seen to great disadvantage, but grown by itself it forms one of the handsomest trees in existence. Combining the pretty staminate flowers of the chestnut with fringed cups of the burr oak and the evergreen foliage, more like certain banksias in texture, it is one of the most remarkable and finest trees in California, well deserving a place in the garden, park, and avenue in preference to many most highly prized trees of cultivation. California possesses several very handsome oaks worthy of cultivation, as the black oak (*Quercus Kelloggii*), the golden oak, or large live oak (*Quercus chrysolepis*); but as California trees perhaps are outside the scope of this report, we must satisfy ourselves by calling the attention to these few.

*Quercus Aegilops*, from South Europe.—Is a nearly evergreen oak, the fruit of which is available for dyeing and tanning; the cups are called valemia, while the unripe acorns are called camata; ripe, they may be eaten. The tree is, furthermore, a fine avenue tree.

*Santalum album santalaceæ*.—Is a small tree found in India, ascending to temperate regions in Mysore. The famous fragrant sandalwood is the product of this tree.

*Santalum Preissianum*.—Is an Australian sandalwood, called the native peach, the quandong or catunga by the aborigines. The fruit is edible, and can be reared in desert tracts.

*Skimmia Wallichii*.—A magnoliaceous tree from Indian mountains to the altitude of 5,000 feet, growing to the height of 100 feet, and yielding a valuable timber.

*Acacia decurrens*, var. *mollissima* (the black wattle of South Australia).—Is, in the bay counties, a well-known ornamental tree. Its great value for tanning is, however, but little known; as experiments in Ferd. von Mueller's laboratory show the artificially dried bark contains from 34 to 54 per cent. of tannin; the mercantile bark has, however, 10 per cent. more moisture; nevertheless, it is extremely rich, only 1½ pounds of this bark being needed for 1 pound of leather, while 5 pounds of English oak are requisite. *A. mollissima* is one of the most rapid growing of the large growing acacias, and deserves planting, especially in dry, sandy, treeless regions. According to our experience it does not thrive in a tenacious, wet soil. The variety *dealbata*, or, as it is called by the colonists, the silver wattle, is distinguished by the ashy line of the foliage and by maturing its seed in less than half the time of the *decurrens* proper. It is a fine tree for lumber, but is especially a very great heater, and most valuable as a source of fuel; on this account it deserves planting in treeless regions, aside from its beautiful appearance.

*Acacia pycnantha*, *falcata* and *saligna*.—Are small trees; very valuable for binding drift-sand and for tanning, specially *pycnantha*.

*Acacia horrida*, the *Doom boom* or *kana doom* of South Africa.—Is, as well as the Australian *A. armata*, available for hedges; the latter is quite hardy along the coast. Of

all the numerous Australian acacias that grace our gardens, none deserves as much to be planted as the *A. melanoxylon*, known as the blackwood. This tree will, under favorable circumstances, reach 80 feet. The wood is most valuable for furniture, railway carriages, boat-building, casks, billiard-tables, and piano-fortes (for sound-boards and actions). The fine-grained wood is cut into veneers, takes a fine polish, and is considered almost equal to walnut. It is the best wood in Australia for bending under steam. Besides all these uses, the bark is available for tanning, air-dried bark containing from 15 per cent. to 28 per cent. of tannin. As the blackwood acacia is a rapid grower, and is hardy where the blue gum will thrive, and even withstands lower temperature, we have here one of the most desirable timber trees, that deserves planting on a larger scale just as much as the favorite eucalyptus. The blackwood acacia is not alone raised easily from seed, but can also be propagated from suckers, that appear in great abundance where a tree is cut down.

*Acacia harpophylla*, from Southern Queensland.—Is said to furnish a great deal of the bark for tanning, and a wood brown, hard, heavy, and elastic. It attains a height of 90 feet, preferring sand lands to the exclusion of other trees; wood pervaded by a violet odor.

*Maples (Acer)*.—Among the numerous beautiful members of this genus the California species, *A. macrophyllum*, certainly deserves a place. Though not very tall, it forms a splendid shade tree for streets and avenues, and if taken proper care of is of rapid growth.

*Acer platanoides*, the so-called Norway maple, deserves trial, as well as the sycamore maple.

*Acer Pseudo-Platanus*.—Both thriving in the same climate as the English oak (*Quercus robur*), that has proved so well adapted to the coast region of this country. The well-known sugar maple; growth comparatively fast, and recommends itself to all old residents of the States east of the Rocky Mountains.

*Albizia julibrissin*, from Caucasus to Japan.—Is a favorite ornamental shade acacia in South Europe.

*Amyris terebinthifolia* (Brazil).—Has proved hardy in Victoria (Australia), and deserves, therefore, trial in California as an avenue tree.

*Angophora intermedia*.—Is the so-called apple tree of Australia, belonging to the myrtle family and a close ally of the eucalyptus, but a better shade tree than most of these.

*Brachychiton acerifolium and populneum*, *Sterculiaceus trees of Australia*.—Very ornamental both for foliage and flowers; the so-called flame tree, *acerifolium*, is perfectly hardy in the locality of Berkeley. Their growth is comparatively slow.

*Buddleia Madagascariensis*.—Of these ornamental trees one of the largest and prettiest may prove hardy in sheltered localities.

*Castanopsis chrysophylla*, the oak chestnut or Western chinquapin.—Is a native of California; though in the drier part of the State it only reaches the size of a dwarf shrub, it becomes a stately tree in the moist northern counties, reaching as much as 125 feet in height; like many other California trees yet to be mentioned, the oak chestnut deserves to be cultivated in the park and garden.

*Casuarina*, the she-oak horsetail pine (*Casuarineae*).—These singular trees can hardly be recommended as shade trees, but among them we find some of the most durable timber trees, most of them content to live in the barren coast as well as in the saline marshes and alkaline lands. If pollarded like willows, they will produce young shoots that cattle will live on.

*C. equisetifolia*, from East Africa, South Australia, South Asia, North Australia, Polynesia.—Attains as much as 150 feet in height; splendid for fuel, giving great heat and little ashes: timber tough: as many of this species will also live in saline ground, the yield of firewood from this tree has been estimated to be four times as great as any return from any tree in France. In India it grows on pure sand, and is much used for railway locomotives. The cost of rearing Casuarinas in India has been from £4 to £8, and the return after only eight years, £13 to £32.

*C. snerosa*, the erect she-oak of Southeast Australia.—Is of fine dense growth; endures the climate of the bay counties well; *quadrialtris*, *glauca*, *torulosa*, and others are valuable for their wood, and all deserve rearing in suitable localities.

*Ceroxylon andicola*.—The wax palm of New Granada, ascending the Andes to 11,000 feet elevation. One of the grandest and at the same time one of the hardiest of all palms reaching a maximum height of 180 feet: trunk exudes a wax, as much as 25 pounds being obtainable at one time.

*Chacmerops martiana*.—A species of palm found in Nepal as high as 5,000 feet above the sea, forming a beautiful tree 50 feet high.

*Cocos australis*.—One of the hardiest of all palms, if not the hardiest, withstanding a temperature as low as 8° C.; therefore even hardier than the date palm: it is a native of Southern Brazil to Uruguay and the La Plata States. *Cyatay*, from the same region, together with *C. datil* from forests here, the latter producing date-like fruits.

*Corynocarpus laevigatus*.—The karaka of New Zealand, and the principal forest tree of the Chatham Islands, attaining a height of 60 feet. It is to be regretted that this

beautiful tree cannot be recommended for general planting; it will, however, live in sheltered localities along the coast, for instance, in Santa Cruz, but will stand only a very slight degree of frost.

*Drimys Winteri* (*magnoliaceæ*).—Is the Canelo of Chile, sacred, under the name of Boighe, to the original inhabitants; reaches in river valleys a height of 60 feet. Wood never attacked by insects (according to Dr. Philippi).

*Eucalyptus*.—This extensive genus has found great favor in California, and planting of gum-tree forests is perhaps on the increase, especially the blue gum. *E. globulus*, though this, no doubt, is the fastest grower, it is by no means the most valuable. Of the extensive list mentioned by Ferd. von Mueller, we shall but mention a few, and refer any one who desires full information on this subject to the *Eucalyptographia*, just published by that author. By far the most important for California is the red gum, *E. rostrata*, which, as far as our knowledge goes, is but little known here. Strange as it is, the red gum sold in San Francisco and neighborhood is mostly *E. viminalis*, a valuable rapid grower, but in regard to the quality of wood greatly inferior to *rostrata*. This species, *rostrata*, will withstand more water inundation than many other eucalyptus, while the timber is one of the most durable and strongest for underground work. As it is naturally found in moist ground, with clay subsoil, it cannot be expected to thrive on the driest hills. It will, however, grow in saline soil. In Australia it is preferred to any other eucalyptus for railways and bridges, for ship-building, and, in fact, for any kind of durable work below or above water, as well as for underground work, and is second only to the famous Jarrah (*E. marginata*) in resisting the attack of the chelra and limnoria, the teredo, or even the white ants.

*E. marginata*.—Is the Jarrah or Yarrah of Western Australia; the wood of this tree is even more durable than teak, resisting the attacks of all borers known. On account of its color it is termed mahogany, and used for furniture, as it takes a beautiful polish. The Jarrah has not been found to be a fast grower as compared with *globulus* or *obliqua*, but infinitely faster than most other hard-wood trees, especially deciduous ones. Unfortunately, it is somewhat more tender than either. Of the other two species, specimens 4 and 5 feet high having been killed at the experimental grounds at Berkeley, the year before last, nevertheless others slightly sheltered escaped, and a specimen this year has survived the season unprotected. The great value of the timber makes it, however, most desirable that this tree should be tried in the southern part of the State, where there no doubt could be found localities warm enough for it. It makes the best wood on ironstone ranges, and, on the whole, the wood from the hills is darker, tougher, and heavier than that of the plains. The Yarrah is not of the tallest eucalyptus, but reaches, nevertheless, an enormous size; stems have been measured 80 feet to the first branch, and 32 feet in circumference 5 feet from the ground.

*E. platyphylla*.—Is a species from Queensland, said to thrive in exposed localities and produce very large leaves, 1½ feet long and 1 foot wide.

*E. citriodora*.—From Queensland, furnishes an excellent timber, and is pervaded with an easily extracted lemon-scented oil.

*Fagus Cunninghamii*.—The Victorian and Tasmanian beech is a magnificent evergreen tree, not rarely 200 feet, furnishing excellent wood, the myrtle wood of the trade. Thriving only in rich damp soils, we can hardly expect to grow it where timber is most needed; but it would form a valuable addition to our shade trees in parks and large gardens.

*Buxus sempervirens*.—The tree box. As the boxwood is in constant demand and its supply in Asia Minor becoming scanty, it is to be hoped that some one will undertake the planting of it, which perhaps will be an investment slow in its return, but likely to be a sure and profitable one in the end.

*Ficus Sycamorus*.—The sycamore fig-tree of the Orient; a splendid shade tree of enormous size; one of the trees in Cairo belonging to this species, legends connect with Christ, is still growing.

*Flindersia Oxylayana*.—The yellow wood of New South Wales and Queensland, as well as *F. australis*, are both valuable hard-wood timber trees, reaching as much as 150 feet in height.

*Jacaranda mimosifolia*.—From Brazil, furnishes the beautiful pallisandre wood; has proved hardy at Sydney, and will therefore probably thrive in sheltered localities in the southern counties.

*Knightia excelsa*.—Another proteaceous tree, the Rewa-rewa of New Zealand, furnishing a most beautiful wood, specimens of which may be seen at the University cabinet collection.

*Laurelia aromatica* (*Laurinca*).—A handsome evergreen tree, resembling the California bay-tree; is a native of Valdivia, Chili, where it produces a wood not attacked by insects. We believe that the seeds distributed by the Bulletin office under the name of Bayoto are of this tree.

#### PLANTS USEFUL ON TIDE OR STRONGLY ALKALINE LANDS.

*Agaves majus*, *Myrsina*:—A tree with habit of the naugrove, that might be utilized for consolidating muddy shores. For the same purpose, the *Aricenna officinalis*, a

small tree belonging to the family *Myopora*, and found in South Asia, New Zealand, and Victoria, is suggested.

*Batis maritima*, *Haloragac.*—A small shrub, native of American shores, is well adapted for reclamation of tidal lands.

For the binding of drift sand no grass has, in Northern Europe, been found as valuable as the *Elymus arenarius*, preparing the land for shrubs and maritime trees.

*Carex arenarius*.—A sedge, is also to be recommended in this connection.

*Frenela actinostrobis*.—Is a cypress-like little tree or bush, flourishing in the Australian salt marshes.

*Melaleuca parviflora* and *trichostachya*.—Both shrubs of sea-coast of North Holland. They have been found hardy in Berkeley and should be tried in alkaline lands.

#### FORAGE PLANTS OF ESPECIAL ADAPTATION.

*Anthistiria ciliata*.—Is the well-known Kangaroo grass of Australia, South Asia, and Africa; deserves, as well as the *Anthistiria arvenacea*, trial in California. The latter is especially thought very valuable in Australia as a fodder.

*Atriplex monnularium*, *Chenopodiaceae*.—From Queensland through the desert tract to Victoria and South Australia. One of the tallest and most fattening of Australian salt bushes, and as Ferd. v. Mueller adds, highly recommendable for artificial rearing. He himself has sent seed of this and a similar species, *A. vesicarium*, to California. Plants reared of this are growing on the experimental grounds in Berkeley. They seem well adapted to the climate there, and will be distributed the coming season to any one desirous of trying them. The young shoots grow readily as cuttings.

*Kochia villosa*, *Salsolaceae*.—Known in Australia by the name of cotton bush on account of its hairiness, is a dwarf bush, resisting the extremes of the interior climate of Australia; deserving trial in our southern dry region, as it will give a very fair fodder.

*Jacksonia cupnifera*.—From West Australia. A leguminous plant, adapted for dry climates. Horses and cattle are very fond of the foliage. It grows to the size of a small tree.

*Lotus tetragonolobus*.—Another leguminous plant, native of South Europe. The pods are used as a substitute for asparagus. In Berkeley it has been found to withstand frost better than any other forage plant, keeping green all winter, and as it is succulent and tender, it might be of great value.

*Medicago arborea* (*Leguminosae*).—A shrubby, yellow-flowering medick, said to promote the secretion of milk. Is a native of South Europe.

*Neurachne Mitchelliana*.—The Mulga grass. In the desert interior of East and South-east Australia, recommended, together with *Neurachne Mmroi*, for dry, sterile land. It is said to endure any amount of drought, but requiring heavy rains to start anew.

*Peutzia virgata* (*Compositae*), of South Africa. A small bush, adapted for desert regions, offering a fair sheep's fodder. It spreads very rapidly by means of the young branches taking root.

The above list of plants likely to prove valuable in the arid regions of the Pacific coast could doubtless be greatly increased by a systematic effort to investigate the subject in the field as well as in literature, by competent persons, and a provision made by Congress to have this done through the Department of Agriculture would be of the greatest importance to agricultural progress in the arid regions. The countries bordering the Mediterranean and Australia would seem to be of the first importance as probable sources of valuable culture plants and methods adapted to arid climates; but the arid regions of Peru, Chili, and Bolivia, as well as the plateau countries of Asia, should not be forgotten.

In further illustration of the latent possibilities that may be developed by systematic experiment, we give the following extract from a report on the experimental field cultures in the grounds of the University of California, made in 1879, by Charles H. Dwinelle, lecturer on practical agriculture in that institution.

#### A SERIES OF FORAGE PLANTS FOR SUMMER AND AUTUMN.

Those having a climate similar to ours, and wishing for green feed from early spring to late autumn, will not go far amiss in following the list given below, which has been made up partly from the results of our experiments in the garden and partly from observation of the practices of farmers in the neighborhood.

1. Canary grass (*Phalaris canariensis*). The same that is used for birds. If sown early it will be 2 to 3 feet high in March or April.

2. Nepal or Bald Barley (*Hordeum trifurcatum*). It should be sown on the best land available, in several plots, from the first rains until the middle of February. Cattle are exceedingly fond of it.

3. Bald or Naked Oats (*Avena nuda*). These make an immense amount of leafy fodder, if cut in bloom.

4. Indian Corn (*Zea mays*).—The smaller varieties from the north mature earlier than the southern kinds. Of field corns the small Canada and King Philip are good, and the Minnesota and Red River sweet corns will mature with wonderful rapidity. For late cutting some of the so-called evergreen kinds should be added. Plant the first as soon as frosts are over, and plant two or three times at intervals of ten days or two weeks.

5. Sorghums (*Sorghum vulgare*). If the following sorghums are sown about April 1 they will come in, one after another, during the latter part of summer and autumn: Chinese sugar cane, Egyptian corn, evergreen broom corn, amber cane, imphee.

The above series is recommended for the coast climate of Middle California, and especially with the addition of alfalfa would afford the dairyman green feed throughout the season in which, at present, "dry pasture" is so largely resorted to. Since the above was written, a highly important addition to the drought-resisting grasses adapted to the climate has been found in the sorghum halapense, variously known as Green Valley grass, Johnson grass, false Guinea grass, &c. Many others are on trial, and there can be no doubt that satisfactory series of this kind can be found for a large part of the region without summer rains, even independently of irrigation.—E. W. H.

### INSECT PESTS.

That a region of country so highly favored, especially in the matter of climate, should be exempt from serious ills could not be expected. Natural conditions render California particularly liable to the introduction and propagation of insect pests. To secure success in fruit-growing "eternal vigilance" must be the guiding watchword of each and all engaged in this calling. While those interested have doubtless been slow in awakening to the true condition of affairs, there is now a healthy, vigorous movement in the right direction, which will, if followed up, end in victory to fruit culturists. The chief executive officer of the State horticultural organization, Matthew Cooke, has shown himself to be an expert practical entomologist, together with thorough business qualifications, which cannot fail to accomplish the desired ends. His investigation leads him to say:

It should be stated that in the beginning of the fruit-growing industry, and until within ten years, the remarkable freedom of California fruits from insect pests was often commented upon. It is chiefly since railroad communication has rendered possible the pernicious system of returning fruit boxes, that the invasion of insects has become more general.

The aggregate amount of damage to orchard property in California by depreciation in value, caused by spread of insects injurious to fruit and fruit trees, within the last five years, cannot be accurately stated, as there are no statistics to refer to; but it can be safely estimated at \$2,000,000. It is not claimed that this amount of actual damage was done, but fruit-growers were ignorant of any reliable remedy, thus causing a greater depreciation in value than was necessary. The damage to apple, pear, and quince crops, by codlin moth and scale insects, since 1877, is at least 50 per cent. of the whole crops produced.

If to the above is added the damage to plum and orange crops by scale insects, by red spider (mite) on almond and cherry crops, the loss in currant orchards by borers, and the damage by caterpillars, squash bugs, &c., to fruit and foliage, not more than 33½ per cent. of what the orchards are capable of producing can be classed as choice marketable fruit.

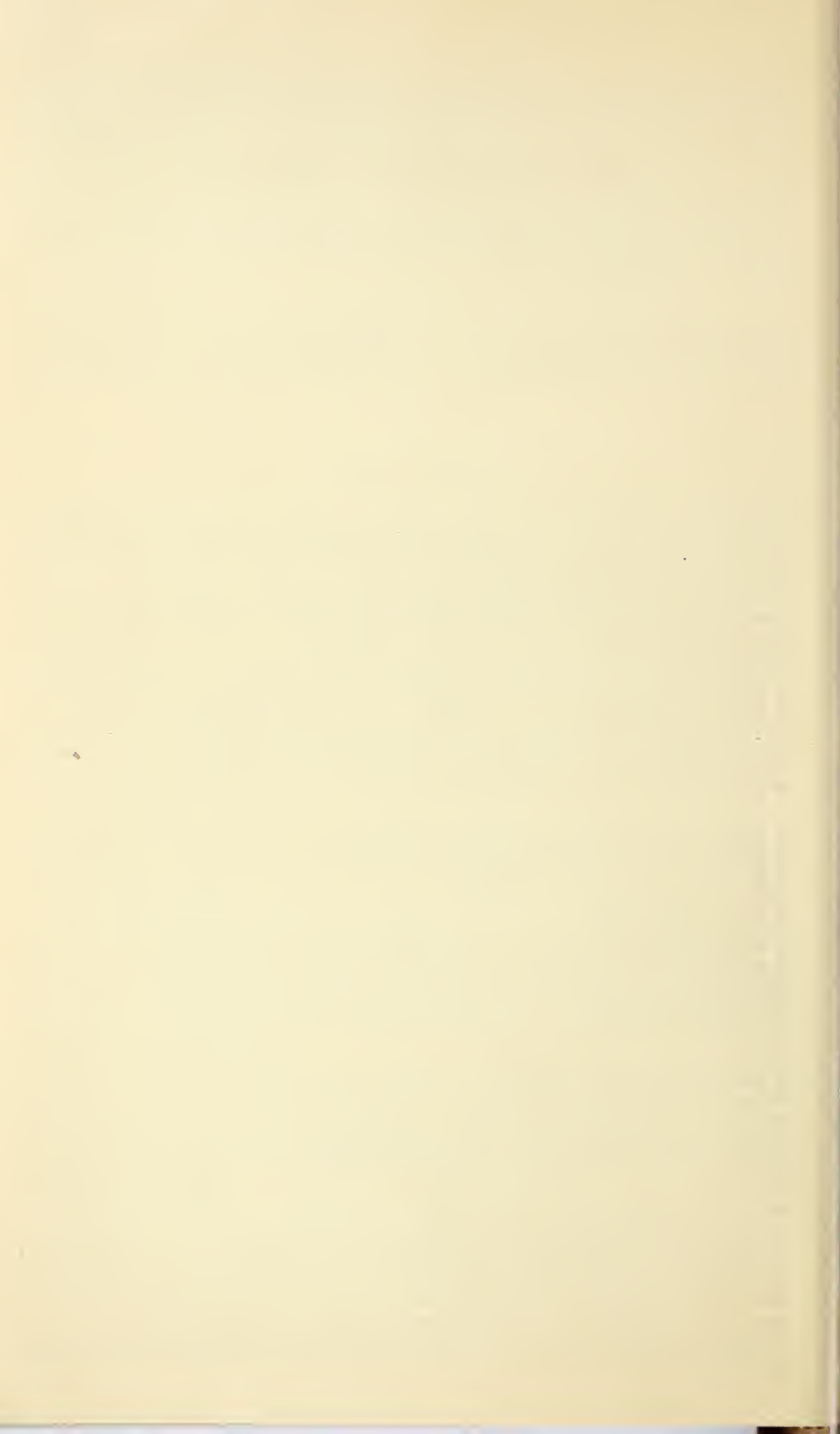
Inquiries concerning diseases of trees and insect pests not heretofore observed in orchards are frequent, all tending to prove that the prospects of fruit-growers in this State are not encouraging if active measures are not adopted for the extermination of insect pests.

Query. Can our orchards be protected from the ravages of insect pests?

Answer. Yes, undoubtedly, by a united warfare for the destruction of insect pests by all persons owning fruit trees, and other varieties of trees infested by noxious insects.

Mr. Cooke's treatise on insects injurious to fruit and fruit trees in California, and remedies recommended for their extermination, lately published under authority of the State Board of Horticulture, is doing much towards rousing fruit-growers into activity. It is concise, practical, and so sparing of technical and scientific terms as to adapt itself peculiarly to the masses.

My own observation leads to the conclusion that more insect ills are found in low lands, valleys and plains, than in more elevated regions, such as the foot-hills.



## THE PHYLLOXERA IN CALIFORNIA.

BY E. W. HILGARD.

The presence in California of this formidable enemy of the vine has been known for nearly nine years; but it is only within the last two years that a definite knowledge of the extent and history of the invasion has been gained, as a result of the creation of the State Viticultural Commission.

It appears that its presence was first definitely recognized in August, 1873, by a committee of the Viticultural Club of Sonoma, in a vineyard situated 2 miles north of the town of Sonoma.

Specimens of the insect were sent to Professor Riley, and identified by him. The area then invaded was stated to be about 8 miles up and down the valley, and about 2 miles across.

It was then attempted to rouse the vine-growers into active precautionary and repressive measures, and legislative action was also sought. But the increasingly depressed condition of the interest, as well as an unwillingness to look the danger in the face, and in acknowledging it to injure the value of vineyards in the valley, prevented any serious or co operative measures being taken. Such were, however, attempted in the large and valuable vineyard of the Buena Vista Company, of which the report of Mr. H. Appleton, published in the first annual report of the State Viticultural Commission, gives the following account:

A vineyard of about 1,000 vines was planted in 1834-'35 and was watered every year. In 1850 and 1852 the vineyards was largely increased, and the system of irrigation was stopped. In 1857 about 200,000 vines were set out, and in 1858 100 acres were put in vines, 680 vines to the acre. Again, in 1860, 50 acres were laid out. In 1862, Col. A. Haraszthy planted 70,000 European vines, and it was among these vines the disease increased most rapidly.

In the spring of 1863 the Buena Vista Company was incorporated, and in the spring of 1864 that company planted 100,000 vines. As early as 1860, decayed and dying vines were noticed in the vineyard, and they were taken up and others planted in their places. An examination was made to discover the cause of disease in these vines, and it was attributed to alkali water, which was found a few feet beneath the surface. The roots were decayed. No microscopic examination of these roots was made. Vines died from time to time, showing short growth, small and colorless grapes, early yellow leaves; in fact, all the symptoms of vines dying from the vine pest were observed. In 1868 about three acres of diseased vines (planted in 1850) were taken up, and others planted in their places. They grew well, showing little signs of decay until they were four years old, at which time the phylloxera committee of the Viticultural Club found the phylloxera on several vines. During the past five years the Buena Vista Company have inaugurated a system of examinations in the endeavor to destroy the phylloxera. These experiments were made in most cases very thoroughly, extending over from ten to one thousand five hundred vines, at a cost of \$2,500 in labor and material to the company. The most of these experiments were useless, and none of them gave general satisfaction in their results.

Bisulphide of carbon was thoroughly used for a number of years. In 1875 and '76, four hundred vines were put under the influence of this chemical, forced under ground by a hollow tube and plunger, with three or four insertions around each vine. Experiments with bisulphide of carbon have been followed up to the present time; as many as one thousand five hundred vines were under its influence at one time. The company also tried coal tar, coal oil, coal tar and gas lime mixed, carbolic acid, concentrated glycerine, bisulphide of carbon and manure mixed, sulphuric acid and water, J. O. Weatherby's remedy, guano, Hoffman's remedy, Dr. E. J. Fraser's remedy,

liquid from tanned skins, liquid from cow and other manure, Descuhes rohart, whale oil and copperas, &c.

Planting corn near diseased vines was tried, and the fact was established that the phylloxera was found in large quantities on the roots of the corn, and the vines seemed to recuperate under its influence.

Examinations were made, and the insect found on the roots 6 feet under ground. Vines were taken up, and the cuttings planted died the next year, and were followed by rooted vines, which showed signs of disease when one year old.

A. S. Edwards' vineyard (commonly known as Butler's vineyard) of 80 acres, had dead vines in it during 1871-'72, and in 1873 the phylloxera committee found the insect in a number of places. These infected vines were heavily manured for a number of years without staying the ravages of the insect. In 1876 the whole of this vineyard was abandoned, and has not been plowed or pruned since.

It was noticed that there was a check in the death of vines after it was abandoned. It is thought by many that this was caused by the hard ground preventing the insect spreading to healthy vines. Many costly experiments have been tried in different parts of the valley, but as they did not accomplish the object desired, I need not mention them here.

Data concerning the Orleans vineyard, located in the foot-hills of the Coast Range, west of Woodland, Yolo County, seem to indicate that there, also, the phylloxera was introduced with European vines, about the same date that its ravages were first noticed at the Buena Vista vineyard in Sonoma.

The writer visited the latter valley in October, 1875, and found the manifestations of the pest precisely the same as described elsewhere. One vineyard was almost completely destroyed, and several miles each way from the town of Sonoma the beginning of the attack was visible in low basin-shaped spots, forming depressions in the luxuriant mass of foliage. Within the ever-widening circles of destruction many vines were entirely dead, while others (and among these oftentimes those earliest attacked) maintained a feeble growth, the roots of these being mostly abandoned by the insect. The latter was found in the greatest abundance, not within the visible circle of damage, but from 10 to 15 feet outside of its extreme margin. Here the outlying white rootlets were fairly clustered with the yellow brood, even at that late season (end of October).

In the hope of drawing attention to the seriousness of the danger, a "bulletin" was shortly after issued by me from the University press, in which I gave a succinct account of the life history of the phylloxera (as then known), of the damage caused by it in Europe, its fearfully rapid progress, and of the efforts thus far made to check it. But little interest, however, was taken in the subject, even in the Sonoma Valley.

Efforts made to secure legislative aid towards the suppression of the pest failed of success. To my surprise, I could hear but little about the phylloxera for a year or two afterward; nor could I obtain any definite information regarding its progress by correspondence, my University duties preventing a personal visit at the time. It appears that the cause of this silence was twofold: First, the great depression of the wine interest, causing a feeling that the culture might as well be given up for something more profitable; second, that although the spread of the insect had continued steadily, yet it was so much slower than has been the case in Europe, and than had been anticipated and predicted by me, that a great deal of incredulity and of wild speculation as to the cause of the dying out of the vines had become current. It was not until the return of brighter prospects for vine-growing, owing to the diminished production in Europe, and to a better appreciation of California wines in the market, that serious attention was at last given to the phylloxera, and the policy of "hushing up" was replaced by discussion as to the means of prevention and relief.

The situation in the Sonoma Valley in 1879 may be summed up as follows: The ravages of the enemy have become manifest in a greater or less degree, from about  $6\frac{1}{2}$  miles above Sonoma town to the lower end of the valley, a length of 10 or 11 miles in all. Within these limits large tracts have been completely destroyed, the vines having been uprooted and grain sown instead for several years. It is difficult to ascertain the total area of vineyard that has disappeared, but it counts many hundreds of acres. On a still larger area, probably, the condition of the vines has become such as to render them unprofitable, so that they are being pulled up and used for firewood in the wineries. So far no material difference in respect to the resistance of the several varieties have been reported, all those grown being of the type of the European vine (*vitis vinifera*), grown on its own or kindred stock. The mission vine, naturalized for over a century in California, is at least as badly attacked as is the Riesling, Zinfandel, Rose of Peru, or any other grown.

Amid the general devastation nevertheless there were some exceptions—Green Islands, apparently of healthy vines, in good bearing, yet surrounded on all sides by defunct vineyards. This was even the case in the vineyard which first succumbed, where, nevertheless, some of the original vines still remain, apparently in good condition. A close study of these exceptions could not fail to lead to highly valuable results. In general, it appears that great care of the vines, good tillage, and manuring have been practiced in all these cases; but there are many others in which no amount of care or manuring has seemed to possess any perceptible efficacy, and where the destruction has been as swift as in the doomed vineyards of France.

Whatever may be the true explanation of these remarkable exceptions, the general fact remains that in four years the insect has spread no more than about  $2\frac{1}{2}$  miles up the valley, from a point of great virulence, notwithstanding the fact that this is the prevalent direction of the summer winds. The natural inference from this fact would seem to be that from some climatic cause the phylloxera in California does not develop largely into the winged form, which evidently mediates its rapid progress in Europe; and that its progress is here chiefly dependent upon the transportation or migration of the wingless forms.

The observations made since 1879 seem to confirm the rarity of the winged form in California. It has not thus far been caught abroad at all, although traps of sticky papers have been numerously hung among infested vines. The only samples so far seen in California have been raised in jars from infested roots. It may be added, that well-authenticated cases of the "winter egg" are also thus far lacking. Observations made during the present winter at the University have shown the live insect, in a discolored, quiescent state, to persist throughout the season near the crown of the roots.

Whatever may be the true explanation of the slow progress of the phylloxera in California, it is a fact of the greatest moment; for it reduces greatly the direct damage as well as the danger of spread to uninfested districts, and so justifies the somewhat severe sanitary regulations imposed by the State board of viticulture, such as in France have been found unavailing on account of the prevalence of the winged form. Meanwhile the investigations which have been made under the joint auspices of the University and of the board of viticulture have shown that the insect prevails over a much wider area than was originally suspected. The invasion is more or less general in the valleys of Sonoma and Napa (in the latter up to Yountville, and in the tributary

valleys: also at one point near Saint Helena); at several points in Solano, Yolo, Placer, and Eldorado; not definitely ascertained in Sacramento, but again in one locality near Stockton; also in several localities near San José; and in the experimental vineyard at Berkeley, where it has only lately been discovered and has not been extirpated for the sake of allowing of some observations not easily made elsewhere.

The invasion thus covers a broad belt reaching from the coast range to the foot-hills of the Sierra Nevada; and were its progress as rapid and irresistible as has been the case in France, it might be inferred that the existing vineyards of non-resistant vines are doomed. But with the natural disabilities under which the insect evidently labors in California, and with the close vigilance now exercised by the majority of grape growers, it is probable that the pest can be kept practically within its present limits. It would also seem that it is easier to keep infested vineyards in profitable bearing here than elsewhere, by the joint use of insecticides and manures. Supposing that all the unprotected vineyards at present planted will ultimately succumb, this will be a hardship for certain localities; but the aggregate loss thus incurred will be small compared with the area likely to be planted within the next few years, and protected against the phylloxera by means of grafting or submersion. Thus on the whole, while the agitation and investigation of the subject has shown the existing invasion to be wider than any one had anticipated, yet the accurate knowledge of the danger has carried with it also the confidence that it can be conquered or prevented, and has placed the knowledge of the means to that end within reach of all. It has brought about the establishment of a manufactory of that most energetic of insecticides, the carbon bisulphide, reducing its retail cost to one-fourth, and allowing of its use not only against the phylloxera, but also against the larger pest of the farmer, the ground squirrel and gopher. Attention has also thus been more prominently drawn to the insect enemies of other fruits and crops, and by united action, backed by a wise compulsory law, there is every prospect of nipping many of these growing evils in the bud.

#### ACTION TAKEN REGARDING INSECT PESTS IN CALIFORNIA.

The several acts passed by the legislature of California for the protection of the viticultural and horticultural interest against insect pests, being the most thorough provisions thus far made within the United States, are here given in full as a matter of general interest:

#### CHAPTER LXII.

AN ACT for the promotion of the viticultural industries of the State.—(Approved April 15, 1880.)

*The people of the State of California, represented in Senate and Assembly, do enact as follows:*

SECTION 1. There shall be appointed by the governor a board of State Viticultural Commissioners to consist of nine members, two to be appointed from the State at large, and one to be appointed from each of the several viticultural districts, which shall be constituted as follows:

First. The Sonoma district, which shall include the counties of Sonoma, Marin, Lake, Mendocino, Humboldt, Del Norte, Trinity, and Siskiyou.

Second. The Napa district, which shall include the counties of Napa, Solano, and Contra Costa.

Third. The San Francisco district, which shall include the city and county of San Francisco, and the counties of San Mateo, Alameda, Santa Clara, Santa Cruz, San Benito, and Monterey.

Fourth. The Los Angeles district, which shall include the counties of Los Angeles, Ventura, Santa Barbara, San Luis Obispo, San Bernardino, and San Diego.

Fifth. The Sacramento district, which shall include the counties of Sacramento, Yolo, Sutter, Colusa, Butte, Tehama, and Shasta.

Sixth. The San Joaquin district, which shall include the counties of San Joaquin, Stanislaus, Merced, Fresno, Tulare, and Kern.

Seventh. The El Dorado district, which shall include the counties of El Dorado, Amador, Calaveras, Tuolumne, Mariposa, Placer, Nevada, Yuba, Sierra, Plumas, Lassen, Modoc, Alpine, Mono, and Inyo.

SEC. 2. The commissioners, excepting the two appointed from the State at large, shall be residents of the districts from which they are appointed, and shall be specially qualified by practical experience and study in connection with the industries dependent upon the culture of the grapevine in this State. They shall each hold office for the term of four years, excepting that, of the nine first appointed, four to be determined by lot, shall retire at the end of two years, when their successors shall be appointed by the governor.

SEC. 3. The board shall elect from among their own number a president, a vice-president, and a treasurer, and they shall appoint a secretary, who shall not be one of their number, and whose salary shall not exceed one hundred dollars per month. And the board shall determine and fix the amount of bonds that shall be given by the treasurer and secretary for the faithful performance of their duties.

SEC. 4. It shall be the duty of the board to meet semi-annually to consult and to adopt such measures as may best promote the progress of the viticultural industries of the State. It shall be their duty to select and appoint competent and qualified persons to deliver at least one lecture each year, in each of the viticultural districts named in section one of this act, for the purpose of illustrating practical viticultural topics, and imparting instruction in methods of culture, pruning, fertilizing, fermenting, distilling and rectifying, treating diseases of the vine, raising, drying, &c., for the better instruction of the people interested therein, as the requirements of each district may show to be necessary and important, and to disseminate all such useful knowledge relating to viticulture, by printed documents or correspondence, as may be within their power to do. The board shall devote especial attention to the study of the phylloxera and other diseases of the vine, and shall make such recommendations in their semi-annual reports as they may deem best for the protection of vineyards.

SEC. 5. The commissioners constituting the board shall serve without compensation and shall be allowed only their actual transportation expenses to and from their places of residence when attending the semi-annual meetings of the board.

SEC. 6. The office of the board shall be in the city of San Francisco, and shall be kept open to the public, subject to the rules of the board, every day, excepting legal holidays, and shall be in charge of the secretary during the absence of the board.

SEC. 7. It shall be the duty of the secretary to attend all regular meetings of the board, and to preserve records of proceedings and correspondence; to collect books, pamphlets, periodicals, and other documents containing valuable information relating to viticulture, and to preserve the same, to collect statistics and other information showing the actual condition and progress of viticulture in this State, and elsewhere; to collect information concerning lands suitable for viticulture, and to impart to the public, upon proper demand being made, information concerning the localities of such lands, prices, cost of cultivation, and means of transportation; *provided*, that he shall receive no fees for such services; to correspond with agricultural and viticultural societies, colleges and schools of agriculture, and other persons and bodies political or private, and disseminate information printed or otherwise as he may be directed by the board of commissioners, and to prepare, as required by the board, semi-annual report for publication.

SEC. 8. And for the further promotion of viticultural interests, it shall be the duty of the board of regents of the University of California to provide special instruction to be given by the agricultural department of the University in the arts and sciences pertaining to viticulture, the theory and practice of fermentation, distillation, and rectification, and the management of cellars, to be illustrated by practical experiment with appropriate apparatus; also, to direct the professor of agriculture or his assistant to make personal examinations and reports upon the different sections of the State adapted to viticulture; to examine and report upon the woods of the State procurable for cooerage, and the best methods of treating the same; and to make analysis of soils, wines, brandies, and grapes at the proper request of citizens of the State; also to prepare a comprehensive analysis of the various wines and spirits produced from grapes, showing their alcoholic strength and other properties, and especially any deleterious adulterations that may be discovered. The regents shall also cause to be prepared, printed, and distributed to the public quarterly reports of the professor in charge of this work, relating to experiments undertaken, scientific discoveries, the progress and treatment of the phylloxera and other diseases of the vine, and such other useful information as may be given for the better instructions of viticulturists.

SEC. 9. The board of regents of the University shall be authorized to receive and accept

donations of lands suitable for experimental vineyards and stations, and shall submit in their next annual report an economical plan for conducting such vineyards, and for the propagation and distribution of specimens of all known and valuable varieties of grapevines.

SEC. 10. There is hereby appropriated, for the purpose mentioned in this act, the sum of seven thousand dollars, to be apportioned as follows: For the necessary and contingent expenses of the board of State viticultural commissioners, four thousand dollars, and for the University of California three thousand dollars; and the State controller shall draw his warrants upon the State treasurer in favor of the treasurer of the said board of State viticultural commissioners and of the University of California, for amounts of four thousand and three thousand dollars respectively, as hereby appropriated, upon proper demand being made for the same; *provided* that the said board of State viticultural commissioners shall, in the month of December, submit to the governor annual statements, duly verified by the oaths of the presidents and treasurer and attested by the secretary of said board, showing in detail the manner in which moneys received from the State have been expended, and also the amount remaining unexpended, together with an estimate of expenses for the ensuing year, beginning on the first day of July next thereafter.

SEC. 11. This act shall take effect and be in force from and after its passage.

## CHAPTER LI.

AN ACT to define and enlarge the duties and powers of the board of State viticultural commissioners and to authorize the appointment of certain officers, and to protect the interests of horticulture and viticulture. (*Approved March 4, 1881.*)

*The people of the State of California, represented in senate and assembly, do enact as follows:*

SECTION 1. The board of State viticultural commissioners, in addition to the duties and powers provided for by the act entitled "An act for the promotion of viticultural industries of the State," approved April fifteenth, eighteen hundred and eighty, shall, in respect to diseases of grapevines and vine pests, constitute a board of health. It shall, in addition to laboratory work, cause practical experiments to be made to determine or demonstrate the utility of known and new remedies against such diseases and pests.

SEC. 2. The board shall elect of their own number, or appoint from without their number, a competent person to serve as chief executive viticultural officer, who shall perform also the duties of viticultural health officer, under direction of said board, and subject to removal from such office at any time by the board.

SEC. 3. The viticultural health officer shall have power, subject to the approval or enforcing rules and regulations in the nature of quarantine; to govern the manner of, restrain, or prohibit the importation into the State, and the distribution and disposal within the State, of all vines, vine cuttings, debris of vineyards, empty fruit boxes, or other material on or by which the contagion of vine diseases and germs of vine pests may be introduced into the State, or transported from place to place within the State; to declare and enforce regulations approved by the board for the disinfection of vines, vine cuttings, vineyard debris, empty fruit boxes, and other suspected material dangerous to vineyards, while in transit, or about to be distributed or transported into or within the State; to classify the vineyards and viticultural regions of the State according to the degree of health or vine disease prevailing therein, and to change the same as circumstances may require to be done, subjecting each class to such varying rules and regulations, respecting the introduction or transportation of vines, vine cuttings, and other material liable to spread contagion of diseases among vines, as may, in the opinion of the board become necessary and expedient for the preservation of vineyards. Such rules and regulations shall be circulated in printed form by the board among the vine growers and fruit dealers of the State, shall be published at least thirty days in two daily newspapers of general circulation in the State, not of the same city or county, and shall be posted in a conspicuous place at the county seat of each county affected by their provisions.

SEC. 4. The viticultural health officer may appoint local resident inspectors in any and all of the viticultural regions of the State, whose duties shall be to report to him concerning the health of grapevines, the progress of vine diseases and pests, and all violations of the rules and regulations of the board; to certify to the proper disinfection of vines, vine cuttings, empty fruit boxes, and other transportable articles required by the board to be disinfected before transportation or while in transit, or after delivery at any point of destination, the methods of disinfection to be determined and approved by the health officer and the board; to seize upon and destroy all vines, vine cuttings, debris of vineyards, empty fruit boxes, and other material liable to spread contagion, which may be found in transit, or delivered after trans-

portation, not certified to as required by the board: *Provided*, That the same may be exempt from such destruction if the cost of disinfection by such inspector shall be provided for by the owner or agent in charge thereof, as may be prescribed for such cases of negligence, carelessness, or violation of quarantine rules, and to keep a record of all proceedings as such inspectors: *Provided*, That there shall be no compensation for such services of inspection excepting a fee not to exceed one dollar for each certificate of disinfection, in case of compliance with quarantine regulations, and not to exceed five dollars for each certificate of disinfection after seizure for non-compliance: *Provided, however*, Such inspection may be employed at the option of the owner of property requiring disinfection to disinfect the same. All vines, or other articles absolutely prohibited of importation, or transportation, may be promptly destroyed by any inspector discovering the same transported or in transit, in violation of regulations, and the cost of such seizure, together with a fee of ten dollars, shall be paid to such inspector out of any fine that may be collected from the party or parties guilty of such violation. Willful violation of the quarantine regulations of the board shall be considered a misdemeanor, and punishable by a fine of not less than twenty-five nor more than one hundred dollars. Whenever required for the convenience of vine or fruit growers or fruit dealers, a resident inspector shall be appointed upon petition of any three neighboring vine or fruit growers, or dealers in grapes, to reside in their vicinity, if not already provided for; and there shall be not less than two inspectors appointed for each county which is subject to such quarantine regulations, and they shall each be subject to removal at the will of the viticultural health officer, if incompetent, or they fail to perform their duties, or are unreasonably distasteful to vine growers and grape dealers.

SEC. 5. It shall be also the duty of the chief executive viticultural officer to personally visit, examine, and report upon the several viticultural regions of the State; to prepare documents for publication, as required by the board, relating to any and all branches of viticultural industry, including treatises for the instruction of the public; to supervise the preparation of reports for publication, and especially report upon the practicability and means of eradicating diseases from vineyards, and to superintend experiments with known and new remedies.

SEC. 6. All printing heretofore ordered by the board shall be paid for out of the appropriation heretofore made for its use. All printing required hereafter shall be done by the State printer.

SEC. 7. The salary of the chief executive viticultural officer shall be fixed by the board, not to exceed one hundred and fifty dollars per month, for services while engaged as such officer, and his actual traveling expenses shall be allowed, not to exceed five hundred dollars per annum.

SEC. 8. The board of State viticultural commissioners shall also appoint an officer, who shall be especially qualified by practical experience in horticulture for the duties of his office, to perform similar duties respecting the protection of fruit and fruit-trees as are provided for in this act in reference to grapevines, with like power; and the salary and traveling expenses of such officer shall be fixed by the said board at the same amount provided for in the case of the chief executive viticultural officer; and the said board shall have power to establish such quarantine rules and regulations as are required for the protection of fruit and fruit trees from the spread of insect pests.

SEC. 9. There is hereby appropriated for the use of the board of State viticultural commissioners, as set forth in this act, and in the act providing for its organization, out of any moneys in the State treasury not otherwise appropriated, the sum of ten thousand dollars for the year commencing July first, eighteen hundred and eighty-one, and ten thousand dollars for the year commencing July first, eighteen hundred and eighty-two; and the State controller will draw his warrants upon the State treasurer in favor of the treasurer of the said board for the said sum, or any part thereof, when they become available, upon proper demand being made for the same by said board: *Provided*, That no claim shall be paid out of said appropriation until the same shall have been presented to and approved by the State board of examiners.

SEC. 10. This act shall take effect and be in force from and after its passage.

#### CHAPTER LXXV.

AN ACT to protect and promote the horticultural interests of the State.

*The people of the State of California, represented in senate and assembly, do enact as follows:*

SECTION 1. Whenever a petition is presented to the board of supervisors of any county, and signed by five or more persons who are resident freeholders and possessors of an orchard or both, stating that certain or all orchards, or nurseries, or trees of any variety, are infected with scale bug, codling moth, or other insects that are destructive to trees, and praying that a commission be appointed by them, whose duty it shall be to supervise their destruction, as hereinafter provided, the board of supervisors shall,

within twenty days thereafter, select three commissioners for the county, to be known as a county board of horticultural commissioners. The board of supervisors may fill any vacancy that may occur in said commission by death, resignation, or otherwise, and appoint one commissioner each year, one month or thereabouts previous to the expiration of the term of office of any member of said commission. The said commissioners shall serve for a period of three years from the date of their appointment, except the commissioners first appointed, one of whom shall serve for one year, one of whom shall serve for two years, and one of whom shall serve for three years, from the date of appointment. The commissioners first appointed shall themselves decide, by lot or otherwise, who shall serve for one year, who two years, and who three years, and shall notify the board of supervisors of the result of their choice.

SEC. 2. It shall be the duty of the county board of horticultural commissioners in each county, whenever they shall be informed by complaint of any persons residing in such county that an orchard, or nursery, or trees, or any fruit-packing house, store-room, salesroom, or any other place in their jurisdiction, is infested with scale bug, codling moth, red spider, or other noxious insects liable to spread contagion dangerous to the trees or fruit of complainant, or their eggs or larvæ injurious to fruit or fruit trees, they shall cause an inspection to be made of the said premises, and if found infested they shall notify the owner or owners, or the person or persons in charge or possession of the said trees or places, as aforesaid, that the same are infested with said insects or any of them, or their eggs or larvæ, and shall require such person or persons to disinfect the same within a certain time to be specified. If within such specified time such disinfection has not been accomplished, the said person or persons shall be required to make application of such treatment for the purpose of destroying them as said commissioners shall prescribe. Said notices may be served upon the person or persons owning or having charge or possession of such infested trees, or places, or articles as aforesaid, by any commissioner, or by any person deputed by the said commissioner for that purpose, or they may be served in the same manner as a summons in a civil action. If the owner or owners, or the person or persons in charge or possession of any orchard, or nursery, or trees, or places, or articles infested with said insects, or any of them, or their larvæ or eggs, after having been notified as above to make application of treatment as directed, shall fail, neglect, or refuse so to do, he or they shall be deemed guilty of maintaining a public nuisance, and any such orchards, nurseries, trees, or places, or articles thus infested shall be adjudged and the same is hereby declared a public nuisance, and may be proceeded against as such. If found guilty, the court shall direct the aforesaid county board of horticultural commissioners to abate the nuisance. The expenses thus incurred shall be a lien upon the real property of the defendant.

SEC. 3. Said county board of horticultural commissioners shall have power to divide the county into districts, and to appoint a local inspector for each of said districts. The duties of such local inspectors shall be prescribed by said county board.

SEC. 4. It shall be the duty of said county board of commissioners to keep a record of their officers' doings, and to make a report to the board of State viticultural commissioners on or before the first day of November of each year, who shall incorporate the same in their annual reports.

SEC. 5. It shall be the duty of the commissioners at large, appointed by the board of State viticultural commissioners for such purpose, to recommend, consult, and act with the county board of commissioners in their respective counties, as to the most efficacious treatment to be adopted for the extermination of the aforesaid insects, or larvæ, or eggs thereof, and to attend to such other duties as may be necessary to accomplish or carry out the full intent and meaning of this act.

SEC. 6. Each county commissioner and local inspector may be paid five dollars for each day actually engaged in the performance of his duties under this act, payable out of the county treasury of his county: *Provided*, That no more shall be paid for such service than shall be determined by resolution of the board of supervisors of the county for services actually and necessarily rendered.

SEC. 7. Each of said commissioners may select one or more persons, without pay, to assist him in the discharge of his duties, as he may deem necessary.

SEC. 8. If any county board of commissioners after having received complaint in writing as provided for in section two of this act, shall fail to perform the duties of their office, as required by this act, they may be removed from office by the board of supervisors, and the vacancy thus formed shall be filled in the same manner as provided for in this act.

SEC. 9. Nothing in this act shall be construed so as to affect vineyards or their products.

SEC. 10. This act shall take effect immediately.

The following extracts from the proceedings of the convention of fruit growers and nurserymen, held at Sacramento in December, 1881, convey some important information regarding the state of affairs that

occasioned the above legislation, and the measures adopted for the repression of insect pests in the State of California.

Matthew Cooke, chief executive horticultural officer, in an address delivered on the occasion, made these statements:

INVASION OF INSECT PESTS.—From the time that Smith, Hollister, and others planted the fruit orchards on the banks of the American River, until 1875, fruit growers seemingly entertained the opinion that their industry in this State was absolutely safe from the invasion of insect pests, such as were known in orchards in States east of the Rocky Mountains. Alas! they were mistaken. In the summer of 1875, the codlin moth, *Carpocapsa pomonella*, made its appearance in the vicinity of Sacramento, and in the same careless manner in which it was introduced it was allowed to spread. No precaution of any kind was taken to destroy the pest; but, as it were, every facility offered for its spread throughout the fruit-growing districts, especially by the introduction of the package known as the return box. The adoption of this package was a serious mistake, so far as the spreading of this pest was concerned. This I say without fear of contradiction. The codlin moth was introduced into this State in less than five barrels of apples in the fall of 1873, and was noticeable in orchards in the vicinity of Sacramento in 1875, and can be found in orchards in the following named counties at the present time: Butte, Sutter, Yuba, Colusa, Nevada, Placer, El Dorado, Amador, Sacramento, Yolo, Solano, Napa, Sonoma, Lake, Mendocino, Marin, Contra Costa, Alameda, San Joaquin, Santa Clara, San Mateo, Tuolumne, Calaveras, Tulare, Kern, Los Angeles, and in some other counties.

Of the twenty-six counties named, county boards of horticultural commissioners have been appointed in eleven of them. It is unnecessary for me to speak of the amount of damage done to the fruit crop, especially apple and pear, by this pest. Unfortunately it is too well known by all parties interested in fruit growing and the various branches of business connected with that industry. And in order to impress upon your minds the necessity of an immediate warfare for the extermination of this pest, I will refer to reports received from some members of county boards of horticultural commissioners. One of the commissioners states in my report: "I have visited all the orchards in his district; three-fourths of the entire crop of this season has been destroyed by codlin moths. But I can say, to enforce the laws, it would take an army of officers. The fruit grower may be induced to put on the barrels, but to get them examined, as required by the rules, would be an impossibility." This may be taken as a purport of the report from two counties.

Since the appearance of the codlin moth in 1875, orchards, in several sections of the States, have been infested by various species of scale insects. In the citrus groves of Los Angeles we find the so-called red scale, *Aspidiotus aurantii*. It was thought, until this season, that the pest was confined to Los Angeles County, but at present it can be found as far north as Marysville.

The black scale, *Lecanium oleæ*, is to be found on nearly every variety of citrus and deciduous fruit tree in the southern counties and in Central California.

The soft orange scale, *Lecanium hesperidum*, is found on citrus trees throughout the State.

The common apple scale—*Mtilaspis pomicorticis*—is found in Central California, especially in the bay counties and Santa Cruz.

The scale—*Aspidiotus rapax*—is found in some of the bay counties, Santa Cruz, and some of the southern counties, especially Los Angeles.

The so-called San José scale (*Aspidiotus perniciosus*) has infested nearly every variety of deciduous fruit tree in Santa Clara County, and can be found in some orchards in San Joaquin, Yolo, and Solano Counties.

The cottony cushion scale (*Icerya purchasi*) is found in Santa Barbara County in several orchards, and is also reported from Los Angeles and Santa Clara Counties.

The white scale (*Diaspis roseæ*) is found on the blackberry and raspberry vines.

The San José scale, black scale, and the *Icerya purchasi* are found on various varieties of ornamental trees, and, in some cases, on vegetables.

There are several species of scale insects on ornamental trees and shrubs in gardens and other places throughout the State that are certainly dangerous to the fruit interests.

RED SPIDER.—The orchards and gardens throughout the State have a liberal supply of this pest (*Tetranychus telarius*).

CATERPILLARS.—In Marion County a species of tent caterpillar (*Clisiocampa constricta*) has done some damage.

In Santa Cruz the tent caterpillar (*Clisiocampa americana*) and the caterpillar of the Tussock moth (*Orgyia leucostigma*) have done some damage; also in some localities in adjoining counties.

WOOLLY APHIS.—A serious amount of damage has been done to the apple trees throughout the fruit counties by this pest (*Myzocallis mali*).

**BORERS.**—The loss of trees in the orchards and gardens of this State from the different species of borers is very great.

**SAND FLIES.**—The damage done to foliage of pear trees by the larvæ of *Nematus similis* and *Selandria cerasi* (pear slug) in 1881 was double that of any previous year.

Add to the above the fungi (*Fumago salicina*) found on fruit trees infested by black scale and the mildew, and it will be readily seen why a united warfare on insect pests, &c, should be organized. The question is often asked, how and when these insect pests came to the orchards of this State. It is not my intention to discuss the question at present, as I consider it of secondary importance. It is an undisputed fact that they are here, and the prominent inquiry should be, How can they be exterminated?

#### DAMAGE TO ORCHARD PROPERTY.

In the absence of statistical information, I have made diligent inquiry as to the damage done to orchard property in this State, and from such information as I received from reliable sources the actual depreciation in value is not less than \$2,000,000.

#### DAMAGE TO FRUIT CROP OF 1881.

The orchard crop of 1881 produced less than 35 per cent. of choice marketable fruits; or, in other words, less than 35 per cent. of the entire crop produced in 1881 could be classed as choice marketable fruit.

From this statement—and I assure you it is not exaggerated—the prospects of the fruit-growing industry are not encouraging. However, the results are such as would be reached in any other industry conducted in the same manner. The system of fruit-growing as practiced in the past by a large number of orchardists may be termed the "go-as-you-please," and has produced a chaos from which order could only be restored by the aid of legislation. Such legislation has been obtained, and the object of this convention is to construct a solid foundation upon which can be organized an united warfare for the extermination of those evils which through negligence have been allowed to spread throughout the orchards of what may be termed the fruit-growing counties of this State.

The following is an extract from an address delivered by Dr. S. Chapin, of San José, on the same occasion:

By far the most injurious scale pest infesting our orchard trees and fruit is the one known recently as the San José small, round, black scale, and named by Professor Comstock *Aspidiotus perniciosus*. This scale produces terrible results in an orchard when once established. The trees become entirely covered with the scale, so that no portion of the bark can be seen. The fruit also, much of it, is in the same condition, rendering it unfit for use. The losses caused by the ravages of this insect cannot be computed easily. Whole orchards are literally destroyed by it. In many cases those who have recognized its presence and destructive power in time have made most strenuous efforts to stay its spread and save their trees, but it has been to a great degree discouraging, owing to the difficulties encountered in fighting an unknown foe. Within the past year, however, great progress has been made in destroying this insect, and it is hoped that it may be conquered within a reasonable time. It is altogether probable that within the coming year the fact will be made plain that a sure remedy has become available. As yet this terrible pest has not become common over many parts of the State, but it is increasing in localities outside of its starting place, until it now has a foothold which will surely bring sorrow to many orchardists, unless their eyes are opened to the consequences following its appearance and efforts at once directed to its extermination.

There is not time here to enter upon the history and description of this insect, but it is not now necessary, as a report upon it has already been made and is in print, and freely distributed to fruit-growers. I will merely state here that three distinct broods of this scale have been discovered this season; the first winged males of each brood being discovered on these dates: First brood, March 23; second brood, July 2; and the third brood, October 17.

The experiments made this season have been quite extensively carried on, and have, we feel confident, resulted in obtaining knowledge which is of practical benefit to all fruit-growers. A large number of these experiments have been printed in the report alluded to, and are available to you all, and will be more fully set forth in a report which will be submitted to the board of State horticultural commissioners.

Experiments have been very carefully made, using many substances, and their effects carefully noted. The most of these materials used have failed to result satisfactorily. This was expected, and they were tried with the object of demonstrating that fact, as negative results are often very valuable, as from their accurate record much labor and vexations and even ruinous delay is saved. The results obtained have been as

follows, stated in few words: The fact fortunately obtains that the treatment effectual in destroying the *Aspidiotus perniciosus* is likewise effectual for the destruction of all these other species of scale insects. The subspecies found to kill this scale have been concentrated by, first, kerosene; next, 110° or 150° test. These two for winter washes, and are only to be used when the tree is dormant. Then as an effectual application which can and should be made in summer, about the 1st to 15th of June, is the mixture of whale-oil soap and sulphur, known as "codlin moth wash." Referring to the experiments above made, examination was made a few days since of the tree No. 21, where the mixture was used in the summer. Its condition is most satisfactory; not a vestige of scale can be found upon the tree, and the tree is in a very healthy condition, the green layer of bark being rapidly restored.

This wash is highly recommended, and should be used in the strength of 1 pound to 1 gallon water, and, if thoroughly applied at the time named, will afford very satisfactory results. My own judgment leads me to the use of concentrated lye as the best wash for winter use. This should be used as follows: 1 pound of the concentrated lye of the American Lye Company, broken up and dissolved in 1 gallon boiling water, for badly-infested trees; and 1 pound to 1½ gallons water for less infested trees; 1 pound to 3 gallons is well adapted for washing, to cleanse trees of all accumulations of moss and other filth.

I am prepared to aver that young orchards can be kept free from the *Aspidiotus perniciosus* by the right use of concentrated lye and the codlin moth wash. This, however, can only be accomplished by most patient watching and prompt measures when the pest is discovered.

In the orchard mentioned in the report, a careful inspection is often made, and at this date not a specimen of this scale can be found, while I am sure that had the scale first appearing been neglected, the spread of the pest would by this time have been overwhelming. The lesson here presented is, make your examination most searching and do your work thoroughly. It should be stated that the extensive washing of trees this winter by the use of lye and of kerosene will demonstrate fully the value or inefficiency of these materials.

The best methods of applying insecticides is in the form of washes, and the most economical means thus far discovered is by the use of a force-pump with hose attached, and a suitable nozzle, producing a fine spray. Such a pump is the Gould force-pump. Another pump, and much cheaper and as serviceable, is the Merigot force-pump, manufactured at San José for this purpose. The best known spray-tip is the one made at San José by the same party, and called the San José scale bug spray-nozzle. One of the greatest difficulties in the use of strong materials is from the spray falling upon the person of the operator, and burning and injuring the skin. In order to overcome this obstacle I have devised a simple extension nozzle of slight cost, which is very light, and which may be made of any length desired, say from 4 to 15 feet, or even longer. By the use of this extension it is perfectly easy to reach and spray any orchard tree without danger and discomfort.

In conclusion, the cost of apparatus and materials should be given. The Gould pump costs about \$16 without accessories. The Merigot pump, \$12; 5 feet suction, 25 feet best hose, plain nozzle with spray tip complete, excepting the extension nozzle, \$9.50; extension nozzle, 4 feet, \$2; 7½ feet, \$3; extension nozzle 14 or 15 feet long, \$4; branch for attaching two hose, \$1.50; total cost of Merigot pump with accessories, \$27.

Concentrated lye, American Lye Company, 1-pound cans, by the case of 48 pounds, 7 cents per pound; kerosene, 110° test, California, by the barrel, barrel returned, per gallon, 15 cents; kerosene, 150° test, by case, per gallon, 30 cents; whale-oil soap and sulphur mixture, called the codlin moth wash, in quantities of 1,000 pounds, at 6½ cents.

Of other insecticide solutions applicable as washes, a decoction of tobacco and the solution of sulpho-carbonate of potassium (the latter being now manufactured in California) have been very successfully employed.

The use of the vapor of carbon bisulphide, in a vapor-tight tent lowered over the tree by means of a derrick, and tightly fastened around the trunk, seems also to offer a feasible method, of easy applicability in the case of young orchards and in that of the compact-growing citrus trees. The mode of proceeding is described as follows by Mr. John H. Wheeler, secretary of the State boards of viticulture and horticulture:

My tent was of canvas coated with perfectly tight and resistant impenetrable material. The body of the balloon was fashioned with hoops like a cylindrical Chinese lantern, which could be lowered from a derrick, and on completion of the treatment might, by tackles, be drawn up or closed up like a Chinese lantern. From the lower hoop hung a curtain, gathered at the bottom by means of strings, which could be

drawn up about the trunk of the tree and wound tight by the strings. The hoops which held the canvas off from the tree were so made that by means of a thumb screw they could be made large or small, the tent following, of course; by this means economy could be effected in treating trees of small horizontal diameter. Again, by the raising or lowering of the lower hoop the tent would fit trees tall or short. By means of the above adjustments, and the formation of the top of the tent, which was conical, there need be no waste space within and no consequent waste of material. This tent when put up would hold water to the very top.

To supply the sulphide of carbon, and to produce a saturated atmosphere as quickly as possible, I devised a series of three cotton disks suspended one above the other. On to the top one (the whole being suspended in the apex of the cone at the top of the balloon or tent) was poured the liquid bisulphide, which, evaporating in part, ran through on to the second, and then to the third, in such a manner that it all turned to vapor immediately, and, flowing down into the tent, would fill up the bottom first, and then rise to the top in a manner analogous to the filling of a vessel with water. Concerning the time required to put this balloon over a tree and inject the necessary bisulphide, it was found to take five minutes.

The insect to be experimented upon was principally the cottony cushion scale or *Icerya purchasi*, which gave the orange orchard, in parts, the appearance produced by a snow-storm passing over it, so thick were they on the foliage.

The work of applying is as follows :

Picture to yourself a man, woman, or child backing up a two-wheeled cart (weighing not more than 200 pounds, tent, cart, and all) on which is erected a derrick. The tree coming between the wheels, the tent is lowered by string or rope, the bottom drawn up about the trunk. One stroke of the piston of a small force-pump on the cart injects the necessary quantity of bisulphide ( $\frac{3}{4}$  to 1 pound) after passing through a pipe, which follows over the arm of the derrick. By using a little brush broom and caustic solution, or even water alone, the trunk of the tree is freed from the insects, and a cordon of tar, lime, or similar material put about its foot to prevent others crawling up. This is the work of five minutes. For the hour or hour and a half during which the vapor is actively accomplishing its work of destruction, the laborer may be engaged with other balloons, or in pruning, hoeing weeds, &c. Disrobing, the tree is found in virgin condition. As to the cost of this process, it is found that for trees 10 to 14 feet high and 4 to 6 feet in diameter, the cost, including labor, cost of tent for 1,000 trees, bisulphide to be used, and incidentals, will not exceed 15 cents per tree. For large trees the cost multiplies rapidly, in proportion to the space occupied by the tree. In comparing the cost with that of treating by means of a wash, it is to be remembered that the complete extermination accomplished by a single treatment with carbon bisulphide is equivalent, if not more, to the three or four treatments necessary when a wash is used. We find, therefore, that, even if the treatment with carbon bisulphide were necessary to repeat each year (of which I think there is little probability), it would then surpass in economy this treatment by means of washing.

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## QUARANTINE RULES

*For the protection of the viticultural and horticultural industries of the State, declared under instructions of and by authority of the Board of State Viticultural Commissioners. First viticultural quarantine rules and recommendations.*

BOARD OF STATE VITICULTURAL COMMISSIONERS,  
OFFICE OF CHIEF EXECUTIVE VITICULTURAL OFFICER,  
No. 111 Leidesdorff street, San Francisco.

*To all whom it may concern :*

Be it known that I, Charles A. Wetmore, chief executive viticultural and health officer of the board of State viticultural commissioners, being duly authorized and instructed by said board, do declare the following quarantine rules and regulations for the protection of the viticultural industries of this State; and due notice is hereby given as provided by law, to-wit, thirty days of publication in two daily newspapers of general circulation, not of the same city or county, in this State, and by posting

notices in all counties affected by these rules. All parties concerned therein are required to conform thereto, subject to penalties provided for by law for any infraction or evasion of said rules and regulations:

#### QUARANTINE RULES AND REGULATIONS.

**RULE 1.** All cuttings of grape-vines made in this State for sale or distribution outside of the vineyard or vineyards where the same were grown, and intended for new plantations, shall be made solely of the wood of the preceding year's growth; all older wood to be carefully and thoroughly removed before leaving the vineyard where made, and to be immediately destroyed by fire, if removed from such cuttings, wherever seized by any duly-authorized inspector for any evasion or infraction of this rule. The reason for this rule is that the winter egg of the *Phylloxera vastatrix* is, according to the best authorities, found only on the old wood.

**RULE 2.** All cuttings of grape-vines and rooted grape-vines imported from any region or country outside this State, intended for sale, gift, or distribution for plantation in this State, shall be disinfected at the place of first consignment within this State, before being further distributed or planted, the method of disinfection to be at the option of the owner or agent in charge of the said cuttings or vines, according to any one of the following methods, viz:

First. Dissolve sulpho-carbonate of potash in cold water; proportions, ten pounds of sulpho-carbonate to one hundred gallons of water; immerse cuttings and rooted vines fifteen minutes.

Second. Dissolve Little's soluble phenyle by pouring upon it cold water in the proportion of fifty gallons of water to one gallon of the phenyle; immerse cuttings and rooted vines ten minutes.

Third. Take two parts heavy oil of coal tar, two parts water, and one part carbonate of potash or carbonate of soda; put in a covered vessel and heat gently to boiling point for one hour; replace water lost by evaporation; pour into suitable vessels and agitate violently; dilute with fifty parts of cold water; immerse cuttings and rooted vines ten minutes.

Fourth. Dissolve carbolic acid crystals in water, in proportion of one pound of acid to twenty gallons of water; immerse cuttings and rooted vines ten minutes.

Fifth. Dissolve sulphide of potash in the proportion of one pound to twenty gallons of water; immerse cuttings and rooted vines ten minutes.

Sixth. Dilute one part of "liver of lime" in twenty parts of water; immerse cuttings and rooted vines ten minutes. [N. B.—To make "liver of lime," take one pound of quicklime, one pound of sulphur, one gallon of water; mix; boil over quick fire to one-half of volume; agitate before using; dilute with twenty parts of water to one part of "liver of lime."]

Any other efficacious method may be used, provided due notice is given to this office and the same be approved.

#### INSPECTORS.

For the convenience and protection of all interested parties throughout the State, there will be appointed local resident inspectors, as provided for by law, for each section or region where vine-growers desire the same, and upon the application of any three such neighboring growers, or parties intending during the coming season to plant vines, such application to be addressed to this office, and to be accompanied, when-

ever practicable, with nomination of suitable persons for the office of inspector. The other inspectors required by law will be appointed by this office.

#### RECOMMENDATIONS FOR THE FURTHER PROTECTION OF VINEYARDS.

All persons planting new vineyards within the State are advised and strongly urged to consider all roots and cuttings suspected, regardless of origin, and to thoroughly disinfect them, thereby accomplishing the destruction of all possible germs of insect pests upon them, as well also those of fungoid disease, which are becoming dangerous in all parts of the country.

#### CERTIFICATES.

For the further convenience of vine-growers, certificates shall be issued by any inspector residing near the vineyard of the applicant or the person in charge of cuttings or rooted vines, setting forth that the provisions of Rule 2 have been complied with, and shall be entitled to charge in each case not exceeding 50 cents for such certificates made out in duplicate, one certificate being sufficient to cover any quantity of cuttings or rooted vines in the possession of the applicant that may be satisfactorily shown to the said inspector to have been disinfected. Certificates of disinfection shall likewise be given any applicant who desires the same, and who shall satisfactorily show to the inspector that cuttings and rooted vines, other than such as are required to be disinfected by Rule 2, have been properly disinfected in accordance with the recommendations of this office.

#### INFECTED WRAPPINGS, ETC.

**RULE 3.** All packages and the packing materials coming into the State with imported cuttings and vines (referred to in Rule 2) shall be disinfected, at the time of disinfecting the contents thereof, by immersing in or washing with any of the solutions named in Rule 2, provided that the strength of the same, in case of mere washing, shall be increased by the reduction of the water in the same to one-fourth the relative proportions named. If not disinfected, such packages and packing materials shall be destroyed by fire.

#### PENALTIES.

All infractions or evasions of these rules will be punishable according to law.

CHAS. A. WETMORE,

*Chief Executive Viticultural and Health Officer.*

SAN FRANCISCO, November 16, 1881.

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#### HORTICULTURAL QUARANTINE RULES.

*To all whom it may concern :*

Be it known that I, Matthew Cooke, chief executive horticultural and health officer of the board of State viticultural commissioners, being duly authorized and instructed by said board, do declare the following quarantine rules and regulations for the protection of the horticultural

interests of the State; and due notice thereof is hereby given as provided by law, to wit, thirty days of publication in two daily newspapers of general circulation in the State, and by posting notices in all counties to be affected by these rules. All parties concerned therein are required to conform thereto, subject to penalties provided for by law, for any infraction or evasion of said rules and regulations.

#### QUARANTINE RULES AND REGULATIONS

For the protection of fruit and fruit trees from insect pests, namely, insects injurious to fruit and fruit trees, authorized and approved by the State board of viticultural commissioners of California.

In pursuance of an act entitled "An act to define and enlarge the duties and powers of the board of State viticultural commissioners, and to authorize the appointment of certain officers, and to protect the interests of horticulture and viticulture," approved March 4, 1881, the chief executive horticultural and health officer may appoint local resident inspectors in any and all of the fruit-growing regions of the State, whose duties shall be as provided in section 4 of an act entitled "An act to define and enlarge the duties and powers of the board of State viticultural commissioners, and to authorize the appointment of certain officers, and to protect the interests of horticulture and viticulture," provided that there shall be no compensation for such services or inspection excepting a fee not to exceed \$1 for each certificate of disinfection, in case of compliance with quarantine regulations, and not to exceed \$5 for each certificate of disinfection after seizure for non-compliance; provided, however, such inspection may be employed at the option of the owners of property requiring disinfection to disinfect the same. And also said local resident inspectors will be entitled to such other fees as are provided for in cases of conviction and seizures.

1. All tree or plant cuttings, grafts or scions, plants or trees of any kind, infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, that are known to be injurious to fruit or fruit trees, and liable to spread contagion, or any tree or plant cuttings, grafts, scions, plants, or trees of any kind, grown or planted in any county or district within the State of California, in which trees or plants, in orchards, nurseries, or places, are known to be infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, are hereby required to be disinfected before removal for distribution or transportation from any orchard, nursery, or place where said tree or plant, cuttings, grafts or scions, plants or trees of any kind are grown, or offered for sale or gift, as hereinafter provided.

2. All tree or plant cuttings, grafts or scions, plants or trees of any kind imported or brought into this State from any foreign country, or from any of the United States or Territories, are hereby required to be disinfected immediately after their arrival in this State, and before being for sale or removed for distribution or transportation, as hereinafter described; provided, that if on examination of any such importations by a local resident inspector, or the chief executive horticultural officer, a bill of health is certified to by such examining officer, then disinfection will be unnecessary.

3. Fruit of any kind infested by any species of scale insect or scale insects, or the germs thereof, namely, their eggs, larvæ, or pupæ,

known to be injurious to fruit and fruit trees, and liable to spread contagion, is hereby required to be disinfected as hereinafter provided, before removal off the premises where grown, for the purpose of sale, gift, distribution, or transportation.

4. Fruit of any kind infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, imported or brought into this State from any foreign country, or from any of the United States or Territories, are hereby prohibited from being offered for sale, gift, distribution, or transportation.

5. Fruit of any kind infested by the insect known as codlin moth, or its larva or pupa, is hereby prohibited from being kept in bulk or in packages or boxes of any kind, in any orchard, storeroom, salesroom, or place, or being dried for food or any other purposes, or being removed for sale, gift, distribution, or transportation.

6. Fruit boxes, packages, or baskets used for shipping fruit to any destination are hereby required to be disinfected as hereinafter provided previous to their being returned to any orchard, storeroom, salesroom, or place to be used for storage, shipping, or any other purpose.

7. Transportable material of any kind infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, is hereby prohibited from being offered for sale, gift, distribution, or transportation.

8. Tree or plant cuttings, grafts or scions plants or trees of any kind may be disinfected by dipping in a solution composed of not less than 1 pound of commercial concentrated lye to each and every 2 gallons of water used as such disinfectant, or in any other manner satisfactory to the chief executive horticultural and health officer.

9. Empty fruit boxes, packages, or baskets may be disinfected by dipping in boiling water, and allowed to remain in said boiling water not less than two minutes; said boiling water used as such disinfectant to contain in solution not less than 1 pound of concentrated potash, or three-fourths of 1 pound of concentrated lye, to each and every 20 gallons of water, or in any other manner satisfactory to the chief executive horticultural and health officer.

10. Fruit on deciduous and citrus trees infested by any species of scale insects or the germs thereof, namely, their eggs, larvæ, or pupæ, may be disinfected before removal from the tree, or from the premises where grown, by washing or thoroughly spraying said fruit with a solution composed of 1 pound of whale-oil soap and one-fourth of 1 pound of flour of sulphur to each and every  $1\frac{1}{4}$  gallons of water used as such disinfectant, or in any other manner satisfactory to the chief executive horticultural and health officer.

11. Owners of fruit of any kind grown in any orchard, nursery, or place in which trees or plants are known to be infested with any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, and all persons in possession thereof or offering for sale, gift, distribution, or transportation, are hereby required to procure a certificate of disinfection before removal for sale, gift, distribution, or transportation.

12. Any tree or plant, cuttings, grafts, scions, plants, or trees of any kind, empty fruit boxes, fruit packages, or fruit baskets, or transferable material of any kind, offered for sale, gift, distribution, or transportation, in violation of the quarantine rules and regulations for the protection of fruit and fruit trees, approved by the board of State viticult-

ural commissioners, may be seized by the chief executive horticultural and health officer, or by any of the local resident inspectors appointed by him; said seizure to be the taking possession thereof, and holding for disinfection, or for an order of condemnation by a court of competent jurisdiction.

13. Any person violating the above quarantine rules and regulations shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punishable by fine of not less than twenty-five nor more than one hundred dollars.

MATTHEW COOKE,

*Chief Executive Horticultural and Health Officer.*

SACRAMENTO, *November 12, 1881.*



# ARIZONA AND NEW MEXICO.

BY R. W. FURNAS.

The topography and general characteristics of New Mexico and Arizona are much the same, and in this report, where not otherwise specifically mentioned, will be treated substantially under the same head.

The obstacles encountered in matter of transportation off the line of railroads were such as to prevent the commission from seeing and examining all localities desired.

A general summing up with reference to viniculture and horticulture of the two Territories warrants the belief that in the main what is said of California may be said of the most favored localities, in both Arizona and New Mexico, where irrigation is feasible.

The general character of the valleys is the same, and where experiments have been made results correspond. Arizona and New Mexico are, comparatively speaking, new and in the "heyday" of their precious-metal experience, and attention is almost exclusively given in that direction. Still, there are those who find the "almighty dollar" to satisfaction in tilling the soil. In Arizona there are numerous fertile valleys. Gila, Salt River, Little Colorado, Verde, San Simon, Sulphur Spring, San Pedro, Tonoita, Babacomoroi, Santa Cruz, Cienego, Arivaca, and Arivaipai are of note, with the smaller ones, Kirkland, Skull, Date Creek, Williamson, Big and Little Chino, Aqua Fria, Hassayampa, Big Sandy, in all of which more or less has been done in the way of successful experiments, agriculturally, viniculturally, and horticulturally. More, perhaps, has been accomplished in matters to which this report is more especially devoted in Salt River Valley, Maricopa County, than at any other point in Arizona. It is known in Arizona as the "garden spot of the Territory." Here the semi-tropical fruits, oranges, lemons, limes, figs, and European varieties of wine and raisin grapes are successfully grown. Wine-making has been engaged in to quite an extent, producing wines which compare favorably with those of California. It is found, too, that canning apricots and peaches is quite a successful industry in the surrounding country.

In the counties of Yuma and Mozave, embracing the great Colorado Valley, semi-tropical fruits have been grown satisfactorily. In Graham County, embracing the upper valley of the Gila, fruits of all kinds do well. The Valley of Santa Cruz, especially near Tucson, has been cultivated successfully for hundreds of years. The soil is rich and well adapted for fruit-growing. In the Sonoita Valley, southeast from Tucson some 50 miles, experience has shown that fruits for canning purposes, and grapes for wine and raisins, can be successfully grown.

In Pinal County, the valley of the Gila and San Pedro, peaches, pears, grapes, apricots, figs, quinces, and pomegranates have been tested, and the results are satisfactory. Those who have experimented freely express the belief that the region is peculiarly adapted to fruit culture, and predict it will ere long become one immense orchard and vineyard.

At and in the vicinity of all the old Franciscan missions are to be found evidences of early fruit-growing and wine-making. The old San Xavier del Bac mission, near Tucson, established as early as 1694, furnishes such evidences. Also the ruins of Saint Joseph, below Tubac. Others might be named, but these will suffice for present purposes.

## DATA REGARDING AGRICULTURE IN NEW MEXICO.

As representative localities, Albuquerque Bernalillo, Socorro, Las Cruces, Mesilla, Upper Menbris, Hudson's Hot Springs, Belen, Las Lunas, Las Vegas, San Juan, and Santa Fé were visited and data obtained.

We find sufficient has already been done in New Mexico to demonstrate that all fruits flourishing in the Middle States are grown successfully in nearly all parts of the Territory; that is, in the valleys and foot-hills.

In Southern New Mexico semi-tropical fruits, oranges, lemons, pomegranates, and European varieties of grapes are grown to satisfaction.

The commission was pleased to note and report a greater area of available arable land in New Mexico than is generally supposed. The valleys are numerous, through which course rivers and streams of greater or less proportions. Some of the principal ones are, Rio Grande, San Juan, Chama, Canadian, Santa Cruz, Picures, Pojoaque, Tesque, Gallistio, San Cristoval, Colorado, Taos, Lucero, Pueblo, Pinos, Ojo Caliente, San José, Gila, Pecos, Benito, Hondo, Concho, Mora, Navajo, Cimarron, Vermijo, Rito Blanco, Florido, Animas, Plata, Chiquito, Zuni, Seven Rivers, Peñasco, Agna, Negra, and other smaller ones.

The valley of the Rio Grande, from the mouth of the Rio de Taos to the Mexican boundary, is between 300 and 400 miles long, with an average width of not less than 100, in which it is estimated there are 2,600 square miles of tillable land, with abundance of water for irrigating purposes.

All who have had experience agree that *wine* is one of the four great agricultural products of New Mexico—cattle, sheep, wool, and wine.

The whole valley of the Rio Grande, from a northern point, say near the latitude of Santa Fé, south, is found to be a fine wine-growing district. The native wine here made is popular, and is being exported to quite an extent.

The principal grape grown, and which has been cultivated for hundreds of years, is that known on the Pacific coast as the "Old Mission." Of late years more skilled attention has been given to the grape and wine industry, followed by increased and more satisfactory success. New vineyards are being planted, and the wine product is becoming more an article of commerce and profit.

At Bernalillo it is found that nearly all who cultivate the soil engage more or less in grape-culture and wine-making. The variety, in native parlance, is, "The old black sort our fathers always had—Mission."

A few persons we found cultivating the Muscat of Alexandria, and Muscatella Gordo Blanco—raisin varieties. But little attention, however, is given to raisin-making. Some were dried simply without sweating or packing, and were really fair as raisins.

The quality of such grapes as are raised in New Mexico we think not inferior to those grown in California. Digressively, we are reminded of irrigation. Here in New Mexico, as a rule, less water is used in irrigating than generally heretofore in California. The natives claim this as a reason for superior products. The commission noted in California that in very many instances there was over irrigation (too much water), followed by an inferior product. In fact, most successful irrigators everywhere now are those who use the minimum quantity of water. It is found that until of late years, comparatively, fully three-fourths more water has been used than was conducive to best results.

From Bernalillo there was shipped, 1881, over 25,000 pounds of table-grapes. Peaches, pears, apricots, and apples succeed well in this vicinity. Peaches cannot be depended on north of this point, except perhaps in peculiarly sheltered and otherwise favorable localities.

South, to El Paso, may be found in perfection white and red wines. An important feature is that we heard of no ills to which the vine has, thus far, been subject in New Mexico.

In the Pecos Valley, near Anton Chico, grapes and peaches are grown in profusion and perfection; and so for near 100 miles below Fort Sumner.

At Santa Fé abundance of staple fruits were found; nothing, however, of a semi-tropical character.

In the valley of the Navajo are found fine peach orchards; also 50 miles west of the Sierra Madre summit. At the mouth of the Zuni, in the valley of the Little Colorado, is said to be a most excellent fruit region.

After personal visitation and observation of portions of New Mexico named, and obtaining reliable information from nearly all parts of the Territory, we learn that, especially in, say, the southern half, the soil, climate, and general conditions are much the same as found in California. In many places the same peculiar soil formation exists as that by which the Sonoma and Napa regions in California are characterized and have become noted as wine-producing localities—decomposed volcanic rock, which it is claimed imparts to grapes desired and essential vinous property.

Therefore, to conclude, we feel warranted in asserting a belief that those particular sections of New Mexico indicated are well adapted to growing such grapes as are most in use and required for successful wine-making; and also such fruits as are most desirable for commercial purposes—canning and shipping.

