Oregon Agricultural

EXPERIMENT STATION.

Bulletin No. 45. - - June, 1897.

Prunes in Oregon.

"Dryed plums, which are commonly called Prunes, are wholsomer, and more pleasant to the stomacke, than the greene plums: they yeeld much better nourishment, and such as cannot easily putrifie, by reason that their crude and superfluous moisture is dryed up and consumed. The Damask and Spanish Prunes are the best, because they are the sweetest: being boyled in brothes, they loose the belley, and excrete out choler: being stewed and eaten betweene or before meales, they are most pleasant to the taste, excellently refresh a weake stomacke and doe also mollifie. They are most convenient for them that are of a cholericke or sanguine constitution. French Prunes, and all such as are somewhat sour in taste, are somewhat of a binding, and not of a soluble faculty."

Published in London in 1628 by T. VENNER, "Doctor of Physics."

The Bulletins of this Station are sent free to all residents of Oregon who request them.

AGRICULTURAL COLLEGE PRINTING OFFICE
L. M. LELAND, G. M. CLARK, Printers.
Corvallis, Oregon, 1897.

BOARD OF REGENTS.

J. T. APPERSON, President, ...*Oregon City.*
W. E. YATES, Secretary, ...*Corvallis.*
J. K. WEATHERFORD, Treasurer,.....*Albany.*
WM. P. LORD, Governor, ... *Salem.*
H. R. KINCAID, Secretary of State, ... *Salem.*
G. M. IRWIN, Supt. Public Instruction, ... *Salem.*
WM. M. HILLEARY, Master State Grange, ... *Turner*
T. W. DAVENPORT, ...*Silverton.*
W. P. KEADY, ...*Portland.*
WALLIS NASH, ... *Portland.*
BENTON KILLIN, ...*Portland.*
JOSEPH M. CHURCH, ...*La Grande.*
SAMUEL HUGHES, ...*Forest Grove.*

COMMITTEES.

EXECUTIVE.

BENTON KILLIN, Chairman, W. E. YATES, Secretary. J. T. APPERSON, WILLIAM M. HILLEARY, SAMUEL HUGHES.

FINANCE.

BENTON KILLIN, WM. M. HILLEARY, J. M. CHURCH.

AGRICULTURE AND CHEMISTRY.

BENTON KILLIN, WILLIAM M. HILLEARY.

HORTICULTURE AND ENTOMOLOGY.

SAMUEL HUGHES, J. K. WEATHERFORD.

MECHANICS AND HOUSEHOLD ECONOMY.

J. K. WEATHERFORD, SAMUEL HUGHES, WALLIS NASH.

LITERARY DEPARTMENT AND LIBRARY.

WALLIS NASH, T. W. DAVENPORT.

ADVERTISING AND PRINTING.

W. P. KEADY, W. E. YATES.

BUILDINGS AND GROUNDS.

W. E. YATES, J M. CHURCH.

FARMERS' INSTITUTES.

J. K. WEATHERFORD, W. E. YATES.

OFFICERS OF THE STATION.

H. B. MILLER, ...*President and Director.*
H. T. FRENCH, M. S., ...*Agriculturist.*
G. W. SHAW, Ph. D., ... *Chemist.*
U. P. HEDRICK, M. S., ...*Horticulturist and Botanist.*
A. B. CORDLEY, B. S., ...*Entomologist.*

PLATE I. SHOWING WELL CULTIVATED ORCHARD.

Oregon Agricultural College.

Corvallis, Oregon, January.— 1897.

The following bulletin on prunes is respectfully submitted to the fruit-growers of Oregon. The bulletin is the outgrowth of a demand among our fruit-growers, in the beginning of an almost new industry, for information dealing with the known facts and methods relative to the industry. The bulletin is, then, essentially only a preliminary report, facts being as yet too meagre and fragmentary to allow of a finished account being published. The writers only hope that it is up to date in the teachings and conclusions set forth and that they as fully as possible meet the demand for such information. Various problems touched upon in this bulletin are still matters of experimentation, to be more fully considered after conclusive results are obtained from experiments now planned or in progress; this is especially true of all questions relating to the evaporation of fruits, to certain diseases and insects, and to some chemical problems. Some parts of Bulletin No. 40, "Prunes, Apples, and Pears in Oregon," are incorporated in this bulletin.

U. P. HEDRICK, Horticulturist and Botanist.

IS THERE PERMANENT PROSPERITY FOR THE OREGON PRUNE INDUSTRY?

APPLICATION OF THE LAW OF VALUE TO THE PROBLEM.

H. B. MILLER, Director of Station.

Many persons are misled in their selection of crops by not having a clear conception of the law governing values. If a big price is realized this year for a given product, thousands of people rush into the business and soon the market is demoralized. The market price of a thing is only one side to the law of value, and before we engage in the permanent production of anything like prunes, we must examine the other and more important as well as the more difficult side of the question; and that is the cost of production. The cost of production in this sense includes growing, curing, preparing and sending to market. After becoming convinced of a permanent demand for a thing, the next step to consider is the natural advantages of production and transportation. This is a broad field and one requiring much careful thought and deliberation.

If the climatic and soil conditions in France, Austria-Hungary or any other foreign country, be better for the production of prunes than this country; if the cost of labor is also permanently less, and the cost of transportation to our market no greater than ours, then it would be folly for us to engage in the business unless the government provides a protection by tariff legislation.

If we have advantages of soil, climate, transportation and labor cost, over any foreign country, or not having these, the government provides for any or all of these deficiencies by a protective tariff; then the scope of our investigation is reduced to our own country, provided that the market is here.

The consumption of prunes in the United States is growing rapidly. In 1891. the importation of prunes to the United States was 34,000,000 lbs., and the production was 29,000,000 lbs.

The consumption could not have exceeded 63,000,000 lbs. of prunes in a dried state. In 1895, the importation was 14,000,000 lbs. and the production about 69,000,000 lbs., showing an increase in consumption of about 20,000,000 lbs. in four years. The consumers pay from ten to fifteen cents per pound for these. When the consumers can procure these prunes at from six to ten cents per pound, as they should and will no doubt ere long, the consumption of prunes will demand a larger production.

The prune grower can look for a much greater consumption of prunes and a more certain and steady market in the future, with a much greater degree of certainty than he can expect increased prices. A strong healthy and reliable market even at past prices, is much more to be desired than an uncertain and fluctuating market.

As to the production of prunes in this country, it seems to be settled, for various reasons, that no other section of the country can compete with the Pacific Coast.

The prospect of a market being assured, the next problem to consider is, — can we compete with California, the greatest prune producing section of the world? If their cost of production is from a half to one cent a pound less than ours, then they will eventually kill the industryin Oregon. California makes a claim of producing a better grade prune; one containing more sugar. While their claim is not altogether true, there is no reason for us to be discouraged if our cost of production is low, for the question of permanent success hinges upon the cost of producing good fruit for the masses. If after a careful examination of all the facts relating to competition with California, we become convinced that the industry can be made a success here, and we concluded to engage in prune growing in Oregon, then we have to consider the same question again, and determine which section of Oregon will produce prunes the best, for there is a great difference in the different parts of our own state. After having determined which section of the state is the best suited, we must still keep the cost of production in view. Will we get the largest and best continuous crops from sandy loam, river bottom land, the ordinary gray valley land, or the red hills? Look at the subject from any point you will, the economic law of cost of production must be the primary factor. If other sections with their natural

influences, can produce them at a less cost, it is folly to rely upon the expectation of an exorbitant price and engage in the industry on wild hopes of a great market. The lowest cost of production for the market will win the day in the production of fruits as in all else.

Law of Value.

The value will be governed by the cost of producing the most expensive part of the required amount. For example, if it should cost one cent a pound more to produce prunes in California than in Oregon and the market required the California product in addition to ours, there would be an assurance of profit to the Oregon producer. If one-third of the prunes raised are produced on hill lands at a cost of half a cent a pound more than on bottom lands, and the market would not take the prunes at the highest cost, then those engaged in prune growing on the hills would have to give up. It is a grievous mistake to engage in production simply on an examination of market rates. If the elements at command insure the lowest cost of production, then there need be no hesitancy whatever in entering the field with confidence and assurance of success if proper attention is given.

This law is so unerring that if the elements of it are followed there need be few failures. The cost of production of prunes in Oregon will vary from two to five cents per pound. Those who can produce at a cost close to this lower cost-line, are assured of a continuous and profitable industry, while those along the higher cost-line may depend upon a hard struggle with every prospect of failure.

In the production of prunes for market in the green state, the same law holds good, and must be the rule of action in determining the wisdom of any locality building up the business. This law is becoming clearer every year, in almost every line of industrial life as is shown by the specializing of manufactured as well as all kinds of agricultural products.

Any locality that can produce a certain line of marketable products the best with the least labor, is leading and producing profits in that line.

The question is constantly being asked—"Is there not great danger of overproduction of prunes?"—"Will it pay to engage in the industry?" Many who have already planted orchards are

wondering whether or not the supposed overproduction will make it unprofitable for them to continue.

A careful examination of the principles outlined above, seems to answer this question completely. The question for the prune grower to determine is not—"Will there be an overproduction," but, "Can I produce near the lowest cost?" If there is an overproduction, those laboring under the most expensive difficulties and whose cost of production is along the higher margin, will be the ones who must discontinue the business; while those whose production is the cheapest can continue with an assurance of profit. The whole question of prune producing in Oregon must be solved by those who undertake it, through the practical competition of cost of production.

There is too great a margin between the amount received by the producer and the amount paid by the consumer. This phase of the subject must eventually be solved by the producer. Prune growers' organizations, I believe to be the only practical method by which this margin of difference can be substantially and permanently reduced.

PRUNE GROWING IN OREGON.

U. P. HEDRICK, Botanist and Horticulturist.

1. General Culture.

INTRODUCTION.

The prune interests are greater than all other orchard interests in Oregon. Within the last half decade the industry has grown from insignificance to be one of the large commercial enterprises of the state. If the market for the product, dried and green, increases in the future as in the past the outlook is most promising for a great industry; for, the prune in Oregon has much in its favor. Climatic conditions are good; the soil is such that productiveness is insured; and there is a comparative immunity from pests. With these advantages Oregon can safely defy competition in the cost of production of prunes, and prune growers can rest assured that there is a good foundation for their industry.

There are about 26,000 acres devoted to prune growing in Oregon. Prunes are grown throughout the western part of the state and along the Columbia and its tributaries in Northern and Eastern Oregon, but the major part of the industry is comprised in the Willamette and Umpqua River valleys. In the Willamette Valley, there are about 15,000 acres of prune orchards. As yet most of these orchards are on the black alluvial soil near the river and have not to any appreciable extent encroached upon the red hill soil farther away, though that this soil will produce prunes is certain. The second largest prune district is in the Umpqua River Valley. Here there are about 6,500 acres of prune orchards. The valley of the Umpqua seems to be the most favored region for prunes, trees and fruit reaching their highest perfection there. The Petite or French prune especially seems to thrive; the Italian can be as well, and perhaps better, grown in the Willamette Valley. The Petite prune, and the Italian more or less, are grown very successfully in the Rogue River

Valley also, where there are approximately 1,500 acres. Attempts are being made to grow prunes in Hood River Valley and along the Columbia in Eastern Oregon, but experienced orchardists say that these sections cannot well compete with the more favored prune localities, and that their splendid fruit resources can be used to better advantage in growing other fruits. In these districts there are about 2,500 acres.

CLIMATE.

One of the resources of Oregon is its climate. An adequate estimate of its functions and value as a factor in producing prunes, and its influence upon prune growing, would lead us far beyond the limits of a brief bulletin.

The horticultural effects of the Willamette Valley climate are as follows. All fungous diseases are more prevalent than in the higher and drier valleys. The great prune pest of the state, shot hole fungus, finds a more congenial home and is far more rampant in the Willamette Valley than elsewhere. Brown rot newly introduced into the state, is as yet found only here and will soon be a grievous pest. In the humid atmosphere, moss and lichens quickly cover the trees. Strong winds, a feature of Willamette Valley climate, make it necessary to head low and prune so as to secure strong, stocky trees. Sunburn is not so common as in the warmer and drier valleys. Fruit ripens from one to three weeks later than in the other valleys. Deficiency in sunlight and summer heat makes the growth of some varieties of prunes unsatisfactory.

The chief horticultural effects of the Umpqua, Rogue, and Hood rivers valleys and Eastern Oregon climates, are, in comparison with the Willamette Valley, fewer fungous, but more insect pests:— San Jose scale, red, and yellow spider are more plentiful, except, perhaps, in Hood River. There is an earlier and more perfect ripening of fruits, especially those of summer and autumn, because of the continual sunshine and dry air. On the other hand, Italian prunes do not attain their full size and best characteristics because of being forced into early maturity. Injuries from hot winds and sun-scald are more frequent. Local influences governed by topography are much more marked in these valleys, making it important that fruit locations be selected with great care. More attention must be given to the special

conditions and natural agencies which contribute to the development of fruit in any location. The rainfall is much less and the atmosphere not nearly so humid so that in some places prune growers may have to resort to irrigation.

The same causes that make the differences in the various valleys make local variations also, and these need always to be taken into consideration by the fruit-grower. There are, for example, all through the state small valleys protected from cold winds and heavy fogs and open to sunshine which produce fruits earlier in the season, and of better quality, than locations not so favored. Elevation ministers to the same effect. Rivers moderate climatic influences somewhat. In general, then, the metes and bounds of latitude are set aside somewhat by local modifications, and the intelligent fruit-grower who chooses his location in accordance with climatic condition, will find in the climate a valuable ally.

SOILS.

Soils and stock are intimately related, but of the latter we shall speak hereafter. Prunes thrive best in a rich, loamy, river bottom soil, as is well demonstrated by the splendid orchards grown on that soil in Douglas county. The second best soil is the black loam of the valleys, always provided that it is well drained. At present, most of the Willamette Valley orchards are in this soil, and better ones can hardly be produced, when other conditions are proper. The red lands are third in the list of soils, but as to whether they are desirable is yet to be determined. Great care in selecting locations on red lands must be taken in regard to depth of soil. One of the grievous mistakes made by planters all through Western Oregon is that of planting on shallow soils. This is especially true on the red lands. The minimum depth of soils for prunes is four feet, and as much deeper than that as possible is desirable. Fine prunes are grown on granite soils, but these soils are not lasting and must be irrigated if best results are to be had. The above claims for the various soils are not arbitrary. In fact, location, drainage, and depth of soil have almost as much to do with prune growing as does the kind of soil. It must be remembered that there are infinite gradations between the various soils.

The prune tree is a gross feeder, its limbs growing often-

times several feet in one season, so whatever the soil, it must be rich. On the other hand a soil may be too rich, producing a weak, watery growth not at all desirable. Prunes contain a large amount of water so that it is necessary to have a soil somewhat retentive of moisture, and also one that can be thoroughly tilled, that being essential to proper conservation of moisture. But, as, before stated, the land for prunes must be thoroughly drained. This is to be emphasized at all times since one of the great faults of the prune orchards of Oregon is that they are not on properly drained land. Briefly, the ideal soil for a prune orchard is: a rich, sandy loam, warm, mellow and deep, containing sufficient vegetable humus to give lightness and retain moisture without being damp and heavy, and having good natural or artificial drainage. The character of the soil is not to be determined by surface appearance but by thorough examination.

Procuring Trees.

Oregon is well supplied with good nurseries and a grower can get first-class trees, but many hardly know what they want. One of the chief complaints among the prune growers is in regard to young trees. Procuring trees is so largely a matter of business and good judgement, that anything which any one aside from the buyer could say would be of little value, but a word or two in a general way will be proper here. Patronize the nearest reputable nursery-men, endeavoring to get stock at a low price, but not purchasing simply because of cheapness. Buy only first-class trees, one or two years from the bud, having as an ideal, trees of medium size, with straight, stocky, hard growth; clean trunks; free from borers, insects and injuries; and a perfect union of stock and scion. Have your trees shipped as soon as they can be easily dug, and set them as soon as possible, having the ground in the best condition. Buy only varieties which show the greatest adaptability to your particular location, a point which seems trite, but which nevertheless is not always observed. Varieties in unsuitable locations and mixed orchards are such common faults that particular attention is called to the fact, that only those you know will do well should be planted.

Stocks.

Prunes can be and at one time were grown on their own roots, but their habit of sending up suckers condemmed this

practice. Peach roots were next adopted as a stock upon which to grow them, but in nearly all prune and plum growing regions, excepting the Pacific Northwest, the peach was discarded for the myrobolan plum chiefly; but recently, because it is said to sucker, to dwarf the scion, and to be hard to propagate from cuttings in quantities, the myrobolan has fallen somewhat in disfavor, and the Marianna takes its place in popular favor. The writer is satisfied that peach stocks have been used too commonly in Oregon and that the poor orchards on the heavy, cold, damp soils are largely attributable to the fact that peach stocks were used.

In the prune bulletin issued last year, information concerning any orchards growing on myrobolan or Marianna stocks was asked for. Several letters came telling of experiences with these stocks. I have been able also to visit some orchards having trees growing on myrobolan and Marianna roots. After a careful study of the question in the orchard and from the experience of others I present the following in regard to the relative merits of peach, myrobolan, and Marianna stocks.

The peach is not desirable in Oregon because there are few soils in the state upon which peaches will thrive; peach roots require better drainage than can commonly be given in Oregon; peach stocks are grown from seeds and as each seed produces a tree different from every other one in habit of growth and vigor it follows that the stocks vary in their capacity to develop a good prune tree. Pits for stocks are obtained from fruits too poor for market and hence always have a tendency to degenerate; prunes do not always take well on peach roots and must often be double "worked;" peach stocks are quite susceptible to borers and to diseases so that a prune on peach stock has a precarious and often a short life. In general, then, peach stocks should be used only when a prune orchard is to be set on a strikingly good peach soil.

From the experience of some of our nurserymen and the descriptions given of their myrobolan and Marianna stocks, I fear that in our state the two varieties are sadly mixed, and so before discussing their relative merits as stocks it may be well to distinguish between them.

In his work upon native plums,* Prof. L. H. Bailey, who

*Bulletin 38, Cornell University Agricultural Experiment Station.

has probably given the subject more study than any other horticulturist or botanist, says that the myrobolan belongs to *Prunus cerasifera* and that "the Marianna is either the same species or a hybrid between it and some American plum, possibly the Wild Goose." The following are descriptions of the myrobolan and the Marianna plums,—of the myrobolan as typified by the variety, De Caradeuc,—taken from Bailey.*

"De Caradeuc.—(myrobolan.) Rather large (1 to 1¼ in. in diameter), globular, deep dull purple red when ripe with a prominently colored suture but yellowish green splashed with red when it first becomes edible: flesh thin, very juicy and sweet: cling, the stone rounded ovate, rather turgid, scarcely pointed and evenly pitted; leaves rather firm, ovate oblong. Early. In central New York it ripens from the first to the middle of August (a little later at the Oregon Experiment Station. U. P. H.) Tree, an erect grower.

Marianna.—Large, round, oblong; short stemmed as compared with the De Caradeuc, bright red and finely speckled and covered with a thin bloom; flesh soft and sweet, juicy; semi-cling, the stone like that of De Caradeuc; flowers small, sessile on short stalks in dense lateral clusters like the native varieties, the calyx lobes, narrow and erect; leaves much as in De Caradeuc; a little later than De Caradeuc, but ripens before the Wild Goose. Tree a very spreading grower. C"

It must be remembered that both myrobolan and Marianna as seedlings vary much. The relative merits of the two plums as stocks can only be determined by longer experience. In the past, myrobolan has been mostly used and is to my mind much superior to the peach. Just now, however, there seems to be a well founded opinion that the Marianna is better than the myrobolan for the reasons that it does not dwarf the tree, seedlings do not vary so much, it does not sucker as much as the myrobolan, unites with all varieties while the myrobolan does not, and lastly the cuttings of Marianna root much easier than those of the myrobolan, a point of much importance since properly all stocks should be propagated from cuttings. The indiscriminate use of variable seedlings is to be condemned, as much of the trouble with stocks can be laid to this cause. In this connection it is well to say that in setting stocks from cuttings if uniform results are to be obtained, particular strains should be used and not anything that may happen to be on hand. It is claimed by those favoring the seedlings that the roots formed from cuttings are weak and in the end make a poor root system and

*Bulletin 38, Cornell University Agricultural Experiment Station.

that oftentimes cuttings are diseased in the roots while seedlings are almost universally healthy. Theoretically there are no reasons why a tree from a cutting is not as good as one from a seed, and it is not at all hard to find good thrifty orchards that have been so grown. It is said that most of the myrobolan stocks in California are grown from cuttings.

Fruit-growers often want to grow their own stocks. For such as may want to grow them from cuttings the following method is advised. Nurserymen usually have their own ways of growing them. Cuttings should be taken before the sap begins running in the spring from well ripened wood of the previous year's growth. They should be from six to ten inches long, two-thirds of the length to go in the ground. The soil best adapted for growing them is a good rich loam, well drained and yet always moist as tender roots die quickly in dry ground. The cultivation should be that usually given to seedlings or tender plants just starting to grow.

We advise any one contemplating putting out a prune orchard to thoroughly look into the matter of stocks. Many grievous mistakes have already been made in selecting trees with peach roots. Longer experience will determine the relative value of myrobolan and Marianna stocks just as it has determined their superiority to the peach.

Draining and Subsoiling.

The notion seems to prevail in Oregon that land does not need to be drained for prunes. At least in the hundreds of orchards in the state there are hardly a score that have been drained. With drainage as with fertilization people have the erroneous opinion that a prune orchard can get along without it. To be sure we have a great deal of naturally well drained soil upon which it would be useless to spend money in laying drains, but in the major part of our prune orchards the character of the land is such that water is held in the soil until evaporated from the surface, keeping the soil in such conditon that the roots of the trees are injured and proper spring cultivation is absolutely prohibited. The whole trend of the information obtained from prune men in regard to the ills of their orchards points to drainage as one of the first of the great fundamentals of a rational system of prune growing in Oregon. The need of it can hardly

be over-estimated and fruit-growers must come to look upon the lack of it as the direct and indirect cause of a multitude of the ills of their orchards. Let us glance at a few of the things to be gained by good drainage.

The essential mechanical features of good fruit land demand drainage. There must be an ability to get rid of surplus water if any orchard tree is to grow and thrive, even if the water is only over abundant when the tree is dormant. Proper drainage helps to retain moisture in the dry season, since, if soil has too much water it becomes puddled, then bakes, and sun and wind quickly evaporates all moisture from it. Well drained land is warmer in spring and fall because of not having the cooler water in it; it is cooler in the heat of summer, when proper root growth demands an amount of moisture, coolness, and circulation of air, that can not be had in a baked, parched, soil. A boggy, miry condition of the soil prohibits cultivation often times when it should be given, and so hinders good tillage. Good drainage makes available plant food that is otherwise lost. By allowing a free passage of currents of air, carrying with them rich substances, in the atmosphere, it helps to fertilize a soil. There are still other conditions, which added to these, make underdrainage, as a rule, absolutely necessary in our prune orchards.

We give the following brief directions in regard to the construction of underdrains. Information is easily available from other sources so we need not go very deep into the subject in this connection. Size of tile varies with the amount of water to be carried off, though in Oregon they should never be smaller than three inches because of the great amount of water to be carried off at certain seasons; a row of tile to every two rows of trees would be a good rule thus making the drains 36, 40, or 44 feet apart; the proper depth is, on most lands, about three feet; tile can be as well laid at one time as another provided the ground is soft from the rains; a surveyor should always be employed to run the levels, otherwise the system is almost be unevenly laid. Good burned drain tiles can be obtained in almost all parts of the state and should be used even though the planter lives at some distance from the factory, as open ditches, cobblestones, mole drains, or any cheap substitute is but a temporary makeshift.

In Eastern Oregon dynamite is being used to a limited extent as a means of breaking the hard-pan so that the water can drain through. I believe the method is not an unqualified success both because of expense and inefficiency. On alkali soils, to allow the alkali to be carried downward the same method has been used with a show of success.

Intimately connected with drainage is subsoiling. What has been said about the necessity of drainage largely applies to subsoiling. It is a peculiarity of Oregon soils that you cannot judge the subsoil with any certainty whatever from the surface, nor can you infer that the same subsoil extends for any great distance under the same surface soil. Conditions vary so that every fruit-grower should examine his soil in several places and judge for himself whether any part of his orchard needs subsoiling.

Any soil having an open porous subsoil cannot be benefitted by having the soil made more open. But any soil upon which water stands, or runs off, having a subsoil that is at all compact, and to any great degree impervious to water, ought to be subsoiled. Oftentimes deep plowing will help to accomplish this object. But generally an implement which can be pulled through this compact soil, breaking and loosening it up, must be used. The nature of the soil determines the depth of subsoiling.

Like drainage, subsoiling tends to dispose of surplus water, allowing it to filter through the hard-pan, and also helps to retain it in a dry season, since the water sinks lower in the ground and is not so easily evaporated, but rises gradually by capillary attraction. The act of subsoiling tends at first to dry out a soil, and unless a rain follows before crops are put in may in this way be for a time injurious. Therefore, subsoiling ought to be done sometime before a crop is planted that the soil may contain the proper amount of moisture. The after-cultivation of land that has been subsoiled should be as shallow as possible, thus by mulching the evaporation is checked and moisture is retained. Such cultivation should be frequent and long continued.

Setting Trees.

There are a few points about setting trees which need emphasizing. It is obvious, first of all, that the rows must be straight. Any man with ingenuity and a "good eye" can secure this result. So far as trimming trees before planting is concerned,

it is advisable to cut away all roots which are broken and injured, since a smooth wound will heal more quickly than a ragged one. Roots of inordinate length may of course be cut back to make a symmetrical root system. When a tree is dug, half of the fibrous roots are left in the ground; the top, therefore, ought to be cut back a corresponding amount, or more, since it will require some time for the roots to resume vital activities. Trees not so trimmed often fail to grow at all, or if they do start, are, in their weak condition, destroyed by drouths or pests.

The following rules for tree planting are always in order. The soil should be well firmed about the roots of trees; the roots straightened out in approximately their natural position; the hole should be large and roomy; the earth fine and dry enough to crumble; the tree to be set a little deeper in the soil than it stood in the nursery row; the roots of the tree must not be long uncovered; and every care must be taken to get the tree in its natural environment as quickly as possible. If the operation of tree planting is to be perfect these details must be observed.

Distance Apart.

It is almost a universal fault throughout the state for prune growers to plant their trees too close together. The shrewd growers are convinced of this and will tell you not to plant less than twenty-two feet apart. The Petite prune, perhaps, may be well grown at twenty feet. Trees are gross feeders and need plenty of room. Additional reasons for a greater distance apart are, that it allows of better cultivation, enables you to spray more easily, and it will give you a well formed, strong tree with an individuality of its own.

Cultivation.

The most widespread, and the most serious fault of Oregon prune orchards is *neglect*. Commonest among the many things neglected, is neglect in tillage. It must be said that prune orchards in general yield so abundantly without tillage that it is not to be much wondered at that the prune growers think they do not need tillage. Every orchard is so greatly influenced by special soils and conditions in which it grows that it is hard to attribute the behavior of an individual orchard to either tillage or the lack of tillage. But if a man thinks for a moment of the

PLATE II, SHOWING NEGLECTED ORCHARD.

worked on the share system—a good yield of fruit and of another crop at the same time.

Cultivaton should begin as early in the season as possible and should be given *frequently* thereafter until the time to cease comes, which, in this climate, is the middle of July or the first of August, this always to be governed by the growth the tree is making. Early cultivation is important since it warms up the soil, puts it in good mechanical condition, kills the sprouting herbage, and enables the trees to get quickly at work. Cultivation should stop as soon as the orchard has completed the desired growth so that the trees can ripen and harden their wood for the winter.

We are not sure but at this time a *catch crop* of rye, crimson clover, or some other quick growing plant might not be grown to advantage, to be plowed under in the spring. The merit of such a course would be that the unsightly crop of weeds which springs up after the summer's cultivation is finished, scattering its seeds to the four winds, certainly poor husbandry, would be destroyed; more important than this the mechanical condition of the soil would be greatly improved since it would keep it from running into a puddled mass in the winter, would dry it out more quickly in the the spring, and add very greatly to the vegetable matter of the soil. It would also aid in ripening the wood of the trees. This matter is only a suggestion, however, to be thought over by the grower. The practice is becoming a favorite one with Eastern orchardists and is recommended by Eastern writers.

In a young orchard it is advisable to plow the land each spring for several years. The after-cultivation should be with an implement, which with the minimum expenditure of time and labor will destroy weeds and keep the surface soil loose and friable. There are so many good implements that there need be no trouble in finding one suitable for any purpose. Disk harrows, spring-tooth harrows, clod-crushers, smoothing harrows, weeders, and cultivators all have their places. The reversible disk harrow, we find, is a favorite implement with many Oregon fruit-growers. The frequence with which one should cultivate, depends upon the soil, season, and purpose. Cultivating once a week some seasons is not too often especially if its object is to conserve the moisture. A crust should never be allowed to form

or weeds to become established. The soil should always be left soft and fine if the fresh and grateful effects of a mulch are to be obtained; when left in this condition the roots are enabled to reach every portion of the soil, thus utilizing a maximum amount of plant food much of which otherwise might remain unavailable. An implement should be used which will allow of working close to trees so that high pruning need not be encouraged on account of close working.

Pruning.

Prune trees, generally, have been fairly well pruned in Oregon. It is an operation not at all difficult to learn since the advice given in horticultural books is plain and generally good. Opinions differ as to what the ideal tree after pruning should be. The concensus of opinion of the best growers, as we conceive it, would favor a tree about as follows: A medium, low, roundish, symmetrical top, upon which the fruit can be readily thinned and picked, the tree easily sprayed, and upon which there are strong branches, that will not break with a load of fruit, and that will shelter the stem from the sun. Such a tree will be vigorous, and long lived. While failures are not often caused by neglect in pruning yet they are aggravated by it, and the experience given from all sources presses home in the most convincing way the fact that careful and thorough pruning has much to do with the success of a prune orchard. A man of good judgment will not adopt arbitrary rules for pruning, but the following hints, may be of value to him.

In forming the head the branches should be distributed upon the different sides of the stock as much as possible. It should be formed by selecting several branches well distributed along the stem for a distance of one foot down from the top and pointing in such a way that the head becomes well balanced and symmetrical. The strongest upright branch should be left as the leading shoot and be so trained that other branches can be given off from it. Side branches should be well cut back.

After the head is formed an annual pruning should be given though branches or shoots out of place ought to be removed as soon as discovered. In Oregon, prune growers consider late winter the best time to prune, but the work can be done any time after the wood has thoroughly ripened and before the buds start

in the spring. It is an almost universal fault in a prune orchard to find too much wood. There ought to be just so much wood with so much fruit, to secure which, you may either head back or thin out branches. If headed back, the cut should be made above a bud growing on the upper side of a limb so that the new branch will take a natural upward and oblique position, making a broad, strong branch with great weight bearing power. Be prudent in thinning out the branches of a prune tree as a tree will support many branches, having a tendency to "open up" as the branches become loaded with fruit. Crotches should be avoided, as when two branches of equal size form a crotch it is almost certain that one of them will break.

A pair of pruning shears or a sharp pruning knife is sufficient to do all the pruning needed if the work is undertaken in time. The use of a saw is to be discouraged though it is frequently a necessary evil. In making a cut no projecting spur should be left and the wound should be as small as possible, care being taken not to tear or injure the bark. The cut should always have a good slant. Whenever a wound is made with so great a diameter that it will not grow over in one season, it should be painted with something to keep the wood from checking and rotting. Shellac dissolved in alcohol is good, or ordinary paint may be used. To prune intelligently the habit of growth of the tree, whether upright, spreading, or close growing, should be studied. In fact, in practice, it will be found necessary to give every variety of fruit a little different treatment.

Thinning the Fruit.

One of the striking facts in regard to profits in growing prunes, is the much greater net profit in growing prunes of a large size. Net profits are almost doubled by an increase in size. The question as to why prune growers do not *thin* their fruit and get large prunes is constantly suggesting itself. In looking over the records of the Survey taken last year I do not find a dozen men who practice thinning their prunes other than by reducing the wood of the tree by pruning. The best prunes cannot be grown on overloaded trees. The quantity of fruit in bushels will be the same on a tree whether the fruit is thinned or not, and you have for the trouble of thinning a hand-

somer and much more valuable product. Thinning requires considerable work, but if systematically done it resolves itself in a simple job, and, at any rate, the fruit must be picked sooner or later and the work done in June and July saves just so much work when the crop ripens. From this standpoint, then, it is an extremely shortsighted policy not to thin fruit, but there is another factor which makes the operation still more important.

On trees that have had their fruit thinned there are, of course, many less pits, the large fruits being mostly watery flesh. For the formation of the excessive number of pits in the fruits on unthinned trees it requires a much greater quantity of the mineral elements of the soil and since these are the elements most apt to be wanting and most difficult to obtain it is obvious that the growth of a tree, overloaded with fruit, is checked, its vitality weakened, and in the end productiveness lessened.

During most seasons, on overloaded trees, much of the fruit drops. Had this fruit been taken off at the proper time there would have been a much less strain upon the tree. If properly thinned, the danger from "brown rot" or "plum rot," which has shown itself in the state and which threatens to do considerable damage, will not be so great, since the disease is communicated from fruit to fruit, hence will be worst where the fruit is thickest.

The thinning can be best done when the prunes are about the size of the end of one's thumb, though no set rule can be given for the operation. The quantity removed must vary with the size, and vigor of the tree, the variety, and the way in which the tree has been pruned. When the work is done the fruit should be evenly distributed over the tree, making due allowance for the size and strength of the various branches. With a little experience a tree can be very easily thinned, the prunes being pulled off by handfuls. The work is much facilitated if the tree has been well pruned, since pruning reduces the necessity and makes it easier to get at the fruit on the tree.

Pollination of Prunes.

Within recent years the importance of cross-pollination for some fruits has been clearly demonstrated by several scientific workers. The matter was first brought prominently before horticulturists by Waite* of the Agricultural Department at

*M. B. Waite, U. S. Dept. Agrl., 5th Div. Path.

Washington in his bulletin on the pollination of pear flowers in which he proved that "many of the common varieties of pears require cross-pollination, being partially or wholly incapable of setting fruit when limited to their own pollen." He also noted that some varietes of apples were sterile to their own pollen. Beach† of the New York Experiment Station found that some of the varieties of grapes need cross-pollination. Of more interest to prune growers are the statements of Bailey‡ of Cornell and the work of Waugh§ of Vermont. The former says that some of our varieties of native plums are not fertile with themselves, and that the "infertility is due to comparative impotency of pollen upon flowers of the same variety rather than to any structural imperfection in the flowers themselves," and that "this infertility is avoided by mixed planting, by means of which foreign pollen is supplied to the impotent varieties." Waugh found that "cross-pollination in plums is provided for by several natural adaptations, especially by the defectiveness of flower parts and by the sterility of certain varieties toward their own pollen." All of this leads up to the question as to whether our prunes, especially the Italian which sets fruit so poorly, would not be benefitted by cross-pollination.

It is a matter of common observation that the Italian for some cause or other, is, in certain locations, or in certain seasons, or under peculiar climatic conditions, a shy bearer. There are reports among fruit-growers that solid blocks of Italians fail to set fruit while in the same locality those in mixed orchards set a full crop. Such reports are not well substantiated, but their being current lends color to the view that cross-pollination, secured by mixed planting, would benefit that variety. Plans were on foot at the Station this spring to determine as far as possible the cause of the variability of the Italian in setting its fruit, but the entire failure of the crop frustrated all plans. The matter is of considerable interest to large growers of prunes and any data or information bearing upon the subject should be given to the public.

---

†S. A. Beach, N. Y. State Station Rpt. 1892. Self Pollination of the Grape.

‡L. H. Bailey, Cornell Expt. Sta. Bul. 38, Cultivated Native Plums.

§F. A. Waugh, Vermont Expt Sta. Bul. 53, Pollination of Plums.

II. Varieties of Prunes*.

At present there are but three varieties of prunes largely grown in Oregon: the Italian or Fellenberg, the Petite or French or Robe de Sargent, and the Silver or Coe's Golden Drop. By far the major part of these are Italians the Petites being second. Most of the other varieties now grown are sold, when cured, as one or another of these three varieties. All black prunes are sold as Italians; amber ones as Petites; and light colored ones as the Silver. The Italian is the great commercial plum of the Northwest for the reason that it thrives best and because its flavor and large size, as grown in Oregon, enables it to command a slightly better price than the Petite, the commonly accepted standard prune. In good locations, as in the Umpqua and Rogue River valleys, the Petite is largely grown and proves to be a more regular and prolific bearer than the Italian. But in growing the Petite we must enter in direct competition with California which at present is a little to our disadvantage, The Silver when well cured and of

*The distinction between plums and prunes is, that prunes can be successfully cured without removing the pits, the product being firm, sweet and long keeping. There is much confusion in horticultural literature regarding the nomenclature of prunes; nearly all of our prunes are known, by different names, in the East as plums.

large size, sells for a larger price than either the Italian or the Petite, but it is difficult to grow, hard to cure, and must be bleached; these qualities forbid its being extensively grown.

It must not be inferred that our wants are sufficiently well supplied by the three varieties named above and that there is no need of new varieties. Prune growers are not at all satisfied with the standard prunes now grown, as all of them have bad qualities which are serious drawbacks to their being put upon the market with the highest degree of success. There is a broad field for the introduction of better varieties. This is not strange since the prune industry in Oregon is but a few years old, and since, as a rule, the best varieties of fruits for any locality originate in that locality. We may then look forward to the time when the Italian and Petite will have been relegated to old orchards, and new varieties, natives of the Northwest, will have taken their places. We already have one or two new varieties that promise to equal or surpass our favorite Italian, and if their good qualities do not prove to have been overestimated it is to be hoped their supremacy will soon be established.

In the following descriptions I have included most of the prunes that have been tried in the state, and some that have not, but which, because of their merits in California, we might well try. All prune growers are urged to establish an experimental plot upon which new varieties may be tried. We shall, then, in the course of a few years, be able to profit by our mutual experiences, and the general approval of certain varieties will simply mark the survival of the fittest.

Much valuable information regarding varieties has been obtained from files of the Rural Northwest*. In writing descriptions of some of the older varieties I have freely consulted Wickson† and Downing‡. Special attention has been given to seedlings that have originated in the Northwest, and it is hoped that the descriptions and historical sketches are in the highest degree accurate. The cuts are mostly of old varieties and are from life and photographs. They are inserted chiefly that better comparisons may be made.

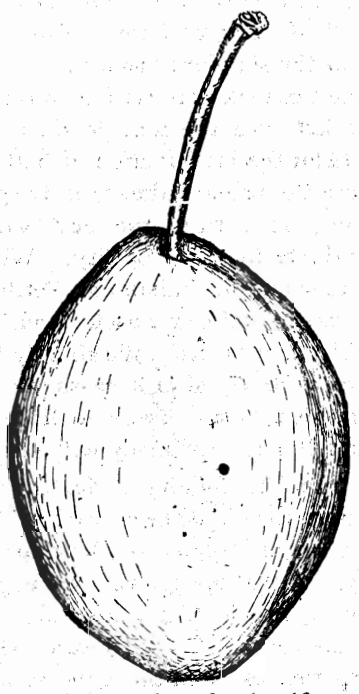
*Published in Portland, Oregon, H. M. Williamson, Editor.

†Downing's Fruits and Fruit Trees of America, Edition of 1888.

‡Wickson's California Fruits, Dewey & Co., San Francisco, Calif.

Description of Varieties.

THE ITALIAN PRUNE.—*Fellenberg, German Prune, Swiss Prune:*—Medium size or large, roundish but tapering at both ends; suture small but distinct; color, dark purple with a heavy bluish bloom; stalk, 1 inch long; cavity, shallow; flesh, yellowish green, juicy, parting easily from the stone; flavor, sweetish, sub-acid, delicious; tree, hardy, vigorous, very productive; rather late. It is not known where the Italian prune originated, but it has been grown in Italy for a long time, where it finds great favor in the fresh state.



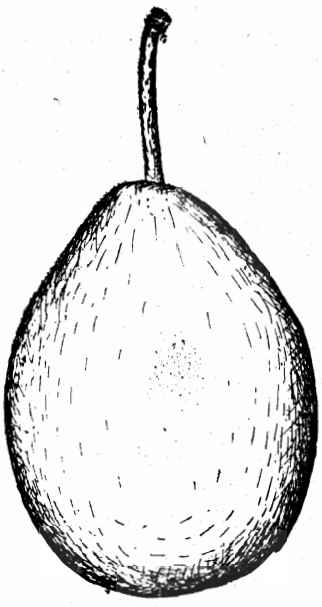
The Italian is at present the leading prune in the Northwest, probably more than four-fifths of the trees in this section being of this variety. Its merits are superiority in size and quality to any other prune grown and superiority in productiveness to all excepting the Petite. When cured it is much larger than the Petite and its sprightly acid flavor makes it more agreeable to the taste for most people. The quality of the Italian prune is such that it bids fair to create a special market for itself, and since it can be well grown only in the Nortwest, possibly when better known to consumers it may command a premium in the markets over other standard prunes.

The dried prune is black or bluish black in color and much larger than the Petite or French prune produced in California. Properly cured it has a most agreeable sub-acid flavor. The flesh is so firm that the fruit cures well and after being cured keeps well. The largest sizes of the Italian prune make a most beautiful product and will always bring good prices from customers who buy from appearance as well as quality.

The Italian prune as a plum has been known in the United States for many years. We are indebted to the Rural Northwest for the following regarding its history in Oregon. "The Italian

prune was first propagated in Oregon about 1857. Mr. Seth Lewelling and the late Henry Miller, both of whom were then engaged in the nursery business at Milwaukee, Oregon, imported Italian stock about that date from Ellwanger and Barry, Rochester, N. Y. So there is a difference of opinion as to which of these gentlemen has the honor of being the first to introduce the Italian."

The Italian prune in the East, or Fellenberg plum as it is known there, has long been considered difficult to grow well. To the contrary, in the Northwest it has been considered quite easy to grow the tree well. But since the Italian prune orchards planted so abundantly a few years ago have come in bearing it is found that it is a comparatively hard matter to grow a good orchard of them. They seem quite susceptible to changes in climatic conditions, are particular about soil, and are preyed upon by diseases and insects to a greater extent than most varieties. This year nearly every Italian prune tree in Oregon has suffered from the curling and withering of the leaves due to causes to be discussed hereafter. All other varieties were in the main exempt from this trouble. This curl-leaf has been present but not prevalent in past years. If in the future it should prove as injurious, and no means be found to stop it, the reputation of the variety as a standard prune for the Northwest, will be greatly endangered.



PETITE PRUNE.—*Prune d' Agen, French prune, Prune d' Ente, Lot d' Ente and Robe de Sergent.*—The fruit as grown in Oregon may be described as follows: Medium sized or small, oval or egg shaped, not uniformly pyriform; suture, small, distinct; color, violet purple with bright colored bloom; stem, short, slender; cavity, small, and shallow; flesh, greenish yellow, sweet, full of sugar, rich and delicious, clinging slightly to the stone. Tree, hardy, strong grower, very productive.

This is the prune most widely grown in the great prune

growing countries, the favorite in the markets, and is mostly known as Prune d' Agen, excepting in the Northwest where it it is always called the Petite. There are several sub-varieties which differ from the Petite chiefly in size and shape; few, if any, of these sub-varieties are known in Oregon, the differences in the Petite as found here being due to differences in conditions. It is probably true that the Petite as we know it is superior to any of its congeners. Prune nomenclature is further confused through the giving of the name Robe de Sergent as a synonym for the Petite. The two are much alike and the writer is not sure but what they are the same, at least there is not more difference than there is between the Petite and some of its sub-varieties. The Petite came to California from France about 1856.

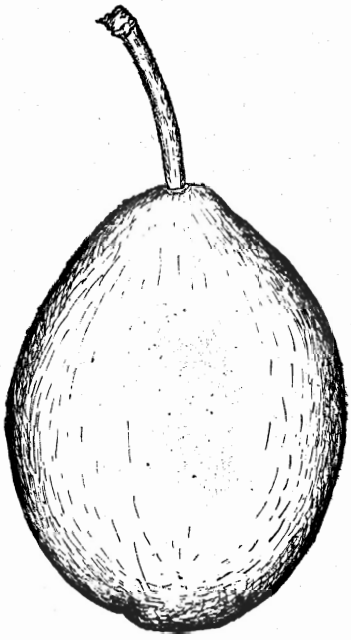
We take the following from a prune number of the Rural Northwest regarding its history. "The origin of the prune is unknown. Tradition in France is to the effect that it was introduced into that country by the monks of the Abbey of Clairac near Tonneins. From their gardens it spread into the valleys of the Garonne and Lot. Owing to the recognized value of this variety it was largely propagated by grafting and thus acquired the name "Prune d' ente," which signifies the grafted prune. By far the greater part of the prunes cured in France are of this variety." The Petite was introduced into California by Louis Pellier from Agen, hence is often called the Prune of Agen, Prune d' Agen. It derives its name, Petite, from the fact that Pond's Seedling was introduced into California about the same time and was thought to come from Agen. To distinguish them one was called the Petite, or small prune, and the other the Grosse or large prune. The name Petite still clings to the former, but the latter is commonly known, on the Pacific Coast, as the Hungarian prune. Since it came from France the Petite is often called the French prune. Robe de Sergent is one of its French names.

The Petite is smaller than most other varieties of prunes, but has a larger proportion of solids and so shrinks less in curing, thus partly making up for deficiency in size. Its special good good qualities are, its wonderful productiveness, vigor of the tree, ease with which the fruit can be cured, small shrinkage in curing and the surety with which it yields a crop. One of its chief

defects is its lack of acid which gives it an insipid flavor, though its insipid sweetness recommends it to many. It is of but little value in the fresh state,—in fact is not marketable except as a cured product.

The Petite needs for its best development a warm, rather dry climate, and a rather light, rich, loamy, soil. In Oregon these conditions only prevail in Josephine, Jackson, and part of Douglas county, and in Eastern Oregon along the Snake river and some of its tributaries. Unless grown to a large size the Petite in its cured state is in demand only as a cheap product. The largest sizes, if well cured, will always be in demand as a somewhat fancy product.

SILVER PRUNE.—*Coe's Golden Drop.*—Size, large, oval or roundish; suture, distinct, one side abnormally large oftentimes, necked; color, light yellow in the sun, dotted with small red spots; stalk, stout, nearly one inch long; flesh, yellow, juicy, firm, adhering slightly to a very pointed stone; flavor, rich, sugary, good quality; tree, a precarious grower, but very productive when all conditions are favorable; season, late.



The variety originated with a Mr. Coe in England in the early part of this century and received the name of Coe's Golden Drop. A few years ago it was introduced in the Northwest as a new variety, the Silver, a supposed seedling. Much discussion was engendered because of the close resemblance to Coe's Golden Drop, and finally led to the appointment of a committee from the State Horticultural Society to investigate the matter. The investigating committee reported that the seedling Silver prune tree was a grafted Coe's Golden Drop plum.

The fruit in the fresh state is large and beautiful and of delicious flavor. The cured product is larger than that of any other variety, ranging in size from 15 to 30 to the pound.

The prune has a very agreeable sub-acid flavor and is much esteemed where ever known. Notwithstanding the size of the fresh fruit the proportion of sugars and solids is fairly large. Unfortunately public taste demands that a white prune be sulphured, which proves injurious to the flavor so that the quality of the Silver prune as commonly found in the market is generally not so good as the unsulphured product.

The tree in Oregon requires the very best attention and in fact cannot be grown except under most favorable conditions. Good prune soil, good drainage, attention in pruning, cultivation, and pests, are requisites that must be well looked after in order to succeed with the Silver prune. When the fruit sets well on the trees, the crop must be thinned in order to get prunes sufficiently large to make them of value, and to avoid the danger of broken limbs because of too great a load.

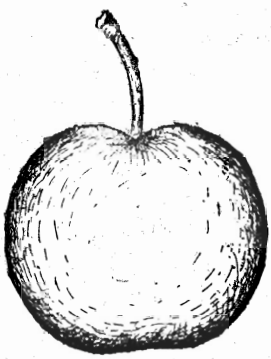
The Silver prune cannot be produced cheaply enough to compete successfully with the low priced prunes, but as a fancy product it will always be in demand. It will, therefore, be found a very profitable variety to grow if one has a location highly favorable to the growth of the trees, and will give them the extra care needed to produce a crop of large prunes, and lastly will give them special attention in curing.

The following taken from a letter written by Mr. W. H. Prettyman, of Mount Tabor, Oregon, tells of the introduction of the variety in the Northwest. It is possible that the so-called Silver is a seedling from Coe's Golden Drop, but if true, the resemblance is so very close to the parent that it serves no purpose, and only multiplies names to distinguish between the two.

"The Silver prune was first discovered in the orchard of Mr. A. L. Alderman, of Dayton, Yamhill, Co., Oregon, by Messrs. Plummer and Spaulding of the Plummer Fruit Evaporator Company. These gentlemen called my attention to it afterwards, got control of the stock, named it the Silver, and engaged me to propagate it. I propagated as many of them as I could for a number of years, but the supply never equaled the demand, the variety being very popular in California. The Silver has proved to be one of the best prunes in quality and leads all others in market value by from one to two cents per pound. The tree is a rapid grower and a very heavy bearer, the latter quality making it short lived unless good care is given and the fruit well thinned."

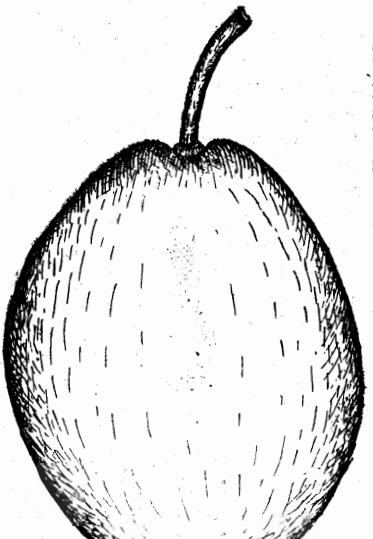
In Wickson's "California Fruits," Mr. Prettyman is quoted as saying, "The Silver is a seedling from Coe's Golden Drop, which it much resembles,

but it is much more productive ; one tree of Silver prune produces more fruit than five of Coe's Golden Drop."



REINE CLAUDE —*Green Gage.*—Fruit, small and round ; suture, not well marked, but showing from stalk to apex ; color, yellowish green, sometimes, or in the sun or at maturity, slightly marbled with red ; stalk, short and slender and inserted in a shallow cavity ; flesh, yellowish green, free, juicy, melting ; flavor, delicious, mildly acid, sweetish, unsurpassed. Tree of low, slow growing spreading habit; very productive.

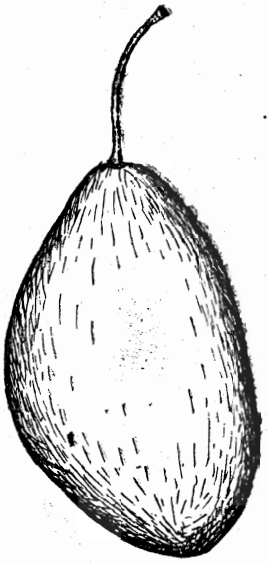
The nomenclature of this variety is somewhat mixed from the fact that the trees come fairly true from the seeds, and that there have thus been propagated several varieties very closely resembling the Reine Claude. There is much discussion as to whether our Reine Claude is the Green Gage plum of the East. The writer feels sure that those he has seen in Oregon are the same. For a prune in the fresh state we have no superior, in flavor, to the Reine Claude. In fact wherever it is known it is universally admitted that it has no equal in quality. The Reine Claude should rank equally high as a prune if properly cured. As yet there are but few who have tried to evaporate them in Oregon, but those who have done so pronounce them the most delicious of any of our prunes, claiming that they are equal to choice figs and raisins. The prune if bleached is bright golden, but if not is a dark amber in color.



YELLOW EGG.—*White Egg, Magnum Bonum.*—Large, oval, tapering at both ends ; suture, very prominent; stalk about an inch long and inserted in a very shallow cavity having a fluted border ; flesh, when ripe, of deep

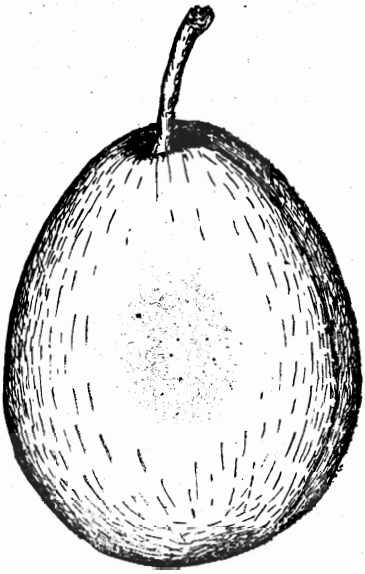
golden color, dotted with white dots and covered with a thin white bloom flesh, yellow, clingstone, juicy, quality rather poor, sub-acid or sweetish coarse grained. Tree fairly vigorous and fairly productive. Chiefly desirable on account of the splendid appearance of the fruit.

GERMAN PRUNE.—A name applied to several varieties of plums and prunes, the name representing a class rather than a variety since the tree comes fairly true from seed. The German prune is a great favorite in Central Europe because of its being easy to propagate and grow. It is an abundant bearer and of fair quality and easy to cure. When prune orchards were first started in Oregon a good many trees of this variety were planted, but because of their being so similar to the Italian, but not equal to it in quality or size, they are not largely planted now.



Fruit, medium size, long, oval, tapering at the ends, swollen on one side; suture very distinct, color, dark purple with a thick blue bloom; stalk, an inch long, slender, inserted in a shallow cavity; flesh, firm and of a greenish color, freestone; flavor good, sub-acid, sweetish. Tree, vigorous and productive. Two weeks earlier than the Italian.

HUNGARIAN. — *Pond's Seedling Grosse Prune d' Agen.*—Fruit, large oval or ovate, tapering at the stem end, and oftentimes having a divided elevated neck; skin, thick and rich in color, sprinkled with brown dots and covered with a thin white bloom; stalk, stout and of medium length, set in a mamelon neck; flesh, yellow, coarse, juicy; quality, rather poor, sweet, but not rich. Tree, a strong grower and prolific bearer. Season,



two weeks earlier than Italian or about the middle of September.

Introduced into California at an early day and supposed to have come from Agen in France, being contrasted with the Petite Prune d' Agen it was called the Grosse Prune d' Agen. How the name, Hungarian, originated is not known though the variety is best known on the Coast by that name, and so sells in Eastern markets. The plum or prune is of English origin and its true name is Pond's Seedling.

For shipment in the green state the Hungarian is our best prune and is being very largely planted for that purpose, no other prune being as fit as this one for Eastern shipping. Its quality after reaching a distant market is good and its great beauty makes it very desirable in the markets. The trees are vigorous and very productive.

DOSCH.—Hon. Henry E. Dosch, Horticultural commissioner for the 1st district, writes me as follows concerning the prune which bears his name and which originated with him :

"Replying to your favor regarding the Dosch prune ; I beg to say : When I bought my present place, there was an acre of Washington plums grafted on plum roots on the place. On one of these trees grew a sprout which started below the union. The former owner called my attention to it and said that he judged from the dark foliage, large leaves, and immense bud shoulders, that it was a promising seedling, and begged me to leave it. I did so and was agreeably surprised at the beautiful, large, dark purple prunes it yielded.

"Its characteristics are : tree a vigorous, hearty grower, leaves, extra large ; dark purple fruit, covered with a fine light blue plush, and hanging on the tree with great tenacity, shriveling before it will fall off; The prune keeps in good condition three weeks after being picked. When ripe the flesh is a golden green and is very aromatic, semi-freestone. It evaporates 45 lbs. of cured product to 100 lbs. fresh fruit. In flavor it is sweeter than the Italian, but not so sweet as the French. It bears every year and is about ten days earlier than the Italian."

CHAMPION.—Large size, roundish, tapering somewhat at both ends ; suture, well marked ; color, dark purple with reddish bloom ; stalk of medium length rather stout and placed in cavity of medium depth ; flesh, firm, very juicy, parting from the stone easily ; flavor much like the Italian. Trees, very vigorous, healthy, and strong growers. Fruit a month earlier than the Italian. Very productive.

The Champion is one of the most promising of our new prunes for shipping in the fresh state. The vigor of the trees, their productiveness, the size, beauty, quality and earliness of the fruit all recommend it. It is a little too juicy to be very valuable for evaporating. A letter from Mr. C. E. Hoskins following the description of the next variety tells of the origin of the Champion.

WILLAMETTE PRUNE.—A dark ruddy brown prune of the Italian type. Said to be some larger than the Italian, a little sweeter, a little earlier, and to dry heavier. The dried prune is dark much like the Italian. It requires considerable skill in curing. In the fresh state it is hardly surpassed in quality.

One of the most promising of our new varieties. Mr. C. E. Hoskins, of the Springbrook Fruit Farm, Springbrook, Oregon, the introducer of the Willamette and Champion, writes as follows concerning these two varieties:

"Soon after I came to this state eighteen years ago, I visited Mr. Seth Lewelling, of Milwaukee, Or., Mr. S. A. Clark, of Salem, and Mr. Jesse Bullock, of Oswego, to learn all I could about prune growing. While at Mr. Bullock's, I was given scions of seven new seedlings to test. After fruiting them I reported that in my judgment only No. 1 and No. 6. were worth introducing.

"Mr. Bullock named No. 1 Champion and No. 6 Willamette. The Willamette has since been renamed "Pacific." But I know that they are one and the same fruit, and I have now growing as old a grafted tree of this variety as there is in the state.

"As regards the merits of the Champion and Willamette, especially as compared with the Italian, will say, that I would not recommend the Champion for general planting for evaporating. It will bring as good a price, but is hard to evaporate and will not evaporate so heavy by two pounds in one hundred pounds of green fruit. Its great value is its earliness. It ripens from two to three weeks before the Petite or French. The tree is healthy and a good bearer but does best on valley land, the fruit being small on hill or red land.

"In regard to the Willamette will say that I think it is the best new prune that I have fruited. It is from seven to ten days earlier than the French and is as large or larger than the Silver. The tree is very healthy and bears grandly.

"I find that it gives a larger percentage of cured fruit to fresh fruit than the Italian and it is also a good shipper in the green state. It does well on either hill or valley land."

PACIFIC.—Said to have originated at Mt. Tabor, Oregon. It has the general characteristics of the Willamette and is probably, as Mr. Hoskins says, the same. Those who call it a distinct variety, say that it is larger and more juicy than the Willamette, qualities that would recommend it for shipping in the green state, but not for evaporation,

STEPTOE.—Many good reports come from a new prune called the Steptoe. It has not fruited on the Station grounds nor have we seen the fruit. The following is the substance of a letter written by Mr. Geo. Purdy, of Colfax, Wash, a well known nurseryman in Eastern Washington, the introducer of the variety, telling how the variety originated and giving some of its characteristics:

"The Steptoe prune originated with Mr. Calvin Throop, now dead, many

years ago on a farm near Steptoe Butte in the Palouse country. Mr. Throop was one of the old settlers in that country and finding that the trees which he imported from the East did not prove hardy he planted pits and seeds of the various fruits. Among the plums of note thus originated was the Throop and the Steptoe prune. My attention was first called to the Steptoe in 1891 when the trees were probably six or seven years old and had been bearing two or three years. The Steptoe tree is an upright, thrifty, grower, bearing every year. The fruit resembles the Italian very much, but is nearly, if not quite, one-third larger. The Steptoe ripens fully two weeks earlier than the Italian which does not always reach maturity in Eastern Washington. Fruit cured in a steam evaporator was said to be a much finer product than that from the Italian. I am confident that in a climate and soil suited for growing prunes the Steptoe will outrank the Italian in every way. But few of the trees have been distributed as yet.'

TENNANT.—A prune of the Italian type, which originated with Rev John Tennant, of Ferndale, Washington. Its most commendable quality is that it ripens much earlier than the Italian, its season being as early as any of our earliest prunes. In Washington it is being planted quite extensively and there are a number of plantations of the Tennant in Oregon. As yet not enough trees have come in bearing in this state so that the variety can be assigned a place.

The following varieties are grown in California, but have not yet been generally introduced into Oregon. Some of them might prove profitable in this state. Descriptions of the first three varieties are taken from Wickson's "California Fruits."

BULGARIAN.—"Fruit, above medium size, almost round, dark purple; sweet and rich with pleasant acid flavor; tree a vigorous grower and an early, regular, and profuse bearer."—*John Rock.* "As prolific a bearer as the Petite prune, but holds its size with a heavy load of fruit much better. The tree is a little more vigorous grower and forms a larger tree and bears its fruit more in the center. Closely resembles the Fellenberg or Italian prune in form and size, but it is not so large. It is rich and sweet when cured. It is not a freestone, but on some soils and in some seasons it has a tendency to loosen from the pit."—*W. H. Jessup.*

ST. MARTIN'S QUETCHE.—"Size, medium, ovate, broadest at base; surface pale yellow often spotted with brown; bloom, white; flesh, yellowish, very juicy, rich, excellent; ripens late and keeps long; tree, hardy and a good bearer; shoots smooth. Approved in Santa Cruz County."

TRAGEDY PRUNE.—"Originated with Mr. Rumyon, near Courtland, Sacramento Co., California. Introduced by W. R. Strong & Co.; appears to be a cross between German prune and Purple Duane; medium size, nearly as large as Duane, and looks much like it, except that it is more elongated; skin, dark purple; flesh, yellowish green, very rich and sweet parts readily from the pit; ripens in June. The first large plum to ripen very fine, and valuable for Eastern shipment."—*L. W. Buck.*

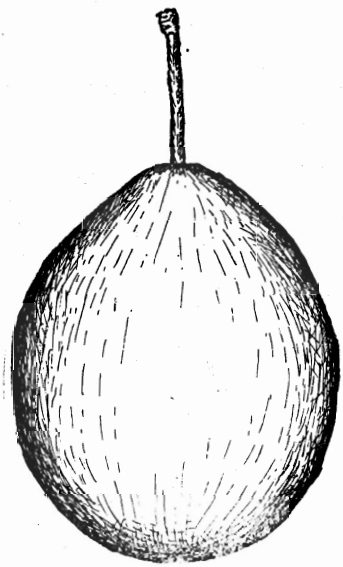
GIANT.—One of Burbank's seedlings. A cross between the Petite and Pond's Seedling or the Hungarian. Fruit large size, larger than Pond's Seedling; in color, dark crimson upon yellow background; flesh, rich yellow; texture, fine; freestone; quality, good, sweet and rich; season abou

that of the Petite. Said to be easy to cure and to make a beautiful product. Well worth trying in Oregon.

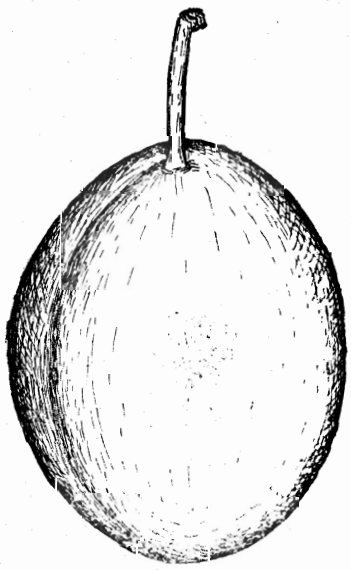
BRIGNOLE.—The variety used in making the famous Brignole prunes of France. Introduced from Brignole. Medium size, oblong; color pale yellow with a reddish cheek in the sun; flesh, yellowish and of good texture; rich and sweet; cures well. Trees vigorous and productive in California.

DATTE DE HUNGRIE.—The date prune of Hungary. Size, large; skin dark purple, covered with a whitish bloom; flesh, greenish yellow, firm, with a very rich flavor; cures well and makes a good product.

ST. CATHERINE.—Medium size; obovate growing small toward the stem; suture, well marked; stalk, long and slender, inserted in a shallow cavity; color, greenish yellow with thin white bloom, occasionally with a blush on the sunny side; flesh, yellow, moderately firm, juicy, semicling; flavor, sub-acid, rich, aromatic, good; season, about that of the Petite—middle of September. Tree, upright. vigorous, prolific.



One of the oldest of our cultivated prunes, not much grown in Oregon, locally popular in California. In France it is much esteemed and it is greatly used in making a superior product of prunes.



WANGENHEIM.—A variety very popular in Germay now grown to some extent in California. Fruit of medium size, oval; color, dark purple, covered with heavy blue bloom; suture well marked, but shallow; stalk, short and stout; cavity small and shallow; flesh, firm, greenish yellow, juicy, freestone; flavor, good, sugary, rich; season, early, two weeks before the Petite, or the latter part of August.

III. Curing Prunes.

TO SERVE the present age, adequately expresses the purpose which prompts the writing of this chapter. Curing prunes in Oregon is yet in a state of evolution and anything said about it must be considered tentative and not conclusive. It is only hoped then that the best methods now known are presented in this chapter. Most of the information given has been obtained from successful prune growers of the state and therefore has the merit of being practical.

Our method of curing prunes is peculiar to the Pacific Northwest. In Europe the prunes are cooked in the process of curing; in California they are cured by exposing to the sun and wind; in Oregon and Washington we cure them by evaporating the surplus water from them in evaporators. We have only our own experience to guide us and our own inventions to work with. There is therefore a broad field for the origination of better methods and the invention of better apparatus, so that the process of curing may be cheapened and a better and more uniform product produced.

Definitions.

It takes an intelligent person some time to learn the meaning of the somewhat technical phrases commonly used in the prune industry. We therefore give the definition of those most current. Some of the words defined are colloquialisms, but most of them are common to the trade.

Bleaching.—The process of changing the dark color of prunes to a lighter hue; generally accomplished by sulphuring.

Bloaters. Prunes which in drying swell up to an abnormal size. The swelling is supposed to be caused by fermentation which produces a gas. Bloaters are generally produced from large, soft, overripe prunes.

Dipping.—A process of cleansing and cutting the skin of fresh prunes preparatory to putting in the evaporator, in which the fruit is submerged in boiling lye, made by using one can of concentrated lye to fifteen gallons of water. Cured prunes are also sometimes dipped in glycerin and water,—one pound of glycerin to 20 gallons of water, which improves their appearance and adds

to their weight and keeping qualities.

Drip.—The syrupy liquid which oozes from prunes in the process of curing; it generally characterizes a poor prune or a poor evaporator. As a verb, the falling of the drip.

Extras.—A superior quality of prunes; generally referring to size.

Frogs.—Small, poorly developed prunes having an abnormal shape. Not a synonym of bloaters. Supposed to be caused by unripe fruit, poor soil, or any unhealthy conditions of the tree.

Grading.—Separation of prunes either before or after curing in uniform sizes.

Pricking.—The process of puncturing the cuticle of the fresh prune preparatory to putting in the evaporator. Pricking is done by means of a machine the essential part of which is a board covered with projecting needles over which the prunes must pass. A substitute for lye dipping.

Sizes.—The number of cured prunes it takes to make one pound. Those requiring from 40–50 prunes to weigh a pound are called 40s–50s; those requiring 50–60, 50s–60s, etc. The "Four Sizes," are the 60s–70s, 70s–80s, 80s–90s, and 90s–100s; commercially, it means equal quantities of these sizes. Sizes and grades are used as synonyms.

Sugaring.—The formation of globules of sugar upon the cuticle of cured prunes rendering them syrupy and sticky and destroying the lustre of the prune.

Sulphuring.—A process cured prunes are put through to give them a lighter color. The prunes are put in a tight room, generally just as they are put on trays before being placed in the evaporator, and subjected to the fumes of burning sulphur for a half hour. Or they may be sulphured after being taken from the evaporator.

Sweating.—A process prunes are subjected to, immediately after being taken from the evaporator, in which they are put in piles or bins with the temperature at from 70° or 80°, turned several times, and allowed to sweat.

Picking and Grading.

There are all sorts of prunes put upon the market. The differences are largely attributable to the care and attention given to the details of curing. Simple as it may seem the picking of the

fruit is one of the very most important matters in the processs of curing prunes. Half the "bad luck" attending evaporation, in which frogs, bloaters, sugared fruit, and drip, are produced, is caused by carelessness in picking. We put the greatest emphasis upon this as neglect in picking is one of the commonest faults in prune making, and its betterment must be recognized as a fundamental requisite of success. I have seen men knocking the fruit from the trees with clubs, handling it with shovels, and pouring it roughly from boxes in a wagon bed. "There is nothing in prunes," was the cry when the product was put on the market.

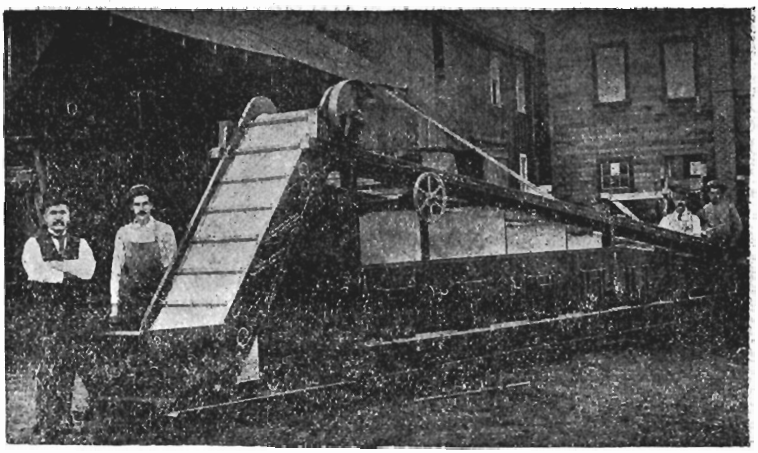
Shortly before the picking season begins the ground under the trees should be cleared of rubbish and worthless fruit and the soil mellowed with a steel rake. The Petite prune, and to a large extent the Italian and other varieties, when ripe enough to dry will drop to the ground, at least no further assistance is given it in falling, than a gentle shake of the tree. If the fruit shrivels a little before dropping, all the better. The object in thus letting the fruit get *thoroughly ripe*, is: that not until then, is there a maximum amount of solids and saccharine matter so desirable in a good, cured prune; much drip is prevented since there is less juice; and the essential rich flavor is not present until the fruit is ripe.

In picking properly, the orchard must be gone over several times, the number depending upon the rapidity with which the fruit ripens. If shaking must be resorted to, labor can be saved by placing a sheet on the ground under the tree and the ripe fruit shaken into it after which it can be turned into boxes. At all times the prunes ought to be carefully handled to avoid breaking the skin thus causing the prune to drip or sugar in the evaporator, and allowing germs to enter to cause fermentation and consequent bloaters and frogs.

Prunes ought to be graded both before and after drying. Before drying in order to remove twigs, leaves, and rubbish, and to attain equality in drying, since the smaller fruit will of course dry more rapidly than the larger. As it comes from the orchard the fruit should be graded in three sizes to insure perfect uniformity in evaporation.

A number of machines and contrivances are used to do the

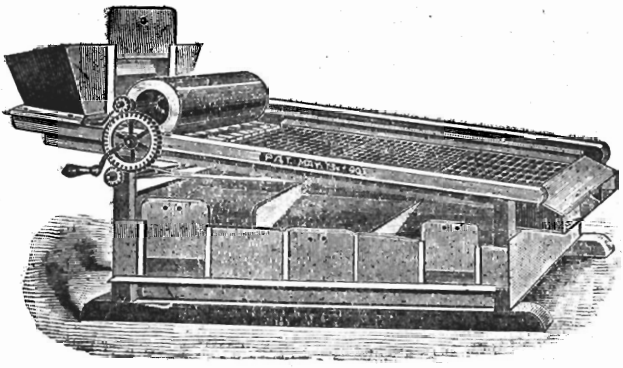
work. Without doubt it is best and cheapest in the long run to get one of the many excellent graders now on the market. These work on various principles, one of the commonest of which is an inclined plane with adjustable slats or screens allowing the large fruits to roll into receptacles at the bottom, while the small fruits fall through into other receptacles before reaching the bottom. One is made with wire screens of different size of mesh arranged as in a fanning-mill, each screen with a spout on the side where each grade drops into a box. All graders should have a screen so small that only dirt and stems can drop through. A good grader ought to be available for grading prunes both before and after drying.



The accompanying cuts show typical graders. The first one is a steam power machine with a capacity of seventy-five tons per day. There is much saving in having in connection with a large plant, all machinery run by steam power. The second cut shows a hand grader with a capacity of forty tons per day. Either of the two graders may be used before or after evaporating. Both are Hamilton graders.

Cured fruit is generally graded just after it has finished sweating. There are usually several sizes in each variety. The price varies from about one-sixth to one-tenth cent per size. The Silver will grade highest by two or three sizes, the Italian second, by three or four sizes higher than the Petite. Commission men

often prefer to do their own grading; the fruit in this case being taken directly from the evaporator to the warehouse. Proper



grading is a very important step in the industry, the way in which it is done having much to do with profit or loss.

Dipping Versus Pricking.

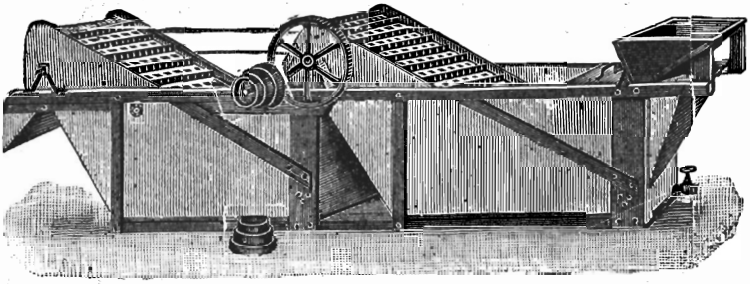
Prunes are dipped in boiling lye, or pricked by needles in a pricking machine, to check and make tender the tough skin so that the moisture can escape easily and drying be thus facilitated. Incidentally the fruit is cleansed. Both processes are in vogue and a discussion of their relative merits is in order.

Lye-dipping, as practiced in Oregon, is about as follows: One pound of concentrated lye is dissolved in from 10 to 50 gallons of water, the proportion of lye and water differing greatly with the various prune growers. The primitive way, is to keep the solution boiling in a large kettle, into which the prunes, placed in a wire basket or a much perforated metal vessel, are immersed and there kept in motion, by twirling or swinging, for from 30 to 60 seconds, depending upon the condition of the fruit. A more modern way is to have the fruit run from the grader to a set of endless chains with carrying aprons and by them carried through a pan containing the boiling lye solution, heated with submerged steam pipes; from the lye the prunes are carried on through fresh water, preferably running water, and then spread on trays.

If the operation is well done the prunes on coming to the trays should have their skins bright and shining and present upon close

examination a finely checked condition. Over or under immersion causes the fruits to dry unevenly; when too much scalded the skin tears and becomes ragged and the fruit beomes soft and mushy, making a sticky, nasty mess on the trays.

The accompanying line cut shows a Cunningham steam power dipping machine. The machine may be attached to a



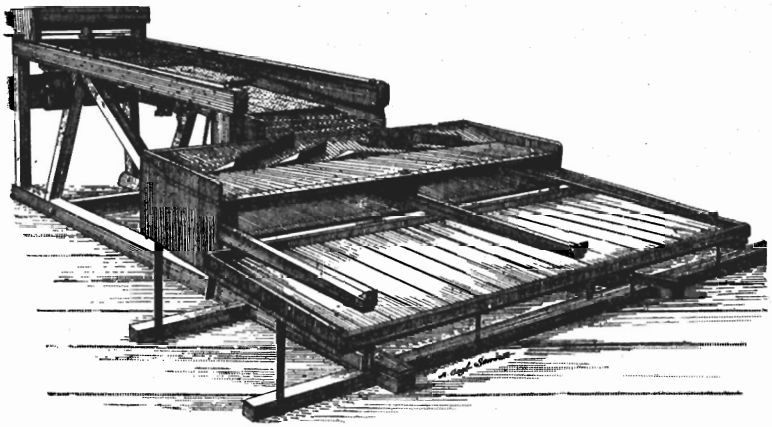
grader and spreader, thereby enabling the grading, dipping and spreading to be done in one operation. There are a number of these machines in use in Oregon.

Pricking machines mechanically cut or perforate the skins of prunes. The fruit is fed over a shaking table that has needle points projecting above the surface, these cut and perforate the skins of the prunes. The needle table can be regulated so that by having different slants the skins may be cut more or less, as the condition of the fruit requires. The dirt and leaves are separated by a sceen and the fruit is washed either by having it pass through hot or cold water, or by having a stream of water play on the fruit as it comes on the pricking table. The pricking machine may have grading and spreading attachments so that the fruit, from the time it is poured from boxes need not be handled until on the drying trays.

Each of the two methods are championed by experienced and practical men, some of whom have tried both, and seemingly have obtained directly opposite results. We must then come to the conclusion that a choice between the two methods rests either upon prejudice or that there is a place for both, depending upon the product desired or the fruit that is to be handled.

The illustration shows the Burrell power pricking machine

with grader and spreader, capacity fifty tons per day. This machine has a device by which the pitch of the needle board



may be changed while the machine is in motion. Hand pricking machines or larger power machines are made.

A discussion of the good and bad points of the two methods probably will not make converts among many of those who have already formed their opinions, but it may enable those who are beginning in this phase of the industry, if they think it necessary to either dip or prick, to make a choice. Right here it may be well to say that lye-dipping has by far more advocates in Oregon than the pricking,–the latter process being comparatively new in this state.

The chief objections to lye-dipping are:

1. It is a nasty process as generally practiced. Without the most scrupulous care, lye, over-dipped prunes, and the drippings and scum, accumulate, produce foul odors, and attract insects.

2. It is unsystematic and unscientific. Scarcely any two men use the same amount of lye, or dip the same length of time, and since several brands of lye are used the strength of a solution is uncertain.

3. It takes in every case a most experienced man to tell whether the operation is rightly done, whether the prunes are dipped enough or over dipped. These three objections, I must admit, do not mitigate against the use of lye, but rather

the abuse of the process. A more important objection is :

4. Lye-dipping, because of cost of fuel, material and labor, is expensive.

The points in favor of lye-dipping are :

1. The prunes are generally better cleansed.
2. Their evaporation is hastened to a greater extent.
3. The skin is rendered less tough.
4, For those who desire a finely wrinkled skin and a bright amber color, lye-dipping gives the prunes a better appearance.

The chief objections to pricking are :

1. The great object sought, that of facilitating drying, is not so well accomplished as by lye-dipping. This is the greatest objection.
2. In evaporation pricked prunes drip and sugar more than dipped ones.
3. A very current objection, which has but little foundation, is that the needles break off in the prunes. They rarely do in a good machine.
4. Another current objection is, that the flavor is not so good as in the dipped prunes. The difference in flavor in dipped and pricked prunes is inconsiderable and may be to the advantage of either according to one's taste ; it cuts no figure in the markets. It is true that the skin is a little tougher on the pricked prunes.

The special good points are :

1. That the process is cheaper, notwithstanding it takes longer to evaporate pricked prunes.
2. Pricking is more cleanly and systematic.
3. The prunes dry more evenly and there are less frogs and bloaters produced.
4. For those who like a shiny, black, smooth prune, the appearance is better.

In conclusion, it may be said, that both processes, have a place in the prune industry. The choice of method must depend largely upon, the special conditions of fruit, congeniality of either the one or the other to the operator, and the appearance of the prunes that the producer likes best. It may be that the consumer's or the buyer's taste will eventually have something to do with settling the question.

Final Processes.

After dipping, or pricking, the prunes are ready for the evaporating chamber. It is impossible to give detailed directions for treatment in the evaporator, since the process must necessarily vary with the character of the evaporator.

But, in general, in evaporators which have an ample circulation of air, the temprature should be about 120° to 140° at the start to be gradually increased to 160° to 180° when the fruit is taken out. Too much heat at first, causes the fruit cells and consequently the fruit to expand and burst, then the prunes drip. Too high a heat, by cooking the fruit, also hinders chemical changes and causes discoloration. In evaporating where the temperature greatly decreases with the distance from the furnace, the fruit should be placed in the coolest part of the evaporating chamber and then gradually be moved to the warmest part.

The time required for drying prunes differs with various varieties, and with each variety depends much upon the circulation of air, since circulation governs the degree of heat allowable. Lye-dipped Italian prunes require from 24 to 36 hours; Petites, 12 to 24; Silvers, 36 to 48 hours. All three varieties are cured in less time, but seldom well cured. A common fault is to hasten the process too much.

There are other factors entering into the process of evaporation,—such as circulation of air, convenience in handling, trays, labor, fuel, etc., but these will be considered under the head of evaporators.

A prune is well cured when it feels soft, smooth, and spongy; the pit should be loose, but should not rattle; the flesh should be yellow in color, elastic and "meaty," the skin should be bright and lively and free from drippings and exudations. An over-cured prune is harsh and coarse and has a dried up appearance. In prunes not cured enough there is risk of loss through molding or fermenting. The Petite prune, well cured, is of a clean, bright, amber color; the Italian, very dark red, appraching black, in color. The Silver must have a beautiful golden hue. This brings us to the matter of sulphuring.

All light colored prunes must be bleached with sulphur fumes. This process without doubt injures the quality of the prunes, but buyers will have to be educated to see this before

they will pay as good a price for the unsulphured prunes as for the lighter colored sulphured ones. Until this time comes the producer cannot do otherwise than make use of a process which adds from one to two cents per pound to the value of his product. Only fresh fruit, just before going into the evaporator, should be sulphured. The rejuvenating of old, discolored, cured prunes, has no legitimate place in the prune industry.

The process of sulphuring is an easy one. The most common method is to build a chamber about six feet high, and as wide and a little deeper than the tray. On the sides of the chamber are cleats which allow the trays to be easily slipped in and out. The door occupies all of the front side. In placing the trays in the chamber, alternately leave a space at the back, and at the front, so the sulphur fumes will pass back and forward over the the trays. The sulphur is put in a metal vessel in a pit at the bottom of the chamber and ignited by hot coals or other burning material. The fumes are distributed by means of simple ventilators at the bottom and top of the room, after which all openings are closed and the fruit allowed to be affected rom one to two hours. The chamber should be nearly air tight. The trays of fruit are transferred directly from the sulphuring room to the evaporator where the sulphur is expelled by heat, its poisonous effects being thus reduced to the minimum.

After the fruit is taken from the evaporators it is put in bins or piles to sweat. The sweating room is generally kept at a temperature of from 70 to 80 degrees. To facilitate the process the fruit is occasionly turned with a scoop shovel. The sweating is sometimes omitted, but at a risk, as fruit will oftentimes discolor and possibly ferment if not alllowed to "go through the sweat."

Preparatory to packing, the fruit is graded to sizes, the various grades indicating the number of prunes to the pound, as 30s to 40s, 40s to 50s and so on to 110s to 120s. By some the prunes are dipped in boiling water and glycerin, or other solutions, but such dipping is in disrepute as indicating an undue amount avarice to secure weight. However, intelligently done, "glossing" or "finishing" prunes, may be made a valuable process.

In packing, many different methods are used. A producer will adopt which ever one for his particular reason, or his partic-

ular market or conditions, will give him best results. Only experience can teach this. Much fruit is packed in cotton sacks, many buyers preferring it so packed as it gives a chance for repacking. Producers with a good product like to establish a reputation for their brands and so pack in boxes. There is a gain in weight by this method as the fruit does not dry out so much as in the sacks.

Packing fruit is an art and must be learned by observation. Lining with paper, filling, facing, etc., all require a little education. If the boxes are to be faced, average specimens of prunes should be flattened and neatly laid in the box which should be upside down. Fill the box, press, nail on the bottom, invert, and brand, or put on the label.

IV. Evaporators.

THE MOST important question prune growers have to deal with at the present time, is that of securing good evaporators. Those who have built evaporators are not satisfied with them; those who intend to build cannot find one that suits them. Men have been stumbling rather blindly about since the beginning of the prune industry in Oregon hoping to bring forth and invention that would meet all requirements for making a good product. But no one has been eminently successful. It is true that great progress has been made, and much valuable experience gained; so much, in fact, has been accomplished, in a short time, that we can quite confidently look forward to the evolvement in the near future of evaporators of very superior excellence to those now in use.

The following chapter is published, not with a view of adding to what is already known about evaporators, or of making suggestions for their improvement, but to bring before the prune-growers descriptions of the types we already have that they may choose more intelligently if they intend to build, or study more carefully if they think of making improvements upon evaporators they now have.

The importance of the erection of better evaporating plants, and more efficient management of them, can hardly be over-

estimated. A good evaporator is the prime essential to success, not only for the individual but for the industry; if, for no other reason, than, that there is at present, such a wide range in the quality and style of our product that it has no established place in the markets, in consequence of which we lose much, buyers always preferring fruit with a good reputation. This would be largely overcome if we had standard evaporators producing, necessarily, a more uniform product.

In connection with this subject we are glad to publish the following from Hon. Henry E. Dosch, Horticultural Commissioner for the 1st District, who has had much experience with evaporators and with the evaporation of fruit.

Evaporators and Fruit Evaporation.

The construction of evaporators on correct principles and the art of evaporating fruit, has engrossed the minds of scientists and layman alike, both at home and abroad, and it seems as yet, we have not reached the wished for goal, but we are on a fair way to it.

To dry fruit is one thing, but to evaporate it, quite another,—simply to put a lot of fruit on a tray, put it into an oven, fire up and wait until it has shriveled away to a bony state, almost any one can do; but to properly "evaporate" fruit, so it is a fine marketable article, requires a good deal of care and intelligence on the part of the operator. It is in this, like in all other business or trades; the principles involved, must be thoroughly understood, in fact the operator must be educated to it, the same as any master mechanic.

The two great principles involved are heat and circulation: without these two, it is useless to attempt to make good fruit—It cannot be done.—And it matters little whether the heat is supplied by a brick furnace with large radiating pipes or by coils of steam pipes, so long as it can be controlled; for remember hot air in space is a very different thing to control, and can only be accomplished in a properly constructed evaporator with thorough circulation.

I have experimented for many years in fruit evaparation in variously constructed evaporators and we have made rapid strides forward, and as I said, while we have not yet reached our goal, we are very close to the line. I will not attempt to describe the many patented and non-patented evaporators, all of which have good points, and while some operators can make fair fruit on any of them, none are yet perfect.

My own experience however has led me to the conclusion; that all fruits must be started at a low heat and finished at a high heat, in order to prevent the loss of the aromatic juices and fruit meats, essential to fine fruits and in order to accomplish this, the evaporator must be so constructed, that the trays of fresh fruits are placed in, furthest from, and be made to gradually advance toward the furnace or steam pipes. There ar

now two evaporators made in Oregon, in which this principle is employed, but it is hardly proper for me to recommend any particular evaporator.

The dipping in lye solutions, so objectionable to consumers of refined taste must be done away with. Thanks to Prof. Hoersch Durren, this is no longer necessary as fruits "steamed" prior to evaporation, make a much finer product. He says, "it will open the pores of the skin to facilitate evaporation and prevent dipping; it makes the skin tender and eliminates that leathery substance found in most of our dried French prunes; it requires less heat and "*fruit will dry heavier or more meaty*" than unsteamed fruit." This alone is a strong recommendation and worth all the trouble and expense; the pressure in the steam box should not be over ⅛ pound; prunes to be subjected from 10 to 15 minutes; pears 15 to 20 minutes; and apples 1½ to 2 minutes, and on removal immediately transferred to the evaporator.

Experiments made recently by Mr. Adam Fleckenstein in his new evaporator, in which both the foregoing principles were introduced, proved decidedly successful; French prunes yield 45 pounds to the hundred, and Italians 33 pounds of evaporated product to 100 pounds of fresh fruit.

Rapid evaporation as claimed by some patentees as a point of merit, is a great mistake; nature if left to her good offices, will dry fruit very slowly in order to develop the saccharine matter, and the closer we follow her, the nearer right we are; nature makes no mistakes; French prunes should never be evaporated in less than 24 to 30 hours; Italian and Silver prunes 36 to 42 hours; apples in 6 hours; peeled pears in 24 hours and unpeeled pears 48 to 60 hours.

I hardly think it necessary to add, that all prunes must be dead ripe.

HENRY E. DOSCH.

Kiln and Box Evaporators.

The first prunes produced in Oregon, were, if I am rightly informed, evaporated in a kiln, or as we commonly know it, a hop drier. The essential parts of which were, a room with a slatted floor underneath which heat was produced by a furnace. It was a primitive affair and has long since been relegated to the past in the prune industry. The kiln was followed by the box evaporator an evaporator still in use and from which, when well operated, oftentimes a product is turned out which is indistinguishable from that produced in the best patent evaporators. In box evaporators the fruit is placed upon trays which are arranged in rows in an upper room or division of the building, the furnace being in the lower division. Various contrivances, depending upon the ingenuity of the builder, furnish ventilation and a draught for carrying off moisture laden air. The particular merit of the box exaporator is its simplicity and cheapness.

The Steam Evaporator.

The steam evaporator is a modified box evaporator. The trays are arranged in tiers; under and above each tray or two trays, is a coil of steam pipes, several runs in each coil. Narrow horizontal doors allow of the insertion of trays, and enable the operator to examine or handle fruit without regard to other trays. These alternate tiers of pipes and trays are of a convenient height for a man to reach, or they may extend through two stories. In width, the evaporator will only allow, conveniently, two trays to be placed side by side, but in length the number is limited only by economy in laying pipes for heating. At the top of the tiers, a very large shaft, or a number of smaller ones carry off the moisture laden air; openings at the bottom allow an inflow of air. The main defect of all steam evaporators coming under the writer's observation is, that poor ventilation causes excessive drip. We believe that the man who solves the problem of building a steam evaporator on the general plan outlined above, in which the moisture laden air can be carried off, so that fruit will not drip, will solve the problem of getting a good evaporator. Good work is being done in several large steam evaporators in the Northwest.

Without question, for a large plant, heating by steam is the most efficient and economical method; this is particularly true because in such a plant power is wanted for running graders, dippers, elevators, and pumping water.

The Carson Evaporator.

The Carson evaporator is a patented, modified, box, evaporator, its particular merit is an ingenious method for securing good ventilation. The Carson is used, perhaps, more than any other one evaporator in Oregon. It is sometimes built in a modified form to overcome an inconvenient way of handling the trays of fruit. Plate III shows a cross section of a pair of Carson evaporators.

The evaporator may be built of various sizes, but the usual size is 18.5 × 8 feet, such an evaporator has a capacity of 5000 pounds of ripe fruit per day. The lower part of the building consists of a furnace room, built of brick, and contains a furnace in each end. The walls of the furnace are 8 inches thick and 16

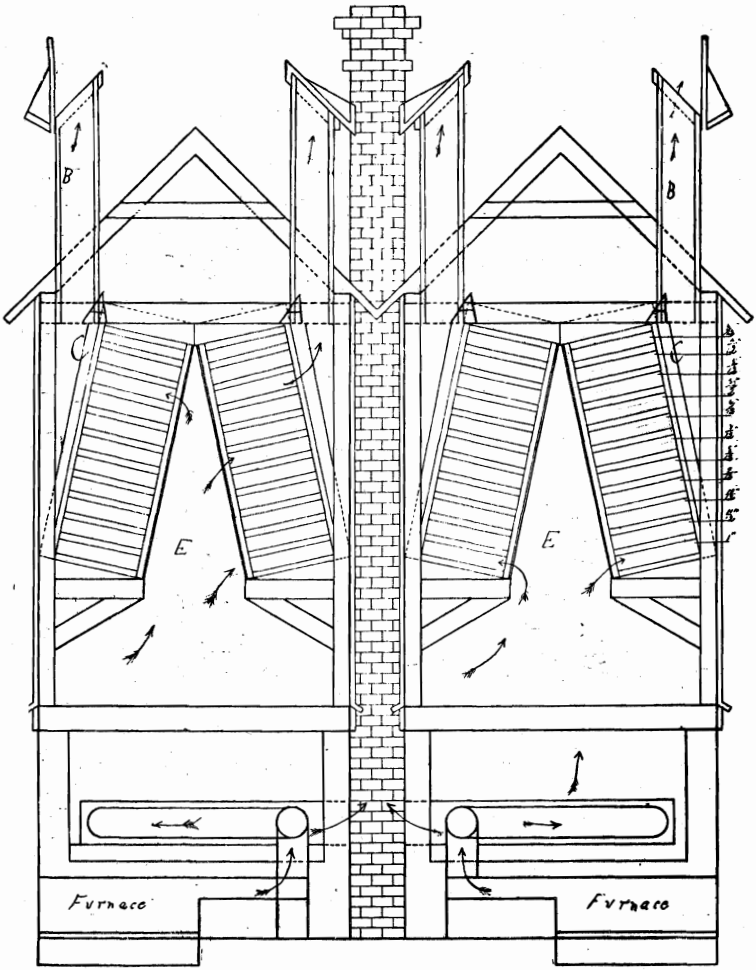


PLATE III. THE CARSON EVAPORATOR.

tunity to condense and settle upon fruit in the upper trays, causing drip and hindering the proper chemical changes from a green prune into a first-class cured prune.

The Carson evaporator has several points of excellence : its cost is small ; there is no machinery to get out of repair ; it is easily operated ; any good mechanic can build it ; and the expense for heating is reduced to the minimum. One objection to the evaporator, offered by many, is that it is inconvenient to place all of the trays in the drying chamber from the ends ; this has been remedied by several builders by having doors on the sides. For a large plant, steam pipes may be used instead of a furnace for heating.

The Penniman Evaporator.

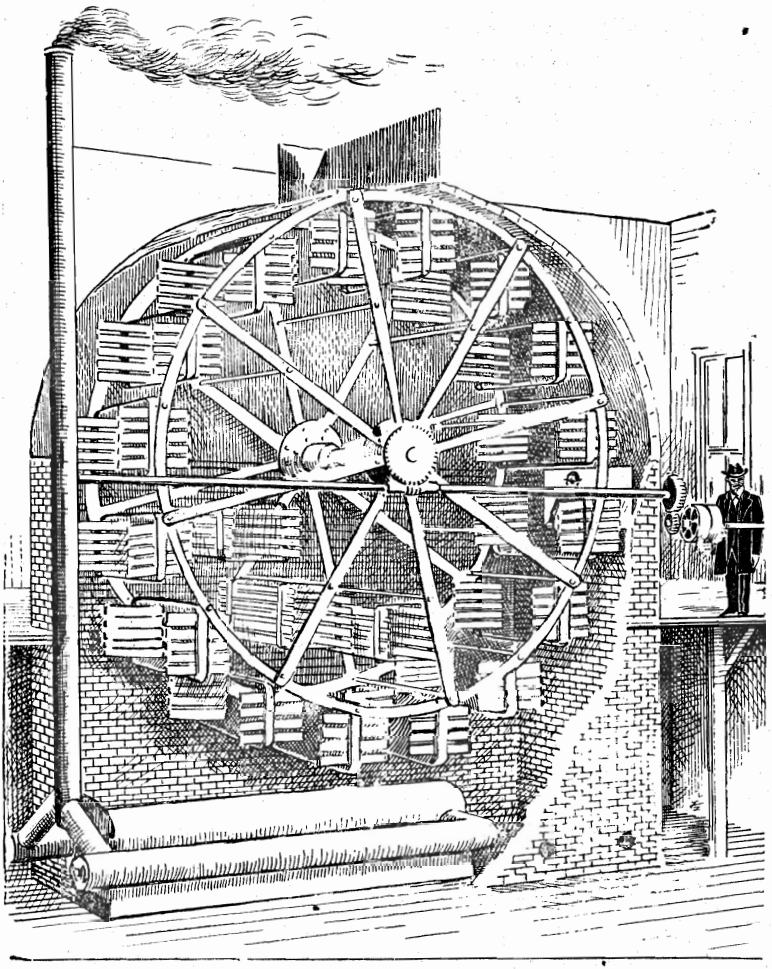
The Penniman evaporator is an ingenious invention in which the trays of fruit are placed on a sort of Ferris Wheel and forced through the heat. The essential features of the evaporator can be readily seen in the accompanying cut.

A narrow, arched, brick building forms the evaporating chamber ; a furnace at the bottom of the chamber furnishes heat; a revolving shaft in bearings, is mounted in the side walls above the furnace. Two large wheels, their rims united with rods, are fitted to the shaft. Hangers, with a series of transverse crossways to hold the trays of fruit, are loosely attached to the cross bars ; the trays are thus maintained in a horizontal position at all times simply by the law of gravity. The trays are put in place through a door at the front, the wheel being slowly rotated by hand. The fruit may be examined, in the process of evaporation, by opening the door or through windows in the upper part of the building. The system of flues, drums, and dampers, is ingeniously arranged to regulate heat. Ventilators admit cold air below and permit heated, moisture-laden air to escape above.

In the process of drying, the fruit is first subjected to a high heat, being on the bottom of the wheel, but as evaporation progresses it is carried to the cooler upper part. At the end of the revolution of the wheel the evaporation is finished. A simple device of cogs and a shaft enables the operator to turn the wheel. Various sizes of the evaporator are made. In the one shown in the cut the diameter of the wheel is 14 feet ; the space between the rims, 6 feet. There are 24 hangers each containing 5 trays,

the trays being 5 × 2 feet, making a spreading surface of 1200 square feet. The makers claim that its capacity is from 6000 to 7000 pounds of green fruit per 24 hours.

The Penniman evaporator is largely used and is highly



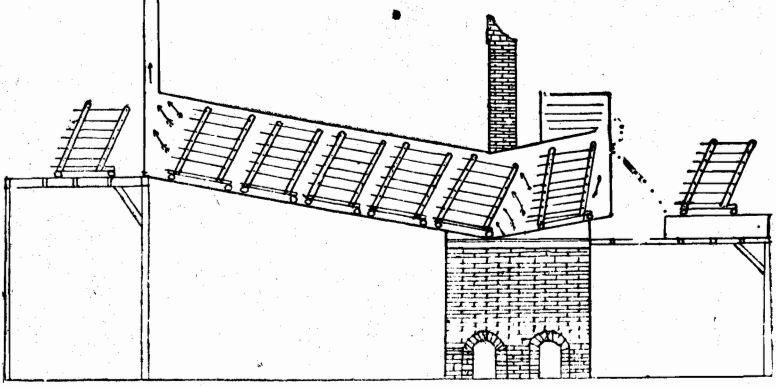
recommended in California. In the fall of 1895 the writer saw one in operation in Southern Oregon, and while the product, in this particular instance, was not first-class, the reason for which might be attributed to lack of care and attention on the part of

the operator, yet there were some points of excellence about the machine. Its durability, safety from fire, the ease with which fruit may be handled, equal distribution of heat, therefore, approximately, uniformity in drying, are the points that commend it.

The Allen Evaporator.

The Allen evaporator is one of the popular evaporators in Oregon; more of them having been built, perhaps, in this state then of any other style excepting the Carson. It is a so-called horizontal evaporator in which the trays of fruit are moved horizontally across the heating surface. The American evaporator was, I believe, the prototype of this style of evaporators, but the Allen is a great improvement upon the old form.

The accompanying cut, a very poor one, represents the Allen evaporator with one side cut away; it shows the inside of a "tunnel" and the position of the cars therein. The details of the evaporator are so meagrely shown by the cut, that a full description will not be attempted; the essential principles of the drier can be readily seen, however.



Mr. Allen believes that prunes should be subjected to a low temperature when first placed in the drying chamber, and as the juice coagulates in the cells, gradually be given a higher temperature; the great majority of those experienced in evaporating prunes believe this, but the Allen evaporator is built with special reference to this point. To secure which, the prunes are put in at one end of the drying chamber and taken out at the

opposite end. The device by which this is done is a series of cars running down grade in "tunnels," from the place where the fruit enters the drying chamber to the furnace. The foremost car is pulled across the entrance through which heat enters the chamber, this permits an opening between the cars and brings the upper end of the tray nearest the fire, thus answering the same purpose as turning the tray around would. The car is now in front of the door of exit and the fruit can be examined at will and taken out when the proper stage of evaporation is reached.

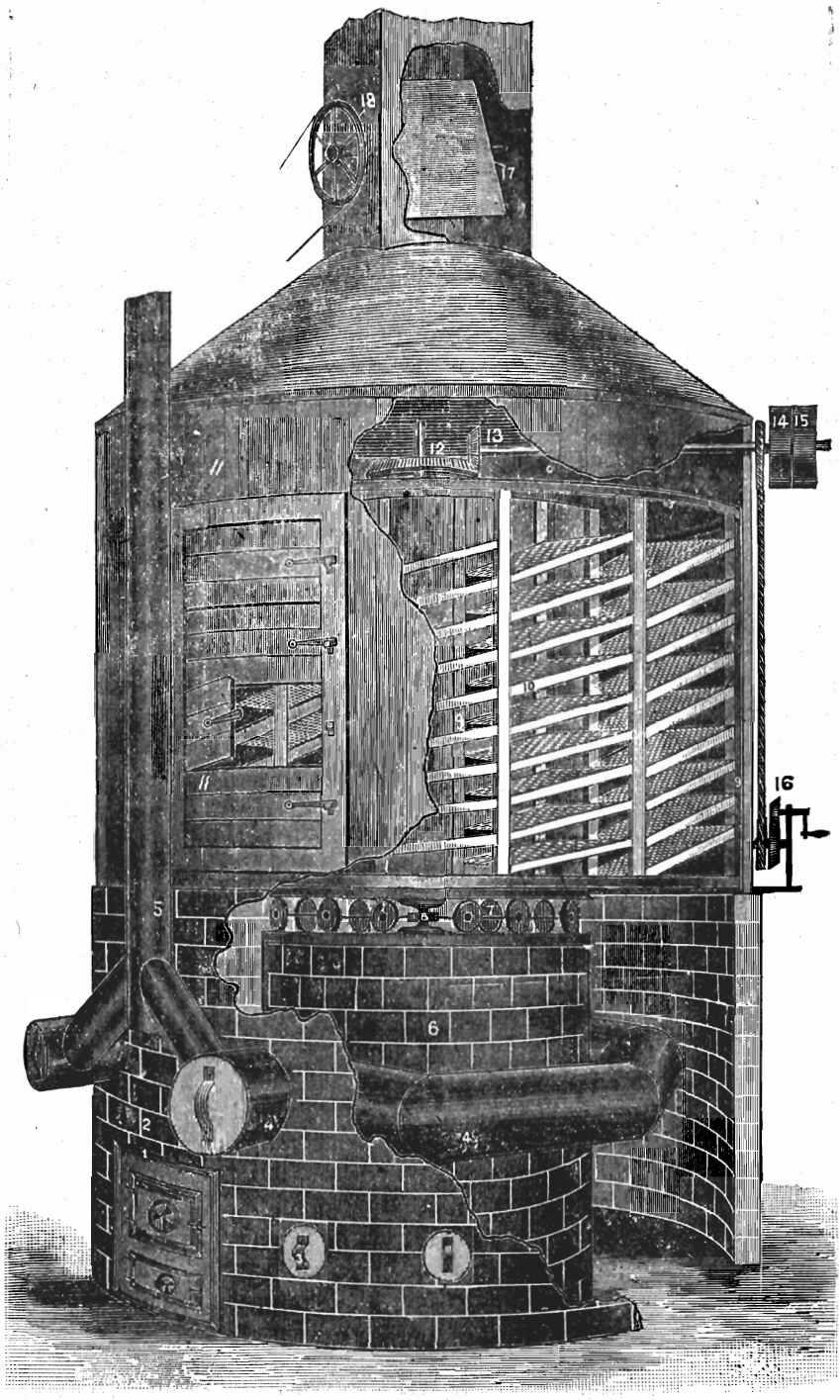
A current objection to the evaporator is, that the fruit can only be examined as it comes before the door in the last stages of evaporation. I have been told by those who have had considerable experience with the evaporator that the objection is not well taken, as the circulation of air is such that the fruit dries, in proportion to the distance from the fire almost perfectly.

A great point of excellence in the Allen evaporator is, the way in which the hot air reaches the fruit, absorbs the moisture, and passes off. The tramways for the cars are constructed so that the edge of the car farthest from the heat is highest—the cars slant forward; as the heat ascends from the furnace it is carried between the trays, the driest air on the driest fruit. The cars are running toward the furnace, hence as the moisture leaves the driest fruit it passes out without condensing as it would should is pass over the greener fruit first. All the moisture from freshly dipped fruit passes out immediately. It is not saying too much to say that the heat is under as perfect control, by means of a novel system of dampers and ventilators, as in any evaporator we have.

Various sizes are made ranging in capacity from 25 to 175 bushels of green fruit per 24 hours. The cost is not excessive, it is economical in fuel, and it is easily operated,—all valuable points.

The Beck Evaporator.

It may be that our California neighbors, with their longer experience and greater resources, have brought forth better evaporators than those commonly in use in Oregon. But a general criticism upon such evaporators from that state as have been introduced into Oregon is, that they are far too expensive, with their complicated manipulating machinery for our conditions,


18
17
14 15
12
13
16
5
6
4
4
2
1

and, especially as it is doubtful if better results are accomplished than with our simpler devices.

The evaporator under consideration, the Beck, while free from the many novel inventions of fans, blowers, domes, and other accessories has in its construction a feature, which, unless overcome by a much greater capacity gained by it, is objectionable; namely, the revolving tray rack involving as it does extra cost and a greater expense in running. The same criticism applies with equal force to the Penniman described before and the Kurtz to be described hereafter, and the rule may be laid down, in general, that evaporators that require a constant power to run them, or complicated machinery to be built and kept in repair in order that the fruit may be forced through the air instead of the air being forced by nature's laws through the fruit, must greatly exceed in efficiency the simpler and less expensive evaporators.

These criticisms must be taken as general and not as applying to the Beck in particular, an evaporator, which we consider of its style, the very best, and as having by increased efficiency, overcome some of the objections noted in the above paragraph. Its principle of construction is certainly most ingenious and well deserves the attention of every fruit-man.

The cut on the following page shows the plan of the Beck. Two circular, brick walls, one within the other, several feet apart, according to the size of the evaporator, are built about nine feet high. In the enclosed space formed by the two walls, a furnace of cast iron, two and one-half feet wide and nine feet long, is placed; attached to this is a heating drum eighteen inches in diameter which circles around the inner wall, passing into the smokestack near the furnace front. Upon the inner circular wall, is a turn-table upon which is a tray rack which extends out over the heating chamber to within half an inch of the outer wall.

The outer wall, from the brick work up, is built circular, as a continuation of the wall, the frame-work being covered on both sides with closely matched lumber thus making an air-tight compartment; at the top is a conical roof in the center of which is a ventilator with a damper to control the draught.

The trays slide into the revolving rack at an angle of six inches to three feet and edge to edge so that they wind around

the inner wall from bottom to top in a spiral twist. The space between the twists of trays, are, in a sense, flues of the dimensions of the distance between trays and the width of a tray, and the hot air is supposed to ascend through them as it does in a chimney. To further facilitate the passage of air between the twists of trays, the tray rack is kept in motion thus forcing the air through the spiral flues under and over the trays of fruit, thus, seemingly, distributing the air current uniformly over the the fruit surface.

The power for turning the tray rack may be hand power in small evaporators, or, as of course would be better, a vapor engine or steam power may be used. In a plant of any magnitude the consideration of power is not so great as would at first appear, because there should be some such power for running graders, dippers, elevators, pumping water, etc. There being but little friction to overcome in revolving the tray rack, strong power is not needed.

The inventors claim that because of the rapid and continuous currents of air caused by the rotary motion the temperature may be raised from fifty to seventy-five degrees higher than it could were the trays kept at a standstill. This of course means a greatly increased capacity for drying. In regard to convenience and mechanism, the machine is as nearly perfect as any upon the market.

The Fleckenstein Evaporator.

The Fleckenstein is one of the latest evaporators to claim attention in Oregon. It was invented by Mr. Adam Fleckenstein of Woodlawn, Oregon; last year was its first season before the public and because of the failure of the prune crop in this state it could not be thoroughly tested. In the trials made, however, it was evident that its merits would rank it among the best of our evaporators.

The Fleckenstein is a most decided departure from any style of evaporator now in use in the Northwest. It falls in the category of so-called stack or tower driers, devices common in the berry and and apple evaporating industry, but not in the prune industry. The fundamental principles involved in this evaporator are not new, there being several prototypes in the East, notably the old Alden, the Williams, and the Automatic,

perhaps one or two others. But many of the accessories and and details of mechanism are new and are great improvements upon similar parts used in other evaporators of this type. This is especially true of the lifting device.

The essential principle of a stack evaporator, which provides that the trays of fruit be placed in tiers in a shaft, admitting air only at the bottom and allowing it to escape only at the top, thus forcing hot air directly through the fruit, is a principle directly opposite to that involved in any other evaporator described in this bulletin. The inventors of all the other devices have sought to provide means by which air once touching the fruit could be passed out as quickly as possible without touching more fruit. It is not to be wondered at then that the splendid reports given of this evaporator by horticulturists of unimpeachable standing have created no little surprise.

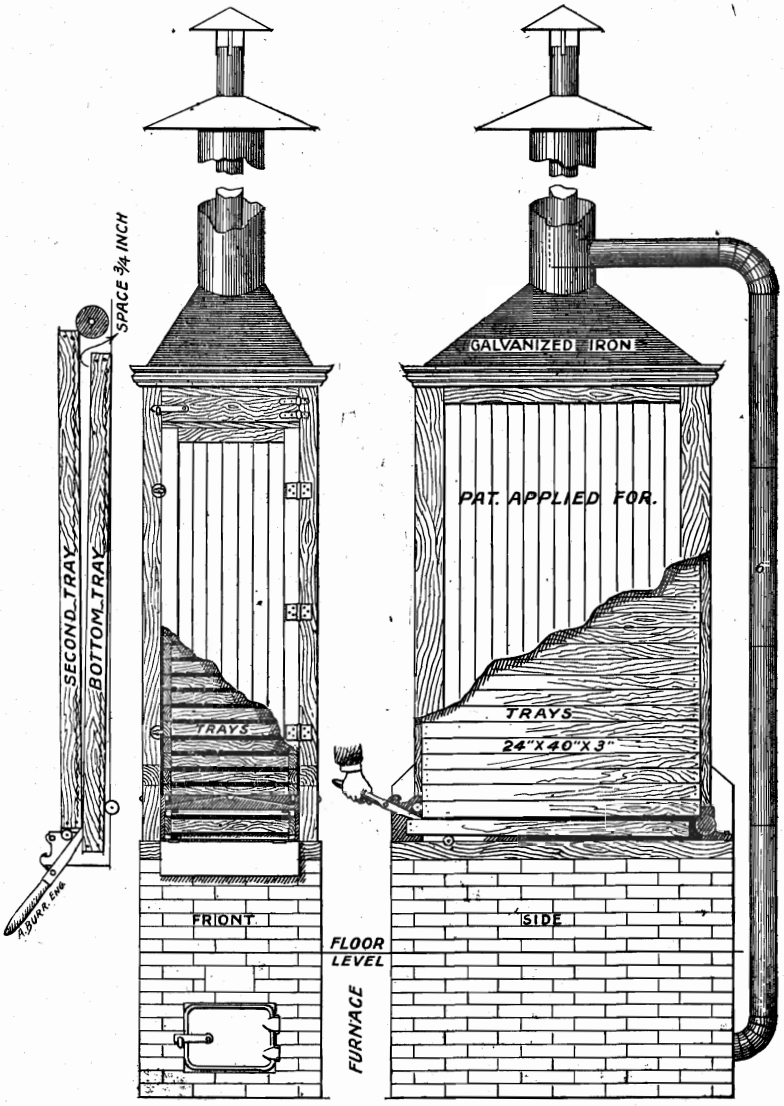
The method of operating the Fleckenstein, as recommended, differs very radically from the method generally used in most other stack evaporators. The fruit in this case is put in the stack, not necessarily but recommended so, at the top, the coolest part, and is finished at the bottom at the warmest part. In this the inventor agrees with the great majority of our experienced prune producers that evaporation should start at a low temperature, but disagrees with most manufacturers of Eastern stack evaporators who advocate that the fruit be "finished" at the coolest part of the evaporator. In fact, Prof. L. H. Bailey* in a bulletin on evaporators, in speaking of a certain evaporator says its chief disadvantage is, "that the fruit is 'finished up' or removed in the hottest part of the stack, instead of being taken out at the top which is the coolest part of the stack." I think I make no mistake in saying that this is counted an advantage in in all the types of evaporators in use in Oregon, and the fact that this can be done in the Fleckenstein is considered one of its strong points.

The accompanying cut represents one stack, holding twenty-five trays, of the Fleckenstein. An evaporating plant may consist of as many of these towers as may be necessary, all to be built over one furnace or several at the option of the builder.

The trays of fruit are handled in the stack as follows:

*Bulletin No. 100, Cornell University Expt. Station.

The bottom tray rests on four small wheels imbedded in the frame-work of the stack ; the front end of the second tray



rests on the bottom tray and the back end rests on two four inch wheels raised about three quarters of an inch above the bottom

tray, so that when the second tray with those above it are raised to a level, which is easily done by means of an ingeniously arranged lever placed under the front end of the second tray, the bottom tray is free and may be removed or examined and returned to place. If removed, the second tray, aided by the two four inch wheels behind slides gently down in the place vacated by tray number one. The bottom tray, it will be observed, is shoved forward an inch or two by the action of the wheels behind, upon which the back end of tray number two is forced to remain. Trays of fresh fruit are put in at the top.

One of the supposed requirements of the evaporator is, that it be air tight at all places except at the ventilator at the bottom of the stack, where air enters, is heated in the fire chamber, and drawn up through the fruit by a strong draught, created mainly by the smoke pipe of the furnace entering the ventilating shaft at the top of the evaporator.

Heat may be furnished by a furnace of any style, or by steam desired. The inventor, however, has for a single stack or a small plant a furnace that is so simple, cheap, and efficient, that I take pleasure in describing it here.

The furnace consists of three lengths of common tile pipe twenty inches in diameter, encased in sheet-iron which is reduced at the back end to the size of a common smoke pipe and to which piping is fitted, carried around the air space under the fruit chamber once or twice, passed out and up into the ventilating shaft over the fruit chamber. It is an easy matter to doors, grates, and dampers. Mr. Fleckenstein has had such a urnace in operation in an old box drier on his place for six years. It has the merit of being exceedingly cheap, economical as to fuel, and the danger from fire is reduced to a minimum. A more elaborately constructed furnace is to be recommended for a large plant, however.

A strong point of excellence in this evaporator is its compactness. Twenty stacks of trays capable of drying 12000 to 20000 pounds of fresh fruit per twenty-four hours only occupies a space of 7½ × 17 feet. The mechanism is extremely simple and so the cost of evaporator and building will compare very favorably with the cheapest evaportors we have.

In the test made so far it is claimed that a first-rate quality

of evaporated Petite prunes can be produced in from eight to ten hours, the prunes having a fine ruby color and the clear yellow flesh characteristic of a perfectly evaporated Petite prune. The Italian was as well dried in from ten to twelve hours, though it is considered best to take at least ten hours for the Petite and fourteen for the Italian.

The Kurtz Evaporator.

The cut on page 60 gives a view of the Kurtz evaporator, an evaporator with a revolving tray-frame somewhat similar to the Beck, differing from it in the manner of support of the tray-frame, and in not requiring continuous motion. The remarks made regarding the merits and demerits of this style of evaporator under the discussion of the Beck applies with equal force to the Kurtz.

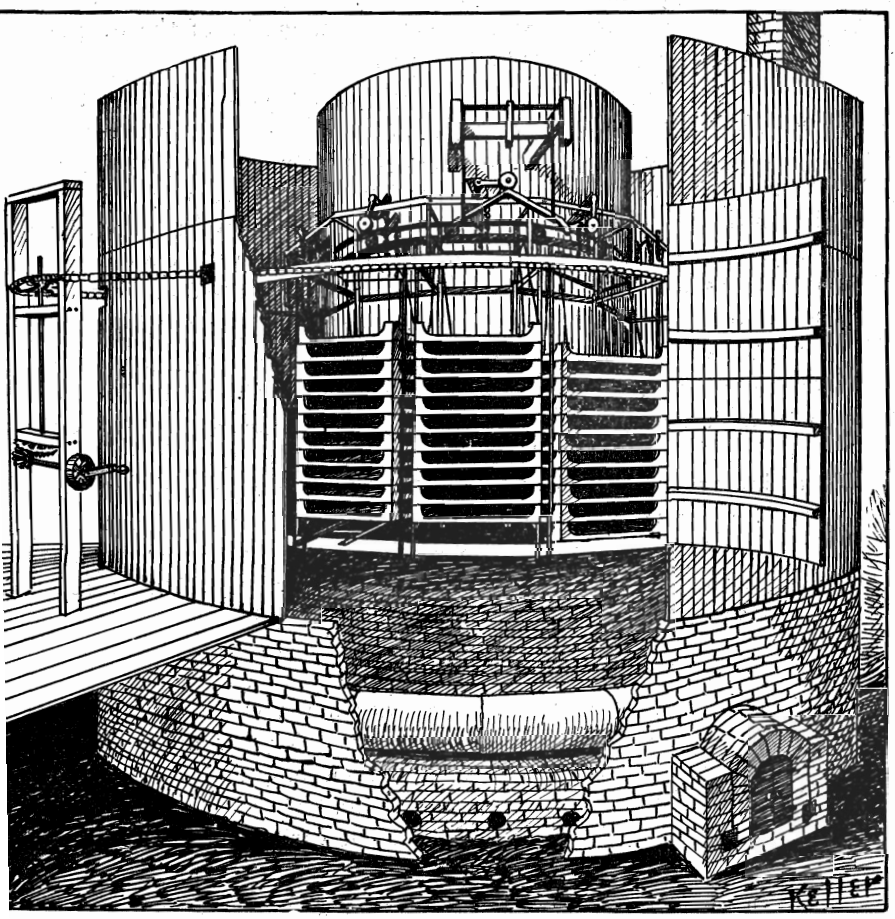
The lower part of the evaporator consists of two circular brick walls, forming a furnace and hot air compartment. Above the inner circular wall, the tray-frame and apparatus for manipulating it are placed. The upper part of the outer wall consists of a tight wooden shell. The construction of these walls can easily be made out by an examination of the cut.

Formerly, the tray-frame rested on a track on the circular foundation, but it is now suspended from above upon supports resting upon the foundation; the frame is revolved upon roller bearings which operate between two tracks the lower of which is stationary, and the upper one, to which the frame is fastened, rotating upon the rollers. An endless chain passes entirely around the machinery and connects with a crank outside of the evaporator; by turning this crank the tray-frame is made to revolve so as to bring each upright section in turn in front of the door where fruit is put in and taken out.

The working theory of the evaporator is as follows: A horizontal row of trays of green fruit is put in at the bottom every two hours and a similar row of evaporated fruit is taken out at the top at the same time. In order to do this it is necessary to lift up each column of trays the space of one tray, hold it there by means of a spring dog, put in a tray at the bottom, take out one at the top, drop the column and repeat the operation until the trays have been changed in all the columns.

The lifting of the columns is done automatically as the tray-

frame turns so that when the the frame stops in front of the door the column has been lifted and is ready to receive a tray. This is accomplished by means of a bridge to be seen in the cut exactly in front of the upper edge of the door if the door were closed. As the tray-frame is revolved, the roller attached to the



column of trays below rolls over this bridge and lifts the column which is then held by a dog which automatically springs out and catches it.

One of the current objections to the Kurtz evaporator has

been that the fruit had to be subjected to the greatest heat immediately upon entering the drying chamber. Mr. Kurtz writes me that this year he has improved the tray-frame machinery so that green fruit can be put in at the top and the finished product taken out at the bottom if so desired. This plan will meet with the approval of most of our prune men though a few will contend that the old way is the better. One of the merits of the evaporator is that it can be used either way.

While in practice it is not generally so operated, yet the manufacturer recommends that the tray-frame be constantly rotated by machine power in order to create a greater circulation of air. Three or four revolutions per minute may be made and it is said that by this means at least one-third more fruit can be evaporated—a matter of much importance when there are large quantities of fruit to dry. The power required to do this work need not be very great.

As in all evaporators the furnace may be built largely according to taste. Mr. Kurtz, however, recommends the one ordinarily built with his evaporator; briefly it may be described as follows: The furnace is built in the inner circular part at the bottom of the drying chamber and consists of a simple curving arch through which pass small air pipes from the outside, arranged so that all air entering the drying chamber is thoroughly heated before doing so. Mr. Kurtz says that one cord of wood will cure 200 bushels of green prunes.

Accessories.

This chapter may well close with a few words concerning the accessories of a good evaporator. The profit in evaporating establishments is often fixed more by the convenience of arrangements for handling fruit, and by the skill, care, and cleanliness, given by the operator in the various processes, than it is by the style of the evaporator.

In the matter of cleanliness there is a wonderful chance for improvement about many of the evaporating plants I have visited in Oregon. Where floors are covered with spilled or refuse fruit, allowed to accumulate from day to day to sour and to be tramped under foot, an evaporating establishment becomes a most unpleasant place indeed. Not a little harm is also done by the

swarms of flies, bees, and yellow jackets attracted to such places and by germs of rots and molds that find a congenial medium for propagation. Scrupulous cleanliness is one of the essentials of a good establishment.

But to get back to the matter of the topic. Particular attention should be given to the accessories of the evaporating plant. First of all there should be plenty of room. The building should be planned so that there may be a receiving room for the green fruit; a working room containing the dipping apparatus or pricker, the grader, and the sulphuring chamber; these and all the minor apparatus should be upon the first floor. If possible a second floor should be built for a sweating room and store-room, and also to hold the apparatus for packing the product. It is almost absolutely necessary to have an unlimited supply of good water. An elevator is convenient and will save its cost in a single season. Tools and a place for making and mending trays, preparing packing boxes, and doing odd jobs of carpentry, is quite necessary. It will be found that the evaporating apparatus proper will occupy but comparatively a small part of a good plant, and that the general outfit will have quite as much to do with the success of the establishment.

In Conclusion:

To have described in detail all the evaporators and appliances used in evaporating prunes would have led us far beyond the scope of a brief bulletin. Other evaporators than those mentioned, especially some that have gained prominence in the evaporating industry in the East, well deserve to have been spoken of but it was impossible to discuss all, and I have simply tried to give an idea of the most prominent types in use in Oregon. Good prunes have been produced with all of them and none should be entirely condemned from hearsay. One thinking of purchasing an evaporator should investigate as many styles as possible; he should see them in operation; talk with the operator; and always take in consideration as to how much success or failure may be due to the man using the evaporator.

V. Diseases of the Prune.

THE STONE fruits in Oregon suffer from the attacks of comparatively few pests. Curculio, black-knot, and brown-rot to any appreciable extent, have not as yet made their appearance in our orchards. This immunity may be largely ascribed, I think, as far as the fungous diseases are concerned, to climatic conditions. It is certain at any rate that both of the diseases mentioned above have been from time to time introduced and yet black-knot connot be found to my knowledge in any orchard at present, and the brown-rot is confined to very limited areas; neither has ever manifested a tendency to spread with the fearful rapidity and destructiveness characterizing them in the East. We have then in this chapter to describe but few diseases, the worst of which is:

Shot-Hole Fungus.—*Cylindrosporium Padi*, Karsten.

This disease is prevalent in all parts of Oregon and is troublesome not only on the plum and prune but on the peach and cherry. It is the most grievous pest that growers of stone fruits in this state have to contend with and the necessity of spraying in order to protect prune, peach, and cherry from its ravages is now an established fact.

In the prune orchard it makes its appearance in June or a little before the leaves are full size. It first manifests itself on the leaves in little purplish or reddish spots, or brownish in the center and purple at the circumference. These spots enlarge, sometimes by coalescing, until they are from a sixteenth to a quarter of an inch in diameter. As the disease progresses the affected spots wither, turn brown, and finally break away and drop out of the leaf. The holes thus formed, sometimes a score of them being found in a single leaf, gives the foliage the appearance of having been riddled with shot hence the name, shot-hole

fungus. The disease is well shown in Plate IV, Fig. 1, reproduced from a photograph.

Shot-hole fungus oftentimes may not attract attention unless as happens frequently the foliage drops prematurely; this generally takes place in August or September, the leaves turning yellow before dropping. It is obvious that any trouble seriously affecting the health of the foliage must be disastrous to the general health of the tree and must, in proportion to its seriousness, affect present and future crops. Fruit-growers do not always realize this and the presence of any pest that is not actually killing a tree seems to give them but little anxiety. The fact needs to be pressed home as forcible as possible that anything that in any way injures the foliage, in the same ratio injures the productiveness and longevity of the tree. Shot-hole fungus, because of its universal prevalence in Oregon prune orchards, does more damage than all the other prune troubles combined, and in the aggregate, yearly causes an enormous loss of fruit and a great retardment of our orchards.

Fortunately the disease is easily controlled. The Oregon Station has done but little experimenting in the way of preventing the disease, but the treatment recommended by other Stations has been given with success in our orchard. The disease has been thoroughly studied and for those who desire a more comprehensive knowledge than can be given here, I append at the bottom of the page a list of the most prominent reports of investigations concerning it.

Bordeaux mixture is the preventive for the disease. The shot-hole fungus appears in midsummer and applications for it must be made late in the season. The first spraying should be given very soon after the leaves make their appearance, this to be followed by a second and third application,—in a very wet season a fourth, at intervals of three weeks. It may sometimes be necessary to spray when the fruit is nearing maturity, if so, one of the clear copper sulphate solutions should be used instead of the Bordeaux mixture.

S. A. Beach, Bulletin 98, N. Y. Ex. Sta., Rep. N. Y. Ex. Sta. 1893: 688–693.
D. G. Fairchild, Bull. U. S. Div. Veg. Path. 1894–6: 39–40.
W. J. Green, Bull. Ohio Ex. Sta. 1891. II 4: 216.
Roland Thaxter, Rep. Conn. Sta. 1889: 176, 1890: 102.

Brown Rot.—*Monilia fructigena*, Pers.

In the fall of 1895 a number of prunes affected with brown rot were sent to the Station. Upon making inquiry it was found that in the infested area nearly the whole product of several orchards had been destroyed by the disease. The writer could find no previous notice of its existence in Oregon and assumed that it had been but recently introduced. Subsequent inquiry developed pretty conclusively that it has been in Oregon for some time but seems to have been dangerous and troublesome only under particularly favoring conditions,—fortunately enough as the brown rot as found in most localities is the most serious fungous disease with which plum growers are obliged to contend.

In the East all the stone fruits are attacked by brown rot, the disease being especially prevalent in the Middle and South Atlantic states. In some seasons in Georgia, brown rot takes a third of the peach crop; in Michigan the aggregate damage done to the stone fruits is as great as that done by all other diseases combined, if we except peach yellows. A bad feature of the disease is that the fruit is often attacked after being picked, as was the case with one of the Oregon orchardists who lost fruit year before last; about 60 bushels of prunes ready for the evaporator in standing over Sunday were almost entirly destroyed by the rot. If it is true that the fungus has been in Oregon for some years without becoming more widely distributed there is but little to fear from it, but knowing its character elsewhere we need to be watchful.

The following is a brief description of the disease. Leaves, twigs, and fruit, are attacked, but most of the damage is done to the fruit. The rot makes its appearance about the time the prunes begin to mature, and the favoring conditions are, warm, moist weather, a certain amount of moisture being necessary at the point of contact of the fungous spore in order that germination take place. After germination the fungus enters the cells of the fruit and robs them of their contents and cell degeneration, or rot, ensues. The affected fruit becomes covered with clusters of ash-grey spores which enable one to easily distinguish it from ordinary decay. If the fruit is not harvested it becomes persistent and shrivels on the tree, it being no uncommon sight to see the shriveled fruit hanging on the trees in midwinter. Oftentimes the twigs of the trees, especially of the peach, are attacked. The blossoms

are also sometimes affected and destroyed.

The life history of brown rot has been well worked out and experiment station literature abounds with references to it, some of the prominent notices of it being found in the bulletins cited at the bottom of the page.

The application of Bordeaux mixture which every prune grower should make for shot-hole fungus will keep brown rot in check though the rot may make, under favorable conditions, its appearance later in the season than the shot-hole; if it does, and at a time when the fruit is approaching maturity, the weak copper sulphate solution should be used or the ammoniacal carbonate of copper solution, the formulas for which are found at the end of the chapter. With this disease, more than almost any other, prevalence will depend on weather conditions, hence changes in temperature and moisture must be closely watched.

Black-Knot.—*Plowrightia morbosa*, Sacc.

Black-knot is a common and destructive fungus on stone fruit trees in the East, and is occasionally found in Oregon though here, as yet, it has never been plentiful enough to do harm. It, therefore, needs but a brief mention in this Bulletin.

Black-knot, as its name implies, is a blackish swelling on the twigs or limbs of the plum and cherry. These swellings are caused by a fungus and not by insects as one might be led to believe by the presence of the latter in many of the old knots. The disease makes its appearance at the beginning of growth in the spring when it may be seen as a light discoloration, growing gradually darker until in June it is purple; the bark at this time seemingly having a thin coating of purplish velvet, caused by the presence of myriads of spores with the organs bearing them. By midsummer the "velvet" has disappeared and the swellings are jet black. At the beginning of winter, minute, black elevations, on the surface of the knots, indicate the presence of the winter spores. They are distributed before spring and new growths are propagated from them. The knots are generally from three to

H. Carman, Ky. Rept. 1889 31—36.
C. McCarthy, Bul. N. C. Ex. Sta. No. 76: 14.
T. E. Humphrey, Mass. Rept. of Expt. Sta: 1890: 213—216.
L. R. Taft, Bul. Mich. Expt. Sta. No. 83: 17—18.
B. D. Halstead, Rept. N. J. Expt. Sta. 1891: 288—260.
F. D. Chester, Bul. 55, Del. Expt. Sta. 10—12.

five inches long, although additions of new swellings from year to year often make them much longer.

The treatment generally recommended is to cut out the knots as soon as discovered and destroy them ; of course the earlier in the season that this can be done the better in order not to allow a crop of spores to mature. The sprayings recommended for shot-hole fungus will tend to keep black-knot in check should it make its appearance. For the benefit of those who may wish to make further investigations of the subject the references at the bottom of the page are recommended.

Prune Rust.—*Puccinia pruni*, Pers.

In some parts of Oregon, the foliage and fruit of the prune have been seriously affected with a rust. Opportunity has not offered so that a study of the disease could be made at the Oregon Station, but I take it to be the same rust that troubles the California prune growers, a study of which has been made, and the results published, by Mr. Newton B. Pierce,* of the U. S. Department of Agriculture.

The rust is known to affect all drupaceous fruits, but does most damage to plums and prunes. It is widely distributed, being found to some extent wherever members of the plum family are found. In some localities the peach suffers greatly from the ravages of this fungus. Judging from what is said by Mr. Pierce in his article, referred to before, the disease is much more virulent in California than in Oregon. There, it seems, trees and orchards are sometimes almost defoliated and the damage done in the way of reducing the aggregate vigor and productiveness of prune, peach, and almond orchards, is immense. In Oregon the most apparent loss to the prune growers is in the quantity of the current year's fruit, or, sometimes, the fruit itself is attacked, the skin assuming a rough, russeted, condition, that greatly injures the appearance of the prune, and also makes it difficult to evaporate it well. But, as in California, the greatest damage is done through the weakening of the vigor and productiveness of the tree and the shortening of its life.

The fungus begins its work early in the season, and may be

E. G. Lodeman, Cornell Expt. Sta., Bul. 81, Ithaca, N. Y.
S. A. Beach, N. Y. Expt. Sta. Bul. 40.
*Journal of Mycology, Vol. VII, No. 4, pp. 354—363.

seen soon after the leaves come out in the spring. Yellowish, irregular, blotches on the upper surface of the leaves, first indicate the presence of the rust. Soon after the spores make their appearance in brown patches on the under side of the leaf, and if the fungus makes a strong growth such portions of the leaf are usually entirely destroyed, presenting an area of brown, lifeless, seared tissue. In different years, localities, and conditions, the appearance of the rust varies somewhat. If the fungus attacks the fruit, the parts attacked swell slightly, become light brown in color, and of a rough texture.

The disease will be pretty well kept in check by the sprayings of Bordeaux mixture recommended for the shot-hole fungus, but in case the rust is particularly troublesome, an added spraying earlier in the season would be of value. The spores are borne on the underside of the leaf and probably germinate there; therefore the under surface should be thoroughly drenched with the spray to obtain the best results in spraying.

Gumming of the Prune Tree.

The prune, in common with all drupaceous fruits in Oregon, is much injured by the exudation of gum from the trunk and limbs of the tree. The trouble is called gummosis. The writer has never seen gumming elsewhere, except as a normal condition of the trees of this class, but inquiry shows that it damages plums, peaches, and cherries in other localities in the United States, as parts of California, Colorado, Texas, the South Atlantic States and Pennsylvania, and is also troublesome in certain parts of Europe.

Notices of the disease, however, in scientific literature, are short and very fragmentary. In fact none of our experiment stations, so far as the writer can ascertain, have attempted to assign causes for the excessive gumming or to prescribe treatment for it. On the other hand, it has frequently received attention in the horticultural press, where I find various causes assigned; as, a bacterium, a fungus, frost, sunscald injuries, over cultivation, etc. About as many remedies are prescribed.

As one of the greatest hinderances to successful prune and cherry growing in Oregon, gummosis has for several years received more or less attention at the Oregon Experiment Station. Most of the efforts put forth have been along the line of controlling the

gumming and in this some results worthy of note have been obtained. During the past year a study of gummosis from a botanical standpoint has been made with a view of ascertaining the cause, and while conclusions have not been reached that warrant positive statements regarding all phases of the disease, yet enough has been done to warrant the stating of a hypothesis as to the cause, and to suggest remedies.

Gummosis may make its appearance at any time of the year if proper weather conditions prevail. It is most prevalent in the spring, especially if the growth has started prematurely, or if the trees have been injured by frost. Trees frequently gum badly, also, in midsummer after a hot wave, or a shower of rain. The first indication of the coming of the gumming, is the tight, smooth glistening appearance of the outer bark. This is closely followed by a swelling of greater or less magnitude, sometimes being not larger than a dollar, but oftentimes extending in irregular patches the whole length of the trunk of a medium sized tree. After a time these swellings burst and gum oozes out, continuing to do so for an indefinite period. If the diseased spot be cleansed it is found that the tissues of the tree have degenerated, and a pocket of some extent, according to the length of time the gum has been exuding, is discovered.

The gum is the same mucilaginous substance that exudes from the cultivated stone fruits the world over, occurring, however, generally as a normal condition, and, perhaps, serving some definite purpose of life. Its consistency varies considerably, ranging from a gelatine-like mass to a thick liquid slime, depending upon the period of growth, or, perhaps, primarily upon the amount of available water in the plant cells. The gum is insoluble in alcohol, slightly so in water and always swelling up in this menstruum; it is colorless, tasteless, and transparent. Chemically, the gum is one of the vegetable mucilages, and is a mixture composed chiefly of bassorin together with arabic acid and its isomer, metarabic or cerasic acid. These occur as compounds of calcium, potassium, and magnesium. The elements found in the acids are carbon, hydrogen, and oxygen in the proportion represented by the general formula, $(C_6H_{10}O_5)n$.

The gum is formed by a chemical metamorphosis of the cellulose composing the cell walls into the mucilage, in consequence

of which it obtains the property of imbibing or absorbing water thus causing the swelling. The consistency of the substance depends upon the quantity of water absorbed. This degeneration of the cell wall may not, as is often the case, affect the health of the tree, but in the circumstances under consideration is always a diseased condition. The degeneration of plant tissue to form gum is to be distinguished from the gum—gumming from vesicles—found in many plants, as the Malvas, Elms, Basswoods and Pines. On the other hand it is formed much as is the gum-arabic, tragacanth, and bassorin of commerce. Like other secretions, they may under certain circumstances, be of use to the plants, but they have no value whatever as a means of adding to the food store of a plant. It was formerly thought that the powerful endosmatic attraction of water in plant cells, so necessary for plant growth, could only be brought about if the cells contained quantities of dissolved substances of the nature of gums, sugars, and proteids. This may be the function of the gum and would explain its presence in the trees in normal quantities.

As stated before, the most common cause popularly assigned for the excessive gumming is bacteria, or other micro-organisms. But in attempting to prove that micro-organisms cause the trouble, only negative results have been obtained; all things tending to show that such organisms appear subsequently and not as the cause of the gumming. From the orchardist's standpoint the theory that the disease is the effect of the work of some lower plant is even more untenable; for, gumming does not appear to be contagious; it is not in the least affected by sprays; all other fungous diseases are restricted in area in Oregon, but gummosis is found in all our orchards; affected trees often fully recovered without treatment of any kind; moreover, there appear to be other causes that clearly, and definitely, influence the flow of gum, and it is these that we assign as the chief cause of gummosis.

Injury to the plant cells seems to be the chief if not the only cause of the gumming. This injury seems to be done by two agencies, frost and heat. Hon. J. R. Cardwell,* President of the State Board of Horticulture, in the last biennial report of that Board, cites definite years and definite cases, dating from 1883

*Fourth Biennial Report Oregon State Board of Horticulture.

in which gummosis, after late spring frosts, and after conditions which greatly favored sunscald, appeared so plentifully that one could only assign the coincidences as cause and effect. Mr. Geo. Coote, the Assistant Horticulturist at the Station, an old and experienced orchardist, has for twenty years observed the same relations between these agencies and gummosis. Hon. Chas. L. Dailey, Horticultural Commissioner for the Second District of Oregon, in a lengthy correspondence, details results of investigations and observations from an orchardist's standpoint, extending over two years, the results of which have well convinced him that gummosis is the effect of frost and sunscald, the former more particularly. Reports of this nature from prominent practical orchardists might be multiplied but these are sufficient.

Both scientific and practical work, then, lend color to the view that gummosis is the result of a degeneration of the tissues of the tree brought about by injuries, principally by frost and secondly, sunscald. Of course, whatever affects the general health of the tree, as lack of drainage, or over cultivation, would make the plant tissues much more easily affected than if perfect health prevailed, and it is possible that these may be at times a primary cause of the trouble.

It may seem needless to carry the discussion of a simple matter of injury by frost and sun so far as has been done in thus discussing gummosis, but I have treated the subject in detail hoping to set at rest the mooted question of what causes gummosis. It now remains to briefly speak of the proper treatment to give an orchard suffering from gummosis.

The great aim that an orchardist seeking to avert gummosis, should have in view is, to have the wood of his trees fully matured and hardened at the end of each season's growth and to keep them back from that luxuriance of growth, indicated by bark-bound trunks and long willowy branches, which seem to be present in trees presenting favorable conditions for gumming. An orchard may be treated in four ways to secure this condition of the wood.

1st.—It may receive a soil treatment that favors the maturity of the wood. Cultivation should be stopped as soon as the trees have made a growth of from two to three feet and every means should then be taken to have this growth harden and mature.

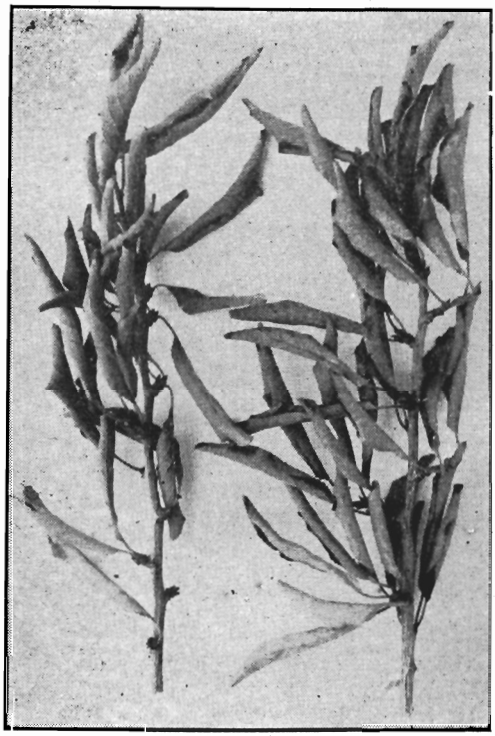


Fig. 2.

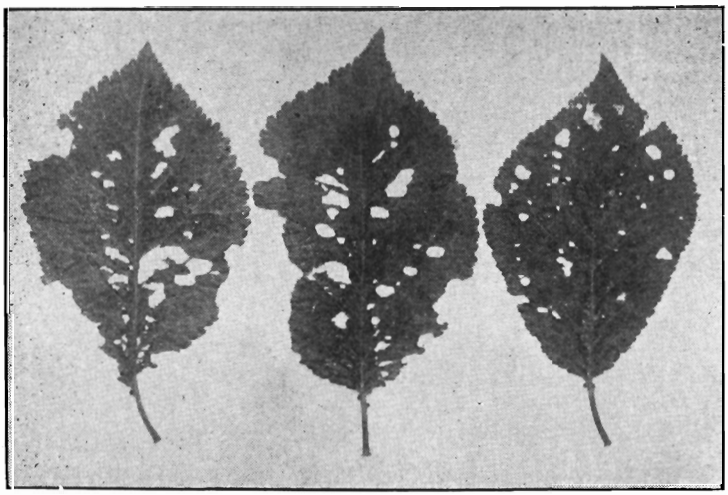


PLATE IV. *Fig. 1.*

This may be accomplished by in any way restricting the water and food supply, as by planting a catch crop of any plant having large leaf surface, as crimson clover or buckwheat.

2d.—The trees may be pruned or rather pinched and so hasten the maturity of the wood. A removal of the terminal buds a month before the leaves fall will check growth and a removal of a few branches bearing the youngest leaves, which actively assimilate food, will do the same.

3d.—The slope or exposure of the land may favor maturity of wood, a northerly exposure being best.

4th.—The trees may be protected from sun and frost by wrapping with heavy paper, cloth, or straw. This treatment has been found effective in numerous cases with both prunes and cherries.

Curl-leaf of the Italian Prune.

A curious phenomenon is to be observed in relation to the Italian prune in the Pacific Northwest. Beginning in midsummer the leaves begin to curl conduplicately without withering, but shriveling somewhat. As the season advances the leaves become a yellowish brown and many of them drop. Plate IV, Fig. 2 shows the nature of the trouble.

This curling of the leaves is reported from all parts of the Pacific Northwest and practically affects all of the Italian prune trees there being but rarely a tree that escapes. As far as I can learn all other varieties are exempt. In some orchards the trees are almost wholly stripped of their foliage. It goes without saying, that the damage done is very great, not only to the fruit crop of the present year, but to the vigor and longevity of the trees. In fact, should this trouble continue, and every year be as serious as last season, and no means be found to check it, the Italian prune must be given up as a standard variety, as trees cannot produce good fruit or live long when subjected to such a drain of vitality as this curl-leaf entails upon the Italian prune.

There are several theories as to the cause of the trouble, but most of them are mere surmises to be rejected at first glance. The commonest belief is that some micro-organism causes the curling, but after a careful microscopic study, this theory seems to me untenable. Moreover the trouble does not act in the orchards as if it were caused by a micro-organism; for instance,

it is found in all orchards no matter how isolated or how far removed from a source of contagion. Some say that only trees upon peach roots are attacked, but I am fully convinced that those upon plum roots are as badly attacked. The appearance of the foliage suggested to many, drouth. But trees are as badly affected in Eastern Oregon where orchards are irrigated as upon dry soil. While the trouble is greatly augmented by lack of drainage, poor cultivation, poverty of soil, and lack of pruning, yet it is prevalent to some extent when there is a surfeit of the opposite of any or all of these conditions, hence any one of them cannot be considered as a cause.

In a lecture given to the students attending the Short Course in Horticulture held at the College last winter Mr. M. O. Lownsdale* first made public a theory which seems to many the most fitting of any yet enunciated. Briefly, it is, that the trouble comes from a physiological or an anatomical defect or weakness in the leaf of the Italian prune under certain conditions, in which the contractile powers of the breathing pores of the leaf, or the guard cells surrounding the pores, are affected in a way that greatly hinders proper transpiration and respiration. Mr. Lownsdale suggests that Bordeaux mixture, by closing up the pores, may prevent much of the curling and orchards so treated coming under his observation seemed benefitted.

On my own part, the first surmise, after having given up the idea of any extended cause, or of the foliage being preyed upon by a micro-organism, was that the trouble might come from a weakness in the epidermal system of the leaves though I did not associate it to any extent with transpiration and respiration. This was suggested to me because the cells in the epidermal system seemed to be the only parts affected; they, always assuming, in the latter stages of the curling and yellowing, a shriveled, corky, appearance. Upon a comparative examination it was found that these cells in the Italian leaves were much larger, seemingly having a more delicate cell wall structure, and differing in general from similar cells in other varieties much more than cells in other varieties differ among themselves.

The first appearance of the trouble last season was immediately after a very hot wave in July. The second bad attack

*See Short Course Lectures, Oregon Agricultural College, 1897.

came after a hot wave in September. These hot waves extended pretty well over the whole Northwest. The fact that heat is the only unvariable factor that could possibly have to do with the trouble, lends much color to the view that heat, in connection with the weakness in the structure of the leaf of the Italian, as stated above, may be the cause. I offer this theory only as a hypothesis, hoping that another season may bring forth definite conclusions as to what the trouble really is, and, if any, the remedies for it.

Formulas for Fungicides.

I shall recommend but three formulas for fungicides, believing these three sufficient for all practical purposes. Bordeaux mixture is the favorite fungicide; the following are directions for making it:

BORDEAUX MIXTURE.

Copper sulphate	6 pounds.
Lime (unslaked)	5 "
Water	45 gallons.

Pulverize the copper sulphate; place it in a coarse sack and hang it in a quarter of the water to dissolve. Slowly slake the lime adding water only as fast as it is taken up; dilute until the lime-water is of the consistency of milk or cream, and then strain through a sieve or a piece of burlap into the barrel containing the copper sulphate solution. When ready for use dilute to 45 gallons. The principal object in adding the lime is to neutralize the acid copper sulphate. If sufficient lime is not added the foliage will be injured. Therefore, *always test as follows:* Dissolve ten cents worth of ferro-cyanide of potassium in a small bottle of water. Add a few drops of this solution to the Bordeaux mixture and if a brownish discoloration appears in the water where the drops fell, add lime until such discoloration does not appear. A little surplus of lime is always desirable.

The strength of Bordeaux mixture can be much reduced and yet be efficient in some cases. For the third and fourth applications 60 gallons of water may be used instead of 45. No fears of burning the foliage need be entertained if the lime is fresh, of proper amount, and carefully slaked. When needed, Paris green can be used as an insecticide with the Bordeaux, thus saving an extra spraying. Some Oregon growers recommend a

greater quantity of lime, thus adding to the sticking qualities of the mixture. Four pounds of molasses added to the mixture will be perhaps more effective in making the mixture stick than the added quantity of lime.

When a large orchard is to be sprayed, a stock solution should be made as follows: Dissolve 40 pounds of copper sulphate in 40 gallons of water. Slake 50 pounds of fresh lime in a box. When to be used add the lime to so many gallons of copper sulphate solution. A sufficient quantity is added when no change in color is produced by the test given above. Dilute with 10 times as much water.

COPPER SULPHATE FOR WINTER SPRAY.

Copper sulphate	1 pound.
Water	25 gallons.

The above is a cheap, simple, effective, winter and early spring spray. Its effect on the fungi is the same as the Bordeaux though the mixture is not so lasting. It is obvious that it should never be applied to any plant then when the leaves are out.

COPPER SULPHATE SOLUTION FOR SUMMER SPRAY.

Copper sulphate	1 pound.
Water	250 gallons.

This is to be used when fruits are nearing their ripening period, when Bordeaux mixture would discolor them. This spray takes the place of the copper carbonate solution and is, we believe, preferable to it. It is too strong for any but the hardiest plants. For peaches there should be 500 gallons of water to 1 pound of copper sulphate.

THE FRUIT SOILS OF OREGON.

G. W. SHAW, A. M., Chemist.

WITHIN THE limits of this article it is out of the question to publish a detailed description of the soils of Oregon. Nor indeed has a very exhaustive study been made, hence in some cases it would preclude the possibility of very accurate generalizations. Still the question of soils is such a vital one to the horticulturist that he should be made acquainted with any facts, favorable or unfavorable, that are likely to affect the horticultural interests of the state.

Owing to the topography and climatic conditions of the state, sharp contrasts in agricultural possibilities are forced upon us. The Cascade range, 150 miles from the coast, divides the state into two parts, differing from each other so much in climate as to render the terms arid and humid strictly applicable respectively to the eastern and western parts of the state. The western area of this grand natural division is subdivided by the Coast range, between which and the Cascade lies the Willamette valley. While under the term humid area, we must include the entire western part of the state, yet the geological formations of the southern part of this area are so different from those of the Willamette valley as to give rise to an entirely different character of soils, and render it necessary to give them a place by themselves. Hence the retention of the term "Southern Oregon," as popularly used, to denote that portion of the western or humid

area south of Lane county, is very apt for our present purpose. The area east of the Cascade range is so radically different from the humid area of the western part of the state as to bring about distinctly different soil conditions, but not different from those of other parts of the world having a scanty rainfall. It is in this sense of limited rainfall that the term arid is used. It does not in the least imply that the lands are not of equal value with those of the humid area. Indeed, it is true that this same "arid" soil, is from natural causes, likely to be the very richest in plant food.

With these few remarks as to the natural divisions of the state, I proceed to discuss some of the more prominent features of the soils as they appear from an examination of a considerable number of samples.

In the following pages only those elements which are of chief importance in having often to be replaced in the shape of commercial fertilizers, will be considered, viz., lime, potash, phosphoric acid and nitrogen. Just what constitutes a sufficiency of these materials for successfully growing a crop will differ somewhat with the nature of the crop, and *very largely with the physical condition of the soil.* Prof. Hilgard, than whom no one is more competent to judge, gives the following as to the minimum percentages for a thrifty growth of green crops:

"LIME.—0.10 per cent in the highest sandy soil; 0.25 per cent in clay loams; 0.30 per cent in heavy clay soils, and it may rise with advantage to one or two per cent.

"PHOSPHORIC ACID.—In sandy loams, 0.20 per cent when accompanied by a good supply of lime. The maximum found in the best Mississippi table lands was 0.25 per cent; in the best bottom land of the same region, 0.30. His investigations in connection with the Northern Pacific survey also showed that this ingredient was more abundant in the soils of Oregon and Washington than in the soils of California.* In the basaltic soils it may even run as high as .30 or more.

"POTASH.—The potash percentage of heavy clay upland soil and clay loams ranges from about 0.8 to 0.5 per cent; lighter loams from 0.45 to 0.30; sandy loams below 0.30 and sandy loams of great depth may fall below 0.10 consistent with good productiveness and durability. Virgin soils with a less percentage than .09 he finds deficient."

The same author says in another article that "no virgin soil having .50 per cent, or over of potash will wear out first on that side of the store of plant food; and much less will suffice in the presence of much lime and humus."

"HUMUS.—This is of great interest to us since it is the storehouse of

*Cal. Expt. Station Report 1888.

the nitrogen supply and its determination serves as a measure of the nitrogen. In oak uplands of the cotton states the range is usually between .70 and .80 per cent; in the poorer sandy soils from .40 to .50 per cent; in black calcareous 1.2 to 2.80 per cent. In Western Oregon it is not uncommon to find 3 and even 6 per cent."

It is not our purpose to discuss at this time individual soils except so far as they serve the purpose of illustration, but rather to discuss general soil propositions and to point out some of the differences existing in the typical soil areas. As a basis for discussion, below will be found a table showing the average composition of the Willamette valley soils, made up from 42 analyses, and in parallel columns will be found the average composition of California soils, and of the humid region farther east. When studied in the light of the preceding principles of interpretation much information may be gleaned.

TABLE I.

ANALYSIS OF FINE EARTH.	Willamette Valley.	Average for States.* (Humid.)	Average for California.* (Arid.)
Insoluble Matter	65.18	84.03	67.88
Soluble Silica	5.02	4.21	8.96
Potash (K_2O)	.23	.22	94
Soda (Na_2O)	18	.09	.28
Lime (CaO)	.83	.11	1.08
Magnesia (MgO)	.76	.23	1.49
Manganese (Mn_3O_4)	.08	.13	.06
Iron (Fe_2O_3) / Alumina (Al_2O_3)	16.45	7.43	15.02
Sulphuric Acid (SO_3)	.03	.05	.05
Phosphoric Acid (P_2O_5)	.21	.11	.08
Water and Organic Matter	10.77	3.64	4.40
Total	99.77	100.19	100.05
Humus	1.63	1.50†	.75

Turning attention at first to the lime content, we find it to be .83 per cent, a somewhat higher figure than that given as probable from data at hand four years ago. Basing our judgment on the principles previously laid down, the valley soils as a rule could not be considered deficient in this ingredient, the figures in many text-books notwithstanding. It is popularly

*"Relation of Soil to Climate," Hilgard. †From limited data.

supposed that the valley soils are deficient in this ingredient, hence I feel that on account of this widespread idea, and its great importance to the horticultural interests, the matter demands a careful consideration. I am at a loss to understand the general acceptance of this idea, unless it be, *first*, that no considerable deposits of lime occur within this area, *second*, that the older text-books have placed the limits for a calcareous soil altogether too high (from 4 to 20 per cent), as shown in more recent experiments, *third*, that poor results are often obtained with clover which is known to be a lime-using plant. However it may have sprung up *it is a fallacy*, at least so far as the bottom lands are concerned. Waiving the first possible cause of this notion as indicating nothing on the negative side of the lime question, as there are other compounds which may give rise to lime in soils, we come to the text-book statement concerning a calcareous soil. It is admitted that the soils are not *markedly* calcareous, yet "very much smaller percentages suffice to do all that lime can do: in very sandy soils less than two-tenths of one per cent impart the calcareous character to vegetation; in very heavy clay soil, from one-half to three-fourths of one per cent is necessary for the same purpose. But any further addition of lime to such soils changes the character of the vegetation no further, unless pushed to the extent of modifying materially its physical condition."* It is admitted as true that poor results with clover are often obtained, but that this is due rather to the present physical condition of the soil than to any inherent deficiency has been amply proven by results obtained at the Station, and also *by those farmers who have solved the problem of a proper physical condition for the crop. At the present time lack of drainage lies at the root of the difficulty with this and many other crops in the Willamette valley.* The presence of lime is well shown in the trouble so often experienced with the drain tile made in the valley. The tile are often found to blister and crack, which under the condition may be easily explained from slaking of the quicklime formed in the burning of the calcareous clay. The soils of the Willamette valley seem to be moderately supplied with lime, but carry a much less amount than either the soils of Southern or Eastern Oregon, the former on account of geological

*"Soil Studies and Soil Maps," (Hilgard) in Overland Monthly.

reasons, and the latter on account of climatic conditions. That these soils should be fairly well supplied with lime would be expected from *a priori* reasons on account of the basaltic origin a large part of them. The lime in the valley soils is not altogether in the form of a carbonate, indeed it is rare that sufficient carbonate is present to cause evident effervescence with acid, but even a casual examination shows a very common occurence of *easily decomposable zeolites*, from which, by weathering, the lime may be constantly supplied. The decomposition of such rocks as those mentioned above *would naturally produce soils rich in lime and poor in potash*. Referring now to the minimum per cent of potash for a strong clay loam we find it ought to carry at least .30 per cent. to be consistent with good productiveness and durability, but in referring to the average content of the valley soils we find but .23 per cent, an amount much smaller than could be desired. But this is as consonant with our premise that such soils are likely to be low in potash as is the high lime content. It is altogether probable, however, that the potash of these soils is of a high general availability on account of the widespread disintegration of basaltic rock and zeolites. It is a well known action of lime to render available potash compounds otherwise inert. Just here, methinks, is, in a measure at least, the explanation of the wonderful fertility of the Northwest soils, but long continued draughts on the side of potash, as will be made by prune culture, is likely to rapidly deplete the soils of this ingredient. Knowing this about the potash content of our soils is it not reasonable to assume that this fact has something to do with the lack of thrift of old apple orchards as well as a lack of flavor in the fruit? For it is a fact well known to science that when potash is deficient in soils plants suffer greatly in their woody portions, which is likely to render them susceptible to attacks of fungous diseases, and in the fleshy part of the fruit, hindering the formation of starch and its conversion into sugar. Taken altogether, then, this question of the relation of potash supply to the health and thrift of our prune orchards, which remove large amounts of this ingredient, is a most important and interesting one, and will demand careful study on the part of the Station. *In the light of the present indications it is altogether likely that when the valley soils "give out" it will be first on the*

side of potash, and that in not a few instances could it be used to advantage now.

Analysis shows the phosphoric acid content to be about .21 per cent, which is all that could be desired, yes, even abundant. It is not at all likely that this will be demanded for many years to come, and this will be particularly true of the hill lands. *This heavy per cent of phosphoric acid in our soils, together with the probably high general availability of what potash does exist, will go a long ways toward explaining the long continued productiveness of the Northwest soils, when sowed to grain. But when the conditions are so changed as to bring the draught very heavily on the side of potash, as will be done in prune culture, if we may judge from the chemical nature of the soils, it is not at all probable that anything like these lasting qualtities will be shown.*

The humus content of the soils—a fair measure of nitrogen—is excellent, 1.63 per cent, and largely exceeds that of California, .75 per cent, in whose soils the potash content is high. With proper care in the treatment of our soils it will be a long time before high-priced nitrogenous manures will have to be resorted to. It is not at all uncommon to find soils showing 2.5 per cent, and in rare cases even more.

I am now to speak briefly of the classes of soils, but limit it to those most prominent, for to undertake a consideration of the varieties due to local causes would demand much more data than is at our command.

In general in the bottom lands of the Willamette valley the soils have a tendency toward clay loams, with clay subsoils forming a hard-pan at varying depths. There are apparently two classes of these soils, one a dark loam, and the other more properly described as a gray loam, running into the so-called "white lands." These are really of about the same chemical nature, and probably represent only different stages of drainage capacity, which has brought about subsequent difference in their composition. Even the so much despised "white land," when properly drained, rapidly takes on the appearance of the other soils both as to color and texture, the better drainage of the darker soils, excepting the adobe, allowing more perfect humification, and preventing the loss of much valuable plant food. *These loams are rich in phosphoric acid, and humus, well supplied with lime, but*

weak in potash. Below will be found their average composition.

Analysis of Fine Earth. (Bottom Lands.)

Insoluble matter	64.72
Soluble Silica	4.39
Potash (K_2O)	.24
Soda (Na_2O)	.18
Lime (CaO)	.83
Magnesia (MgO)	.81
Manganese (Mn_3O_4)	.08
Iron (Fe_2O_3) / Alumina (Al_2O_3)	17.15
Sulfuric acid (SO_3)	.03
Phosphoric acid (P_2O_5)	.19
Water and Organic matter	10.57
Total	99.19
Humus	1.69

On account of the greater depth and lime supply of these soils they are perhaps the better prune soils, but the red hill soils *of sufficient depth* may equal them in potash and humus content, and surpass them in phosphoric acid, but it is not probable that the potash of the hills lands is as available. These red hill lands are nearly always better drained, and unless careful attention is paid to drainage of the bottom lands, they may well be chosen in preference to the latter. No better soil could be desired physically than that upon which the Belfontaine Prune Co.'s orchard is located, an analysis of which is here given. Physically it does not differ materially from the average of these lands.

Analysis of Fine Earth. (No. 411.)

Insoluble matter	65.74
Soluble Silica	4.94
Potash (K_2O)	.21
Soda (Na_2O)	.40
Lime (CaO)	.46
Magnesia (MgO)	.05
Manganese (Mn_3O_4)	.01
Iron (Fe_2O_3) / Alumina (Al_2O_3)	12.50
Sulfuric acid (SO_3)	.02
Phosphoric acid (P_2O_5)	.34
Water and Organic matter	14.82
Total	99.55
Humus	5.96

There are many prune orchards now on bottom land that will be short-lived unless attention is soon given to draining them. Wretchedly bad drainage is the most common fault of prune

orchards in the valley, either from ignorance concerning the necessity of this all important matter, or from a "penny wise and pound foolish" policy of large acreage instead of a well prepared soil. This matter of drainage demands the attention of all horticulturists.

The following shows the average composition of the red lands:

Analysis of Fine Earth. (Red Lands.)

Insoluble matter	63.43
Soluble Silica	7.76
Potash (K_2O)	.27
Soda (Na_2O)	.59
Magnesia (MgO)	.62
Manganese (Mn_3O_4)	.01
Iron (Fe_2O_3) / Alumina (Al_2O_3)	15.46
Sulfuric acid (SO_3)	.01
Phosphoric acid (P_2O_5)	.29
Water and Organic matter	11.89
Total	99.33
Humus	1.34

To summarize the matter of valley fruit soils, the bottom lands offer, as a rule, the following advantages over the hill lands:

1st, Greater accessibility.

2d, Greater depth.

3d, Greater lime content.

4th, Probably a greater availability of potash.

As an offset the following advantages are offered by the hill soils:

1st, Better drainage, and therefore a more friable soil.

2d, Better supply of phosphoric acid.

In other respects there appears to be little to choose between them chemically.

Southern Oregon Soils.

There are two prominent valleys included in this area within which prunes are grown to a greater or less extent, the Rogue and the Umpqua river valleys. On account of the limited amount of work done upon the soils of this area it is not possible to present data with so much certainty as in the case of Willamette valley soils.

The characteristic soil of the southern area seems to be a reddish clay, which terminates in the high plateaus. The

characteristic dark loams, resulting from the decomposition of carbonaceous slates, occur in abundance throughout the valleys. Granite soils are also a common feature of the Rogue river valley.

From analyses that have been made it appears that *the soils of Southern Oregon in general carry considerably more lime than do the soils of the Willamette valley*—at least twice as much—the average so far stands 2.22 per cent for the former against .83 per cent for the latter. Such a condition we would expect to find from geological reasons, this section having been the area of fringing and barrier reef lime deposits in the early geological history of Oregon. The lime is most frequently present as a carbonate. The approximate average composition of the soils is as follows:

Analysis of Fine Earth. (Southern Oregon.)

Insoluble matter	62.45
Soluble Silica	8.74
Potash (K_2O)	34
Soda (Na_2O)	.21
Lime (CaO)	3.22
Magnesia (MgO)	.80
Manganese (Mn_3O_4)	.25
Iron (Fe_2O_3) Alumina (Al_3O_4)	15.35
Sulfuric acid (SO_3)	.01
Phosphoric acid (P_2O_5)	.13
Water and Organic matter	9.52
Total	100.02
Humus	2.25

It is safe to say that the soils are stronger than the Willamette valley soils, not only in lime, but also in potash, *but weaker in phosphoric acid. It is not likely that these soils will first wear out on the side of potash, but rather on the side of phosphoric acid.* In this respect they approach the California soils as will be seen upon examination of the table given on page 78, although richer in phosphoric acid. The humus content of the soils of Southern Oregon thus far examined has been considerably higher than in the Willamette valley. We are not prepared to offer an explanation of this fact at present, although it may be due to the long continued wheat crops grown on the latter soils, and the open culture thus necessitated.

Taken all in all *the most lasting soils for the prune in Western Oregon will doubtless be found in the dark loams of the Umpqua valley.* These are fairly represented by the following analyses:

Umpqua Valley Soils.

ANALYSIS.	No. 612.	No. 613. (Sub-soil.)
Coarse Material	93.00	90.00
Fine Earth	7.00	10.00
ANALYSIS OF FINE EARTH.		
Insoluble matter	64.84	66.03
Soluble Silica	5.57	8.33
Potash (K_2O)	.33	.21
Soda (Na_2O)	.26	.13
Lime (CaO)	2.32	5.15
Magnesia (MgO)	.83	.72
Manganese (Mn_3O_4)	Trace	Trace
Iron (Fe_2O_3) / Alumina (Al_2O_3)	15.77	12.78
Sulfuric acid (SO_3)		
Phosphoric acid (P_2O_5)	.04	.14
Water and Organic matter	9.52	7.05
Total	100.58	100.54
Humus	3.55	.11

The red soils of the foot-hills of the southern area are likely, from their origin, to be quite variable in their composition, which will, perhaps, account for the ill esteem they have acquired. Before orchards are placed on these soils there should be a very thorough investigation of their lasting qualities. *The granite soils are proverbially short-lived.* They usually carry a high per cent of potash, but are sure to be very variable. While orchards are likely to do well on these soils for a time, they will not be found durable for prune culture.

I have been asked several times as to the "adobe" soils of Southern Oregon and have replied, and do reply now, as follows, and it is as true of the Willamette valley as of Southern Oregon:

There are two classes of soil that commonly pass under the term "adobe" in each of these sections—one a soil sour on account of an excessive amount of organic matter, and consequently after neutralizing the acidity by applications of lime this soil is as easily handled as most others. The soil is well supplied with plant food and is likely to be durable. The other passing under this name is an intensely tenacious black soil, rich in organic matter and usually in other plant food, being weakest in potash. On the following page an analysis is presented.

Adobe Soil No. 454.

Coarse Material > .6 m. m.	32.79
Fine Earth	67.21
Capacity for water	46.00

ANALYSIS OF FINE EARTH.

Insoluble matter	52.68
Soluble Silica	6.85
Potash (K_2O)	.19
Soda (Na_2O)	.09
Lime (CaO)	.65
Magnesia (MgO)	.46
Manganese (Mn_3O_4)	.23
Iron (Fe_2O_3) / Alumina (Al_2O_3)	18.56
Sulfuric acid (SO_3)	.04
Phosphoric acid (P_2O_5)	.13
Water and Organic matter	13.60
Hygroscopic Moisture	6.62
Total	100.00
Humus	5.59

It is impossible to treat this satisfactorily except by tile drainage. When so drained it forms a most excellent soil for fruit and other crops. In its present condition it is not at all suited to fruit, although pears, and possibly some varieties of apples, might be placed upon it, after it has once been well cultivated, if kept in excellent tilth for an inch or so. The first cultivation, however, is difficult to secure for it must be made at exactly the right time. Mulching would be beneficial to prevent rapid surface evaporation which causes compacting and cracking. Straw could be utilized to good purpose in mulching this land. *No permanent remedy can be expected except by under-draining.*

Soils of Eastern Oregon.

The appearance of the soils in Eastern Oregon is altogether different from those of the western part of the state. By far the larger part is of a gray, ashy appearance, darkening much on being wet. One coming from the darker soils of the Eastern States would be unfavorably impressed, but experience teaches that these soils are abundantly supplied with plant food, and analysis shows that they are probably the most fertile soils of the state. The wonderful fertility of these soils is shown in their enormous yield of crops from year to year. The soil is exceedingly deep in most localities, and of such a texture as to be easily worked.

The difference in composition between the soil of Eastern

and of Western Oregon is well shown by the following table, giving averages of a considerable number of analyses.

Analyses of Fine Earth.

	Willamette Valley.	Eastern Oregon.
Insoluble matter	65.18	66 59
Soluble Silica	5.02	13.12
Potash (K_2O)	.23	.43
Soda (Na_2O)	.18	.22
Lime (CaO)	.83	1.22
Magnesia (MgO)	.79	.75
Manganese (Mn_3O_4)	.08	.10
Iron (Fe_2O_3) / Alumina (Al_2O_3)	16.45	10.68
Sulfuric acid (SO_3)	.03	.04
Phosphoric acid (P_2O_5)	.21	.14
Water and Organic matter	10.77	6.21
Total	99.77	99.51
Humus	1.63	1.44

Comparing the soils of the arid with the humid areas along the lines of so-called critical elements, it will be noted that the two sections differ markedly in lime content—*the Eastern Oregon soils carrying much more lime than those of the humid or western area.* There is one feature that differs materially so far as observed, viz., that *there appears to be no great difference between the lime content of the uplands and the lowlands of the arid area.* This conforms with conditions pointed out by Prof. Hilgard, of California, *that all arid soils are naturally calcareous.** The converse of this, however, is by no means true, for there may be local causes which will very materially alter the conditions. We have an illustration of this in the southern area of the humid region, where the lime supply suspasses that of the arid area. (See page 78.)

The potash supply of the Eastern Oregon soils is also superior to that of the humid area, standing .43 per cent against .23 per cent. In view of this abundant supply *it is not at all likely that these soils will wear out on the side of potash.* The greater abundance of potash in these soils is augmented much by being in a very soluble form thus rendering it even more available than that in the soils of the Willamette valley. The phosphoric acid supply of the humid area, however, is superior being .21 per cent against .14 per cent for the Eastern Oregon soils. This is doubtless the weakest point in the soils of the arid area of the Northwest.

*Report of California Station, 1892-1893.

The humus percentage is excellent, although, as might be expected from climatic reasons, not as high as in the Willamette valley, *but recent experiments indicate that the humus of the arid regions carries much more nitrogen than do those of humid areas in the ratio of 3 to 1.** If in future experiments this proves to be true in our state, as without doubt it will, it means that while the humus per cent is lower the actual nitrogen content is higher in the Eastern Oregon soils than in those of the western area. Summarizing the lime, potash, and phosphoric acid of the three great areas we find it as follows:

TABLE II.

	Willamette Valley.	Southern Oregon.	Eastern Oregon.
Lime (CaO)	.83	2.22	1.22
Potash (K_2O)	.23	.34	.43
Phosphoric acid (P_2O_5)	.21	.13	.14

The climate has much to do with these differences, although the abundance of lime in the southern area is mainly due to geological reasons as mentioned before. The difference in rainfall, forming the basis of our classification into humid and arid areas, is admirably set forth in an article by Mr. B. S. Pague, so long at at the head of the Weather Bureau in this state.†

"The air, ladened with moisture, passes from off the ocean, and meets its first obstruction, the Coast Range of mountains, on which and to the westward to the ocean the moisture is condensed and falls in the form of rain. * * * * The moisture which is not precipitated on and to the west of the Coast Range is carried across the Coast Range and distributed through what is locally called the Willamette, Umpqua, and Rogue River Valleys extending from the Columbia River to the California line. These are the interior valleys; and in them the moisture decreases from the north to the south, the average rainfall at Portland, in the north, being 49 inches annually, while at Ashland, on the south, it is but 21 inches annually. The moisture-laden winds, continuing on their eastern course, pass over the Cascade Mountains; and having deposited a large proportion of their moisture already, but little remains for the vast area east of the Cascade Mountains, termed Eastern Oregon. This section of the State has an elevation south of the Columbia Valley of from two to six thousand feet, and has an average annual rainfall of from 10 to 15 inches. In the Columbia River Valley the annual rainfall varies from 14 to 20 inches. This brief resume shows a decline in the amount of precipitation from the west to the east."

Thus it is seen that there is a difference of from 20 to 30 inches in the annual rainfall of the two sections. *This difference in rainfall and the lower level of the bottom water, or country drainage, ex-*

*California Station Report, 1892–93. †Resources of Oregon.

plains the accumulation of lime, potash, and other soluble compounds in the soil of the eastern area In not a few instances have these accumulated to such an extent that the salts appear on the surface in the dry season as alkali. In a later bulletin it is intended to discuss this more at length, but inasmuch as in a few instances orchards have been placed on these soils they demand a passing notice. It is well to state here that the material composing alkali is no different than that being formed constantly everywhere, and that its appearance on the surface is simply due to the fact that the rainfall is insufficient to carry these soluble salts into the country drainage, but from year to year they are periodically washed into the soil to the depth of a few feet only to rise again with the evaporation of the water at the surface. Hence it is seen that the deeper the water penetrates—provided only it does not reach the country drainage—and the greater the evaporation, the more salts will there be brought to the surface to appear as alkali. The depth to which the water of precipitation penetrates in most cases is marked in most by the existence of a hardpan at varying depths. This hardpan has invariably been formed by the cementing action of the lime upon the diffused clay carried down by the storm water. These basins are always found underlying bad alkali spots and *before any permanent cure can be effected the impervious layer must be destroyed, otherwise, whatever may be done will be but a mere makeshift.*

It is well known to those who live in regions where alkali prevails that there are two kinds, viz., the white and the black varieties. Of these the former is by far the least injurious on account of its comparative neutrality. The main ingredient of the white variety is sulfate of soda, which, not having the power to dissolve the organic matter of the soil, remains white. It is comparatively harmless, and unless it has accumulated in excessive amounts is easily managed. *The most permanent remedy will be under-draining the land with tile and then thoroughly washing out the salt.* This is the *best* as well as the most expensive means of removing the difficulty. There are other cheaper and less expensive remedies such as digging open ditches lower than the level of the surface of the land to be treated, running these drains into the nearest natural outlet. Then by flooding these lands, not allowing the water to stand long enough to soak into the soil

and thus carry with it the dissolved salts, most of the alkali that has collected on top can be removed. This treatment repeated a few times and followed by thorough and deep cultivation will be all that is required. In many cases, where the white salt has not accumulated in too great quantities, deep and thorough cultivation will be all that is needed. Such frequent and deep tillage keeps the ground in good tilth, and prevents the rapid surface evaporation. It also mixes the top, which is likely to be the strongest, with the soil lower down, and therefore dilutes the salt. It would be far better to avoid these soils for fruit unless they are permanently cured by under-drainage, devoting them to other crops which can be used to advantage.

The black variety of alkali is far more difficult to deal with on account of its ability to dissolve the organic matter, *humus*, of the soil. In times of drought these spots are marked by a series of black rings left about the margins of the dried up pools. The active alkaline ingredient of these soils is sodium carbonate, commonly called sal soda. the corrosive action of which is well known to housekeepers. When water is available, chemical remedies, coupled with those given above, may be successfully employed. By means of gypsum applied at the rate of 500 lbs. per acre, the black form will be changed to the white, which may then be given the above treatment. *Gypsum is the only practical antidote for black alkali.* It should be sowed broad-cast and well harrowed in.

Certain crops also have the power to remove a considerable amount of alkali from the soil if grown for several years in succession. Among these are beets carrots, turnips, and any crop which will shade the ground thereby lessening the amount of surface evaporation.

These alkali soils are the very richest in the state, a number of the compounds composing the alkali being recognized as of direct value as fertilizers, as sulfate of potash, phosphate of soda, nitrate of soda, chlorid of soda. and carbonate of ammonia, which occur together with the sulfate of soda, and carbonate of soda mentioned above. Thus it will be seen that from the very nature of the case these soils are bound to be very lasting, and in many instances will well repay for the trouble required to recover them.

THE COMPOSITION OF OREGON PRUNES.

By G. W. SHAW, A. M.

OUTSIDE OF the state of California but little systemati investigation of the chemistry of fruit has been undertaken in the United States, and if grapes and wine be excepted, but a limited amount of work has been done there. Quite extensive plans had been formulated for studying undried prunes the past season, but the conditions which prevailed rendered it impossible to prosecute the plan in full. It is intended that these investigations shall be a part of the continuous work of the Station, and to study not only the composition of prunes and other fruit, but also the draught of the various fruits on the soil. It must be borne in mind that such work is extremely intricate, and requires a large amount of time and labor, hence amid the multitudinous duties pressing in other directions, progress is necessarily slow.

The prune has been selected for the first work since at the present time it is demanding a large share of attention in the state, and is undoubtedly to be one of the leading fruits of the Northwest. The work here presented is far too meagre to serve as the basis for broad conclusions, but there is a sufficient number of analyses to serve as an indication of the condition of our fruit. It is hoped by the continued study of the proximate and ash composition of the various fruits, and their varieties, to determine something of value as to their relative merits as food, and as to the influence of climate, soil and fertilizers upon them. The question of soil exhaustion is bound to be a burning one, and by "taking time by the forelock," we hope to show the lines of heaviest draught upon soil ingredients. This together with a study of the soil capabilities is of the utmost importance to the horticulturist. Again, the question of food composition is rapidly orcing itself to the front, and ere long

TABLE III

Showing Analyses of Fresh Prunes.

Laboratory No.	Variety.	Grower.	Locality.	Average Weight in Grams.	Number per Pound.	Per Cent of Flesh.	Per Cent of Pits.	FLESH. Per Cent of Juice, Pressed.	FLESH. Per cent of Pulp.	SUGAR. In Fresh Flesh.	SUGAR. In Juice.	SUGAR. In Fresh Fruit.	Acidity in Juice, Terms of SO_3	Nitrogen in Flesh.	Albumenoids in Flesh. N x 6.25	Crude Ash.	PROXIMATE COMPO'N. Water.	Organic Matter.	Crude Ash.	Total.	Laboratory No.
579	Italian	Wm. Hartless.....	Corvallis.....	29.5	15.4	97.29	2.71	75.8	24.2	14.04	18.55	13.66	.43	.212	1.33	1.63	74.28	24.09	1.63	100	579
580	Petite.....	H. F. Fisher.....	"	30.5	14.8	95.08	4.92	73.5	26.5	17.52	23.02	16.66	.61	.265	1.66	.45	75.26	24.29	.45	100	580
581	Silver.....	"	"	47.8	9.5	95.29	4.71	75.5	24.5	10.26	13.59	9.77	.42	.257	1.61	.57	81.43	18.00	.57	100	581
582	German.....	S. Whiteside.....	"	16.7	33.7	95.38	4.62	75.0	25.0	8.16	10.90	7.70	.38	.153	.96	.69	79.40	19.91	.69	100	582
584	Italian.....	John Hall.....		36.6	12 4	93.01	6.99	61.0	39.0	12.92	21.28	12.01	....	.181	1.13	.87	77.89	21.24	.87	100	584
585	Petite.....	"		29.2	15.5	92.17	7.83	78.6	21.4	16.42	20.89	15.13	.67	.233	1.56	.67	74.11	25.22	.67	100	585
586	Italian.....	J. D. Johnson.....	Corvallis.....	31.5	14.4	95.28	4.72	68.2	31.8	11.44	16.77	10.89	.92	.170	1.06	.88	75.34	24.78	.88	100	586
587	Petite.....	E. Witham.....	"	23.0	19.7	92.00	8.00	75.0	25.0	8.90	11.86	8.19	.65	.233	1.56	1.02	83.41	15.57	1.02	100	587
588	Silver.....	D. C. Rose.....	"	57.0	7.9	93.18	6.82	63.2	36.8	15.16	23.97	14.03	.65	.170	1.06	1.07	69.91	29.02	1.07	100	588
720	Petite.....	J. R. Shepard.....	Zena.....	17.7	25.7	92.60	7.40	75.7	24.3	15.08	19.79	14.04	.35	.200	1.24	.63	77.70	21.67	.63	100	**720**
721	Italian.....	"	"	32.1	14.2	94.56	5.44	70.2	29.8	8.52	12.13	8.08	.37	.....	.....	1.01	69.92	29.07	1.01	100	721
722	Silver.....	"	"	36.3	12.4	92.77	7 23	83.0	17.0	14.80	17.83	13.80	.29	.....	.....	.71	77.58	21.71	.71	100	722
733	Petite.....	"	"	24.2	18.7	94.12	5.88	80.0	20.0	16.54	20.67	15.61	.24	.....	.....	.....	.....	.....	.....	.....	733
742	Italian.....	G. A. Hobbs	Freewater.....	.....	.....	.....	.....	73.4	.....	14.03	17.52	.....	.46	.....	1.32	.85	76.35	22.80	.85	100	742
743	Italian.....	Geo. Thompson.....	McMinnville....	.....	.....	.....	.....	.....	.....	12.38	.....	.....	.49	.229	1.37	.....	.....	.....	.....	.....	743
744	Silver.....	C. L. Dailey.....	Salem.....	.....	.....	.....	.....	.....	.....	14.58	.....	.....	.30	.200	1.25	.....	64.31	.....	.....	.....	744

properly balanced rations will demand the careful attention of the housewife. The physical data as to pits, flesh, juice, etc , from a commercial standpoint, and the albumenoids and sugar content, the nourishing parts of the fruit, render it important to the consumer to know the relative merits of varieties, and no less is this true of the producer, who should be made aware of the real worth of the fruit he grows. It is only in this way that the special merits of fruit grown in different localities can be determined. Further it is proposed to examine the different methods of curing the fruit, which is of itself worthy of consideration, for to be able to produce a better quality and quantity of fruit may mean the difference between profit and loss to many a man. To illustrate, if it is possible to demonstrate that for every 100 lbs. of fruit now cured by a certain method there would be a gain of no more than 5 lbs. by the exercise of particular care in certain lines it would return, many times over, the cost of the work. Thus the question of the composition and curing of fruit is not of minor interest either from a scientific or economic standpoint, but is one of paramount importance to the industry.

The accompanying table shows the composition of some Oregon prunes as analyzed at the Station.

Notes on the Analyses.

WEIGHT OF PRUNES.—The range of all prunes examined is from 16.7 grams in No. 582 to 5.70 grams in No. 588. The average weight of the Petites was 24.9 grams. This is against 23.6 grams, the weight of California French prunes so far published. Thus the Oregon French prune requires 18.2 prunes for a pound while those of California require 20.4. The average weight of the Italian prunes was 32.4, which would require 13.4 prunes for a pound. Italian prunes No. 584, from the Umpqua valley are worthy of notice on account of their large size; and they are also significant on account of the size of their pits, which constitutes more than one-fifth the weight of the prune. It will be interesting to watch future work as to whether all prunes of that region are characterized by these same features.

PROPORTION OF PITS TO FLESH.—The percentage of pits ranges from 2.71 in Italian No. 579 to 8.co in Silver No. 587. The average for the Petite prune, 6.81 per cent, indicates that the fruit contains about 14 times as much flesh as pits. The

California analyes show a little smaller pit, making the per cent of flesh about 3 per cent higher. The California prune approaches more nearly the European in this respect, for the average pit percentage for the European fruit is 5.4. After further investigation 14 may be found too low a number to express this relation of flesh to pits, yet it is hardly probable that it will be changed so much as 3 per cent. The Italian prune seems to carry about 19 times as much flesh as pits, making them so far as the *amount* of flesh is concerned much the more economical fruit. At this point it is interesting to refer again to analysis 584, and recalling the large size of these prunes together with their large pits, and to note that the proportion of flesh to pits is as 13 to 1 while the average for Italians was as 19 to 1. I deem it to be the more interesting to follow future analyses from this locality closely since the exceptionally large and apparently well developed fruit from that region has attracted much attention, and it is popularly supposed to be the best region in the state for prune culture.

PROPORTION OF JUICE TO FLESH.—The largest proportion of juice is shown by the French prune, the average being 75.5 per cent, exceeding the Italian by about 9 per cent.

THE SUGAR AND ACID CONTENT.—The chief interest in prunes centers about the sugar and nitrogen content. The honors can be divided about equally between the California and the Oregon fruit, for the former evidently excels in sugar and the latter in nitrogen. An examination of the table shows the average sugar content for all prunes analyzed to be 17.52 per cent *in the juice*, or 14.03 per cent in the flesh, or edible part. The soft-fleshed French prune shows 2.21 per cent more sugar in the juice than the average for all prunes, i. e., 19 25 per cent against 17.52 per cent, and a difference of 2 per cent in favor of the French over the Italian, which contained on an average 17.18 per cent sugar in the juice. It is regretted that data is not at hand to indicate the difference in the sugar content of early and late picked Petites. Some indications may be had from the following little table showing the composition of ripe and unripe prunes when dried. These prunes were selected of about the same size, and those marked *ripe* were such as fell from the tree after a *very gentle* shake, while those marked *unripe* required a *very vigorous* shake to remove them. The flesh of the former

was just beginning to soften, while that of the latter was still quite hard and unyielding. The two samples were dried in the same tray at the same time, and contained respectively when dried 18.82 and 18.47 per cent of water.

Ripe fruit (735) contained 25.60 per cent sugar in flesh.
Unripe fruit (734) " 19.18 " " " " "

Analysis of the undried prunes from which the above samples were taken showed them to have a much lower sugar content than the average Petite, and it will be noted that the sugar content of the dried product is very low as well, yet the analyses serve to illustrate what may be expected from drying prunes, when too green. Neither of the samples were sufficiently ripe, and do not represent what should be expected of well ripened prunes when correctly dried. Such prunes should carry at least 10 per cent more sugar than the best of the above mentioned, (735).

There is still another reason, one which appeals more directly to the financial side of the case, why the fruit should be allowed to become thoroughly ripe. This lies in the fact that 100 lbs. of ripe fruit when dried will yield a greater per cent of the dried product than will unripe fruit. This is well illustrated by results obtained in drying the prunes mentioned above.

TABLE IV.

Lab. No.	Condition.	Lbs. used.	Dry Fruit obtained.	Lbs. Dry from 100 lbs. Green.	Hours Dried.	Water.
734	Unripe	5	1.75	35	23	18.47
735	Ripe	5	2.00	40	24	18.82

That the importance of observing this simple precaution in the drying of prunes may be the better appreciated attention is directed to the following figures: Assuming that the above figures represent average amounts of fruit obtained under the conditions given, and that an average yield of a mature orchard is 12,000 lbs., the saving of this small amount on the product of an acre would be 600 lbs. of dried fruit, which at 5 cts. a lb. represents a saving of $30 for each acre, a sum not to be ignored by any means, even if the results in future experiments should lessen it by one-half.

The California Reports show the French prune to contain on an average (13 analyses) 23.69 per cent sugar in the juice, indi-

cating a difference in average sugar content in favor of the California fruit of about 4 per cent. The average sugar content of all analyses (13) is related to those of California as 17.52 to 20 per cent in the juice. From the difference in the climatic conditions, we might expect, *a priori*, such a difference to occur.

While it is possibly no positive injury to Oregon prunes to to be characterized by a distinct tartness, yet care should be exercised that this is not unnecessarily increased. The tartness may be reduced to a minimum by seeing to it that the fruit is thoroughly ripe before drying. After careful observation and experiment I am satisfied that it is an altogether too common practice to dry prunes before they are sufficiently ripe, thus securing a prune which is not only of low food value, but also of increased tartness. Carelessness in this direction will tend much to lower the standard of Oregon prunes in the market, and cause them to lose the position they might otherwise occupy.

Contrasting the Oregon fruit with 17.52 per cent sugar in the juice with that of Germany carrying 6.15 per cent sugar, we see that the prune product is nearly 3 times as rich in this ingredient. In this respect the sample of German prune, No. 582, is significant in carrying 10.90 per cent sugar in the juice, which is 4.75 per cent higher than the average of all prunes for Europe.

In the acid content the prunes examined present a wide variation. The average acidity in terms of sulfuric acid was found to be .46 per cent.

ALBUMENOIDS.—This is a class of bodies which contain about 16 per cent of nitrogen, and which in all ordinary analyses is determined from the nitrogen content by multiplying it by 6.25. It is the function of this class of bodies, and of this class alone, to form flesh or muscle in the animal body. So far as we know none of this material is elaborated in the body, but must all be obtained from external sources, hence the great importance of the albumenoids in any article of food.

Referring to the table, the maximum, 1.66 per cent of albumenoids, will be found in the Petite, No. 580, and the minimum per cent, .96, in the German, No. 582. The average for Petites was 1.50 per cent against 1.20 per cent in the Italian, and 1.30 per cent for Silvers (in the case of Italian and Silver inclusive of of one analysis each not given in the table because incomplete).

Nos. 580 and 585 are particularly rich in these ingredients. In this connection it is interesting to note that the report of the California products show as an average of 20 analyses .837 per cent albumenoids in the flesh against 1.32 per cent for Oregon fruit. No analyses showing the albumenoids in the edible portion of European prunes is at hand, but in the whole fruit there is reported .78 per cent.

It is indicated that Oregon prunes carry *double* the albumenoids contained in the European product, and have a somewhat higher per cent of this ingredient than the California product. This is evidently one of the strongest points of the Oregon fruit, and as the study of human foods progresses in the United States will tend to bring our fruit into greater prominence.

Food Value of Prunes.

Below is given a table showing the average food constituents of the prunes so far analyzed.

TABLE V

Showing Food Constituents in the Edible Portion of Oregon Prunes.

CONSTITUENTS.	Petite.	Italian.	Silver.	German.	Average.
Water	77.62	74.33	76.31	79.40	76.35
Solid Matter	22.38	25.67	23.69	20.60	23.65
Total	100.00	100.00	100.00	100.00	100.00
Sugar	14.89	11.75	13.70	8.16	14.03
Albumenoids	1.50	1.20	1.30	.96	1.32
Crude Fiber, Fat, Nitrogen-free Extract	5.04	11.16	7.61	9.59	6.99
Ash	.69	1.02	.78	.69	.85
Acid	.26	.54	.30	.20	.46
Total	22.38	25.66	23.69	20.60	23.65

An examination of this table indicates that the French prune exceeds the Italian in water by about 3¼ per cent, and that it leads in albumenoids, or flesh forming matter, the Italian carrying less of this substance than either the Petite or Silver. On the side of carbohydrates, of which sugar is the principal ingredient, the Petite also leads with 14.89 per cent in the edible portion. In relation to the distribution of nitrogen in the *whole* fruit, concerning which we have made no investigations on account of pressure of work in other lines, I quote:* * * * * * "The flesh holds 85 per cent of

*California Station Report, 1892-1894.

all the nitrogen, leaving 15 per cent of it as waste, so far as food values are concerned. Second, the proportional distribution of nitrogen in the pits of the prunes and apricots to the kernels and shells rate on the whole about the same (12 to 1) although we note great variation in this respect in both fruits."

Below a table is given showing the food constituents of 13 samples of dried prunes, all but the last two of which are Petites, Nos. 746 and 747 being Silver prunes.

TABLE VI

Showing Composition of Dried Prunes.

Laboratory Number.	Water.	Albumenoids.	Ash.	Sugar.	Other Carbohydrates.	Acid, as SO_3	Total.
724	22.45	2.38	2.83	23.76	48.02	.56	100
726	19.22	1.94	2.03	.....	.....	.28	100
728	20.11	2.38	2.12	29.64	45.40	.35	100
729	21.46	1.41	2.21	36.66	37.86	.40	100
730	21.03	1.94	2.92	24.74	49.05	.32	100
731	19.75	1.56	2.42	31.26	44.62	.39	100
734	18.47	2.12	2.62	19.18	57.29	.32	100
735	18.82	1.37	3.02	25.60	50.87	.32	100
736	16.85	2.00	2.52	28.55	49.80	.28	100
741	25.82	2.43	1.58	27.36	42.49	.32	100
745	18.84	2.00	2.05	22.92	54.01	.18	100
746	26.68	2.62	1.78	16.42	52.25	.25	100
747	27.49	1.68	1.86	18 06	50.94	.29	100

In examining these results it must be distinctly understood that they are in all respects preliminary, and are recorded as indications which are very likely to need more or less modification as our work progresses.

ASH AND ITS COMPOSITION.—Among the most important considerations concerning any crop is the composition of the ash, for the constituents of the ash represent the draught upon the soil. An article recently appeared in the "Rural Northwest" from which I quote:

"There is no doubt that the many failures in fruit production in the East are largely due to the exhaustion of important elements of plant food in the soil. All farmers realize the importance of keeping up the fertility of the soil for the production of their annual crops of grain and vegetables, but somehow the idea has been prevalent that a tree can take care of itself. Men look at the great trees of the forest and see how they grow and how the soil increases in fertility under their influence, and think that the same should be the result in the growing of fruit trees, while they are carrying

off continually, not only the fruit that the orchard produces, but in many cases expect the land also to produce food for their stock. And then, when the orchard fails to give the expected fruit, and its decrepit condition makes the trees alike the prey to insects and fungous diseases, they declare that the climate has changed and we can no longer produce crops for that reason. It has really been because they and their fathers have robbed the soil until the needed food for the production of healthy trees and perfect fruit is no longer available."

It is essential to future prosperity, then, that careful study be made as to the draught not only of our prunes but also the other fruits on the soil of the state. Work in this direction has progressed sufficiently to say that the Petite prunes carry less than the average per cent of potash—about two-thirds as much as the California fruit. When the condition of our soils as set forth by the writer elsewhere in this Bulletin is considered this low content of potash in the ash is not at all surprising. Again the phosphoric acid content of the ash is in excess of the average of prunes elsewhere.

This matter will be treated more at length in a future publication for which experiments are now in progress.

INSECTS OF THE PRUNE.

By A. B. CORDLEY, Entomologist.

THE PRUNE, wherever grown in the United States, has been unusually free from insect injury. Nearly or quite two hundred kinds of insects feed upon the apple. Probably half as many feed upon the pear, or peach, or cherry, and yet scarcely a score of species are known to feed upon the prune. The apple has its codling moth, its woolly aphis, and its green aphis. The pear has its blister-mite and its pear-tree psylla. The cherry has its slug and the plum its curculio; but fortunately no insect has as yet established a claim to being distinctively classed as a serious prune pest.

There is no good reason, however, for hoping that this immunity from insect injury will long continue. Prunes have been grown extensively in Oregon only within recent years; hence there has been no opportunity for the rapid multiplication of insects that feed upon it— no opportunity for those species which may have accidently acquired a taste for the various parts of the tree, or for the fruit, to transmit that taste to any great numbers of their progeny.

So soon, however, as any crop is grown extensively in a given locality, experience has shown that, in their intense struggle for existence, native and introduced species of insects will be driven to acquire the habit of feeding upon it, and some of them will eventually multiply to such an extent as to become more or less serious pests. Such has been the history of insect depredations upon numerous other crops, and there is no good reason for hoping that the prune is to be an exception.

Already, scattered reports begin to come in from different parts, of more or less serious injury from insects that, hitherto, have not been known to feed upon this plant. Even within our own state several species have become quite generally injurious,

while others are doing more or less serious damage in certain localities.

In view of the above facts, it has been thought best to conclude this Bulletin with a preliminary report on prune insects, in order that the grower may be enabled to recognize some of the worst pests as soon as they appear upon his trees, with the hope that it may aid him in subduing their attacks, and that it may create an interest in the subject which may lead to many new and important observations in the future. We expect to continue our investigations along this line, and sincerely hope that every one interested in prune-growing will aid, by sending to us any insects they may find injuring either the tree or the fruit of the prune.

For the greater convenience of those who may wish to refer to the following pages, the insects have been classed under the following heads:

A. Insects injuring the roots, Nos. 1 and 2.
B. Insects injuring the trunk, Nos. 1, 2 and 3.
C. Insects injuring the branches, Nos. 4, 5 and 6.
D. Insects injuring the leaves, Nos. 7, 8, 9, 10, 11 and 12.
E. Insects injuring the fruit, No. 13.

No. 1. The Peach-Tree Borer.

Sanninoidea exitiosa, (*Say*).

This insect, which promises to be one of the very worst insect enemies of the prune, is the well known Eastern Peach-tree Borer. It was first described by Mr. Say nearly seventy-five years ago under the name *Aegeria exitiosa*.* Several years ago the species was transferred to the genus *Sannina*, since when it has been known as *Sannina exitiosa*. Recently, however, Mr. Beutenmuller, who is making a critical study of the North American Sesiidae, has concluded that the species should form the type of a new genus, *Sanninoidea*,† so that henceforth this insect will probably be known scientifically as *Sanninoidea exitiosa*, (Say).

Prevalence in Oregon.

My attention was first called to the work of the borer upon prunes very soon after I arrived in the state, by Mr. Brady Bur-

*Jour., Phil. Acad. Nat. Sci., Vol. III, p. 216, 1823.
†Bul. Am. Mus. Nat. Hist., Vol. VIII, p. 126, 1896.

nett, a graduate student in entomology, who, early in October, 1895, brought me a number of the larvæ of various sizes that he had taken from prune trees just south of Corvallis. Since then, observation in different parts of the state, and numerous letters of inquiry from various localities show that it is widely distributed at least in Western Oregon.

Under date of July 27, 1896, Mr. C. L. Dailey, Horticultural Commissioner for the Second District, wrote me as follows:

"I find in my district that the Peach-tree Borer is doing a great deal of damage to prune trees—it seems to make no difference whether the trees are grafted on peach or plum stock. As old a pest as this is and as familiar as I am with it, I find very little authentic information has been published as to its life cycle and description. I am not convinced that the borer, that we have here to contend with in our prune trees, is the same as the Peach-tree borer of the East. They are serious this year and I should like more definite information regarding them."

Aug. 8, 1896. Mr. Dailey sent me specimens of the larvæ and pupæ of this insect and wrote:

"We are cutting out as high as twenty larvæ from a single tree. They have done a world of damage. Many trees will die. *The trouble is mostly with my Silver prunes, the Italians not nearly so bad.* The trees have been "grubbed" every year, but I have never seen them so badly infested as now."

Aug. 19, 1896, Mr. R. V. Pratt wrote from Lookingglass, Oregon:

"I have now inspected some 4000 out of 6000 trees. We have found several hundred trees infested by this pest. In quite a number they have penetrated the heart of the tree and it breaks easily when bent. Many of t e trees have been entirely girdled and will die. I found from one to six "grubs" in a tree. *About all the damage is to the Italians.*

The above extracts from my correspondence, together with the fact that during a recent visit to Southern Oregon, the borer was found doing considerable injury to both peach and prune trees, and a recent examination of about 1200 trees about Corvallis, revealed that nearly ten per cent of them were infested, are sufficient to show the injury being done to prune orchards by this pest.

Introduced into Oregon.

Just when and where the peach-tree borer was introduced into Oregon is not known, but it probably made its first appearance at Salem nearly twenty years ago. Mr. S. A. Clark, who has been so long and intimately connected with the fruit interests of the state, writes as follows:

"My first acquaintance with them was about 1881, when I purchased trees from a local nursery. I found, when too late, that they were infested."

Mr. J. H. Settlemier & Son, proprietors of the Woodburn

nurseries, write that to the best of their knowledge the borer was introduced near Salem about 1880. They write:

"It is presumed that they came in trees from eastern nurseries, as at that time there were quite a few trees sold here from nearly all the large eastern establishments."

Is Spreading Rapidly.

Although this borer has been present in Oregon nearly a score of years, yet as Mr. Dailey says. very little authentic infortion has been published regarding it. What few references there are to it, in the horticultural literature of the state, would lead one to infer that only within the last two or three years has it attracted attention as a prune pest, and when viewed in the light of our recent observations, show conclusively that it is multiplying and spreading very rapidly in prune orchards.

Prof. F. L. Washburn mentioned it as "one of the worst pests with which Oregon orchardists have to contend," and adds that in addition to peach trees, "cherry trees and plum trees sometimes suffer from their attacks."* In a later publication he states that it is abundant, but under the head of plants injured mentions only peach trees.† Mr. Varney writes that it is "quite troublesome" in some localities, but lists it as the peach-tree borer and does not mention that it injures other trees.‡ In a still later publication, Prof. Washburn evidently refers to the prune in the statement that the moth "lays its eggs on the plum, cherry, and peach trees (*or peach stock whatever the tree may be*).§ Mr. E. W. Allen refers to it in a short illustrated article and states that "it also works on the plum."‖ At the time the Third Report of the State Board of Horticulture was issued (1895) the borer seems still not to have been recognized as a serious enemy of the prune, since the only reference to it is to cite readers, who desire information, to the First and Second Reports. In his last publication as Station Entomologist, Prof. Washburn makes the first definite reference to the work of the insect upon prunes in Oregon, that I have been able to find, stating under the head of "Prune Insects" that "the peach-tree borer is a troublesome pest wherever any tree is grafted on peach or plum stock."¶ Mr.

*Bul. No. 5, Ore. Expt. Sta. 1890.
†Bul. No. 14, Ore. Expt. Sta. 1891.
‡First Biennial Rpt. Ore. State Bd. of Hort., 1891, p. 27.
§Bul. No. 18, Ore. Expt. Sta., 1892.
‖Bul. No. 5, Ore. State Bd. of Hort., 1891, p. 76.
¶Bul. No. 38, Ore. Expt. Sta., 1895.

C. L. Dailey has recently written that "the worst insect pest of the prune and peach trees in the Willamette valley and probably over the entire state is the peach-root borer."*

Description and Life-History.

The adult insects are beautiful wasp-like moths, the males and the females of which differ so much that they are readily mistaken for entirely different species. They are from one half to three-fourths inch long, and have a wing expanse of from four-fifths to one and one-half inches.

The body of the female (Plate V, *a*, Fig. 1.) is deep steel blue in color, with the fourth and sometimes the fifth segment of the abdomen, orange. The fore wings are of the same color as the body, while the hind wings are clear, transparent, bordered by a band and fringe of deep blue, and with a few scales of the same color at the base and along the front margin.

The male (Plate V, *b*, Fig. 1.) is somewhat smaller than the female, has small flecks of yellow, upon head and thorax, the second, fourth, fifth and sixth segments of the abdomen are narrowly banded with yellow, and all four wings are transparent, with a narrow border and fringe of steel blue.

TIME THE MOTHS APPEAR.—I have no direct evidence concerning the time of year at which the moths appear in Oregon; but a large series of larvae collected in October contained specimens varying in size from those not more than one-fourth grown to those fully grown. This indicates that the period of egg deposition extends over a considerable time, thus corresponding with the well known habits of the insect in the East, where the moths are known to continue to issue and deposit eggs, from early in May until the first of October. We may safely infer that any time between May and October, these beautiful wasp-like moths are flying about in the bright sunshine depositing eggs upon the bark of prune and peach trees.

THE EGG.—These eggs are scarcely more than one-fiftieth of an inch long by half as broad, and are nearly oval in shape. They are usually deposited at or near the surface of the ground, but occasionally one occurs high on the trunk or even on the lower branches. They are deposited singly and are stuck to the outside of the bark by a gummy substance, no effort being made

*Fourth Biennial Rept. Ore. State Bd. of Hort., 1897, p. 133.

by the moth to secrete them in crevices of the bark as is generally supposed.

THE LARVÆ.—The eggs in a few days hatch into very minute and very active larvae which immediately bore into the bark, usually entering through some minute crack. Having once entered the inner layer of bark the larva usually bores downward until it is just beneath the surface of the ground, where it remains feeding upon the inner bark and sapwood throughout the remainder of the season. During the winter it remains dormant in its burrow, but on the opening of spring commences to feed and continues to do so until fully grown. In the case of the larger ones this is but a short time, while the smaller ones undoubtedly continue their injury until well past midsummer.

A recent examination of some twelve hundred trees has shown that at this season of the year (April) larvae can be found in all stages of growth from those not more than one-fourth inch long, to those nearly or quite fully grown. They are yellowish white in color, nearly cylindrical, the head and first segment is brown, and when fully grown, they are about one inch long. (See Plate V, *c*, Fig. 1.)

THE PUPA.—When grown the larva usually leaves its burrow, enters the ground and builds from its own frass and particles of bark held together by silken threads, an elongate cell or cocoon in which it transforms to a rather slender brown pupa. (Plate V, *d*, Fig. 1.) Although no pupae have been found as yet this season, a number of fully grown larvae were present, in the soil at the base of the tree, where they had evidently begun to construct their cocoons. From this fact it is inferred, since the pupal stage lasts but a few days, that the earliest moths emerge in this locality not far from May 15th, and since larvae in all stages of growth can be found it would seem that they will continue to pupate, and to emerge as moths throughout the summer.

Injury Done.

In badly infested trees, the larger roots and even the base of the trunk may be entirely girdled and the tree greatly injured or even killed outright. The presence of a borer in a tree is always indicated by a mass of jelly-like gum mixed with sawdust-like castings about the base of the tree, at or just beneath the surface

of the ground, or at least by the presence of the sawdust-like castings.

So far as our observation goes all varieties of prunes are alike attacked, irrespective of whether they are grown upon peach or plum stocks. Mr. Dailey states that they have injured his Petites most; Mr. Pratt, that in his orchard the Italians are worse affected.

Preventives and Remedies.

All successful means of preventing injury from these borers are based upon the fact that the moth deposits her eggs upon the outside of the bark, and the young larvae when hatched are compelled to eat their way into the tree from the outside. Bearing this fact in mind it is evident that any application to the tree during the summer months, that will prevent the moth from depositing her eggs upon the bark, or that will poison or otherwise destroy the young larva at the beginning of its career, will prove perfectly effective in preventing all injury from these borers.

Many methods have been employed to accomplish these results, all of which can be conveniently grouped under two general heads, viz., (1) mechanical protectors; and (2) various destructive washes.

Mechanical Protectors.—Several kinds of tree protectors, warranted to prevent all injury from borers and other pests, have been placed upon the market. Some of them are very effective; but for cheapness and efficiency there is probably nothing better than to wrap the base of the tree with a band of heavy paper eight or ten inches wide. The earth should be removed from about the base of the tree, the wrapping applied so that it will extend two or three inches below the surface of the ground, and the soil replaced. Care should be taken to confine the wrapping closely to the trunk with strings, otherwise the moth is liable to crowd in and deposit her eggs upon the bark. Instead of paper, a wrapping of straw may be used successfully if care be taken to leave no crevices through which the bark is exposed. At first thought this process would seem to be very expensive, but Mr. Dailey, who has wrapped a very large proportion of the trees in his thirty-five acre orchard, tells me that

the expense is almost nothing as compared with that of cutting the grubs from unprotected trees. He found that with a little experience one man could wrap 600 trees per day, and that the expense for material is very slight indeed. The total cost of wrapping his trees was about sixteen dollars, whereas he had just previously expended nearly three hundred dollars in "worming" the same trees. It is hardly necessary to add that his trees will be protected by wrappers in the future.

WASHES.—Various washes are used to prevent the moth from depositing her eggs, or to coat the bark with a substance impenetrable to the larva, or to destroy it before it has penetrated the bark.

For the first purpose Dr. Lintner recommends a wash made by mixing one pint of crude carbolic acid in one gallon of soft soap, then diluting with eight gallons of water.

For the second purpose probably no wash is better than a good stiff whitewash, to which a little glue has been added to make it more permanent and impenetrable, while for destroying the young larvae nothing is better than some poison, applied with some substance that will make it stick to the bark.

For all practical purposes the combined effect of all three of the above washes may be obtained by using a good whitewash to which has been added a little glue, a small amount of carbolic acid, and a little Paris green. Use about one pint of the acid and two or three ounces of Paris green to each ten gallons of whitewash, and apply the mixture thoroughly with an old broom or good stiff brush. The application should be made between the first and fifteenth of May, and should be repeated whenever it appears that the coating is becoming imperfect. We are of the opinion that this is, withal, the cheapest effective preventive of injury from the peach-root borer.

REMEDIES.—The above mentioned measures are only preventive. When once the larva has entered beneath the protecting cover of the bark and exuding gum it is beyond the reach of any external application of insecticide substances. The only satisfactory remedy then, is to examine the trees carefully, once in the fall and again in the spring, remove a little of the dirt from the base of the tree, and whenever the presence of a borer is indicated by the exuding gum or sawdust-like castings, cut it out. It is then a

good plan to prevent decay by covering the wound made with grafting wax.

Even with experience, this method of controlling the root borer is quite expensive, and should be employed only as supplementary to one of the preventive measures above described. At best it only removes the borer after the injury is done and then only at the expense of a more or less serious wound to the tree. First use one of the preventive measures, then if an occasional tree becomes infested use the knife.

Various other methods of destroying the borer have also been recommended. Apparently good results have been obtained by scooping out a shallow basin about the base of the tree and filling it with hot water, while others by using a small oil can, or similar device, inject a small quantity of kerosene oil or bisulphide of carbon into the burrow made by the borer, and report that it is effective.

All of these methods, however, are fully as expensive and troublesome as the "knife remedy" and have the disadvantage that one leaves the tree not knowing that this work has been effective.

No. 2. The Pacific Peach-Tree Borer.

Sanninoidea opalescens, (Hy. Edw.)

This insect is undoubtedly present in the state, and in fact may very largely take the place of *S. exitiosa* in Southern Oregon, where it seems to have been introduced from California between ten and fifteen years ago.

It so closely resembles the latter, however, both in general appearance and in habits, that it is unnecessary to speak of it in a work of this kind other than to state that the same preventive and remedial measures that have been recommended for the eastern peach-tree borer, will prove equally effective against its western relative, except that the latter is somewhat more difficult to remove with the knife, since it frequently bores more deeply into the solid wood.

It is probable that the letter of Mr. R. V. Pratt, above cited, refers to the work of this insect where it states that "they had in many cases penetrated the heart of the tree." The larvae of *S. exitiosa* confines itself almost entirely to feeding upon the inner bark and sapwood.

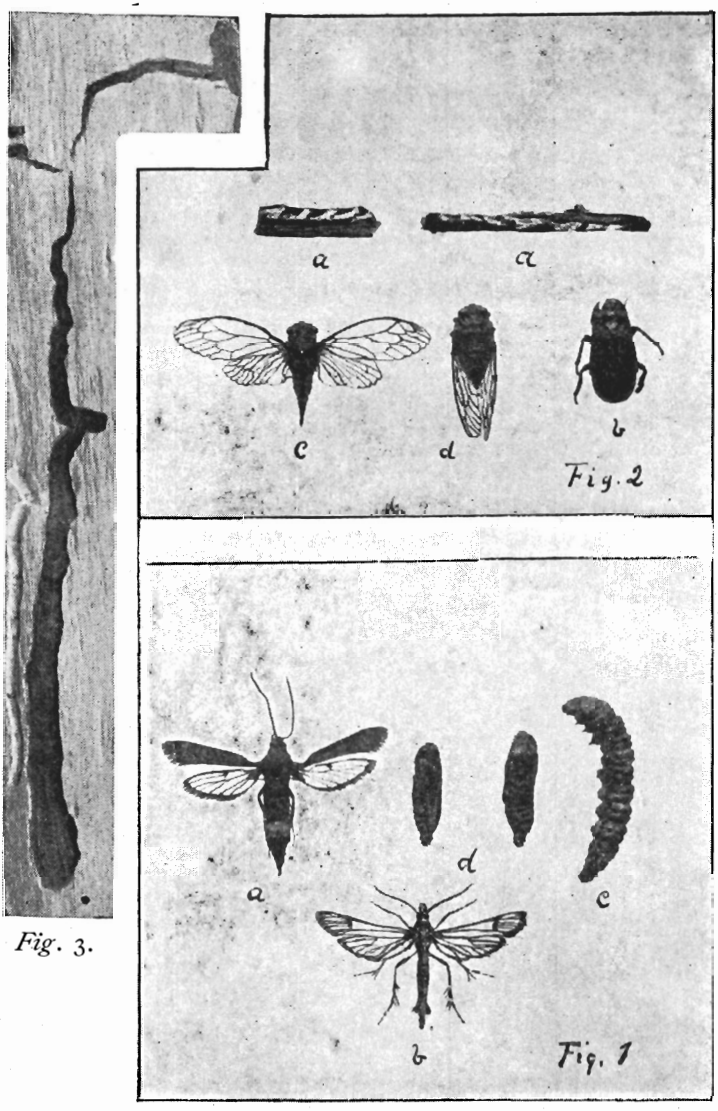


Fig. 3.

FIG. 1, *Peach-Tree Borer.* FIG. 2, *Cicada.*
FIG. 3, *Work of Flat-Headed Apple-Tree Borer.*

PLATE V.

No. 3. The Flat-Headed Apple-Tree Borer.

Chrysobothris femorata (Fab.)

In addition to both of the above mentioned root--borers, which occasionally attack them as high as the lower limbs, the trunks of prune trees are sometimes attacked by the larvae of this well known apple-tree pest.

During the last two years I have received several reports of such injury by this insect, and have recently received from Mr. Julius Priester, of Oregon City, a section of the trunk of a young prune tree containing a borer that I have been able to identify as the larva of this insect.

Description and Life-History.

The adult insect, *d*, Fig 1, is a beetle belonging to the family *Buprestidae*, to which many of the worst enemies of fruit and shade trees belong. It is nearly ½ inch long, flat and rather oblong in shape, and is a greenish-black color above with the surface uneven, but polished and shining. Beneath it has a brilliant coppery lustre.

The beetles are most abundant in neglected orchards where they may be seen running actively about on the tree trunks in the bright sunshine of a May or June day.

Although most commonly known as a pest of the apple they originally worked upon the oak and in addition are also known to attact the soft maple, willow, mountain ash, box elder, linden, peach, pear, cherry, and prune.

When working upon fruit trees the female usually selects one that has been injured by sun-scald or by "winter killing" or that is for some other reason unthrifty, and deposits her eggs under the loose scales or in the crevices of the bark, fastening them in position with a glutinous substance. Usually only one is deposited in a place, but occasionally several are placed together in a group. A small tree trunk about four inches in diameter and three feet long, that is before me, shows the work of no less than fifteen of these borers. Plate V, Fig. 3, shows one of the burrows near the origin of which are the beginnings of two similar ones.

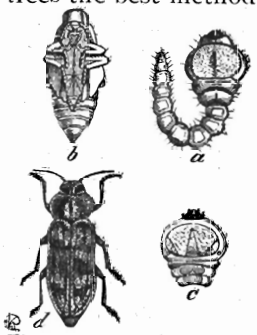
The eggs soon hatch and the young larvae after boring through the outer bark, continue to feed upon the sapwood, the burrows gradually becoming broader and broader as the larvae in-

crease in size. One such borer may completely girdle and kill a small tree, and several of them will greatly injure or even kill trees of the size above mentioned, or even larger. When fully grown each larva bores deeply into the solid wood, or at least excavates a chamber or cell in which it changes to the pupa shown at *b*, Fig. 1. Just before the change, it is about ¾ of an inch long and its head and anterior segments are enormously developed. Its characteristic appearance is well shown at *a*, Fig. 1.

Dicerca divericata (Say), another borer very similar to the above, but somewhat larger, has also been reported by Prof. F. L. Washburn as occasionally injuring the prune.*

Preventives and Remedies.

Since these insects rarely attack perfectly healthy vigorous trees the best method of preventing injury is to insure such trees by extra care and cultivation, by preventing so far as possible all injury from "sunscald" and "winter killing" by shading the trunks of young trees with a piece of board or something similar stood upright in the ground by the south-west side of the tree, or by wrapping them as for the peach-tree borer. However, trees that are not vigorous or that have been injured in any way may be effectively protected from borers by applying the poisoned whitewash or the wrapping recommended for the peach-tree borer. They should be applied for this purpose about the middle of May.



Flat-headed Apple-tree borer. a *larva*, b *pupa*, c *head of borer*, d *beetle.*

FIG. 1.

No. 4. Cicadas or Harvest Flies.

Platypedia putnamii Uhler.†

One of the injuries to prune branches most often referred to the Entomologist is shown at *a*, Fig. 2, Plate V. It consists of a conspicuous irregular double row of punctures in the bark, through each of which a small "brush" of splintered wood protrudes. This injury is caused by a female cicada in the act of depositing her eggs. These insects are closely related to the celebrated seven-

*Bul. No. 38, Ore. Expt. Sta, p. 19.
†Determined by Mr. C. F. Baker.

teen-year "locust" which occasionally does such serious damage to fruit and forest trees in the Eastern States, but differs from that insect in several respects, the most important of which is the fact that, whereas, that occurs in a given locality only once in seventeen years, our native species occurs annually.

The young, or *nymphs*, (*b*, Fig. 2, Plate V) of this insect live entirely under ground and do no appreciable harm. When fully grown they emerge from the ground, ascend trees or other objects and soon become firmly attached. In a short time the skin splits down the bark and the adult insect (*c*, Fig. 2, Plate V) emerges.

After pairing, each female resorts to some tree and proceeds to deposit her several hundred eggs. Selecting a suitable twig, with her strong saw-like ovipositor she makes a ragged double puncture in it, and deposits an egg in each. Then moving forward she repeats the operation. This process is continued until a row of perhaps a dozen punctures have been made, when she repairs to another twig and repeats the operation. One female may thus injure a large number of twigs before her supply of eggs is exhausted.

The wounds made by this process are almost invariably found on twigs not more than one-half the diameter of an ordinary lead pencil, and so weaken them that they are easily broken by the wind during the first or second season. If this does not occur no serious injury is done, since the young cicadas as soon as hatched drop to the ground without working upon the tree at all.

Fortunately these insects are not numerous, and a very large proportion of their eggs are deposited upon other than fruit trees. It is the conspicuous nature of the injuries, rather than their frequency, that brings them so prominently before the attention of orchardists. There is, however, no cause for alarm, and no remedial or preventive measures need be employed, unless the attacks become much more serious than they have yet been. It is usually recommended to cut off and burn the freshly punctured branches, but since the injury itself would not do more than cause the loss of the twig, and since the very few eggs destroyed would not preceptably diminish attacks in the future, I do not see the necessity for such a course. *d*, Fig. 2, Plate V represents a less common species with wings folded.

No. 5. The Branch and Twig Borer.

Polycaon confertus Lec.

Very rarely prune trees in this state are injured by this beetle, which bores into the smaller branches and twigs. The axil of a bud or of a small branch is usually selected as the spot to begin operations and from there the comparatively large open burrow extends downward and inward to the center of the branch. The injury itself is insignificant, except that the branch may be so weakened that it readily breaks in a strong wind.

Very little is known regarding this insect and its habits. The adult beetle, which does the injury is one-half inch long, is nearly cylindrical and is brown in color. In California it is said to be partial to olive trees, but has also been reported as attacking the peach, apricot, almond, apple, pear and grape, and the grub or larva has been found boring in live oak, and almond trees. In this state adult beetles, in freshly made burrows in prune twigs were received at the Experiment Station in January.

Remedies.

Unless this insect becomes much more injurious than it has been no means of preventing its attacks will be necessary. Should a remedy become necessary, it is probable that a spraying with lime, sulphur and salt or with whale oil soap, at the time the attack begins would repel the beetles from the trees. If Paris green should also be added to either of these sprays it would probably poison any of the beetles that should attempt to eat into the twigs.

No. 6. The San Jose Scale.

Aspidiotus pernicious Comst.

Scales in General.

There is no group of insects of greater economic importance than that which contains the peculiar creatures known as scale insects, or simply scales. There is hardly a shrub or tree that is not subject to their attacks, and often entire orchards are seriously injured by their ravages. The often minute size of the creatures and the difficulty of destroying them, together with their wonderful prolificacy, all combine to make them formidable pests of the orchardist. It is only necessary to mention the mealy bug of greenhouses, the fluted scale of California,

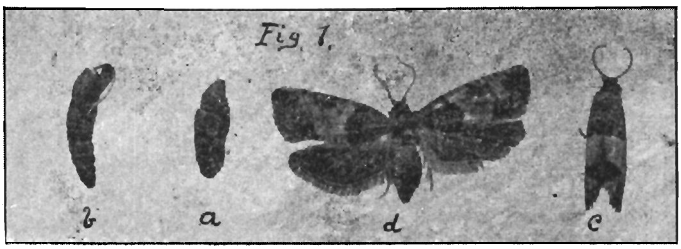


PLATE IV. THE BUD MOTH AND ITS WORK.

the peach scale of the south-eastern United States, the New York plum scale, or the well known subject of this article to establish the truth of this statement.

The life history of scale insects is very peculiar and bears an intimate relationship to the proper remedies to be used in destroying them. The fully grown individuals are covered with a waxy excretion which may be of a white fluffy nature, or may form a dense protective scale. These scales vary in size, shape, color and markings with the different species or kinds, and give to the insect a peculiarly lifeless appearance, so much so that it is difficult, in many cases, to realize that they are covering living organisms which may be seriously reducing the vitality of the infested plant. But if some of these scales be carefully lifted from their resting places there will be found under them either soft fleshy bodies, the insects themselves, or numerous eggs. In the former case the females will usually begin to produce living young or eggs on the advent of settled warm weather, and will continue to produce them for several weeks. In the second case the eggs will all hatch nearly at the same time.

In either case the very young scales are active, six legged microscopic creatures, which at first crawl rapidly about but soon attach themselves firmly to some tender growth and feed upon the sap. When first hatched the males and females are very similar, but their future development differs greatly. The females grow rapidly, but when fully grown consist only of a fleshy body covered by a more or less dense scale. The legs, antennae and eyes have entirely disappeared, and of all the appendages of the body only the well developed mouth parts remain. The body gradually becomes distended with eggs or young and after they

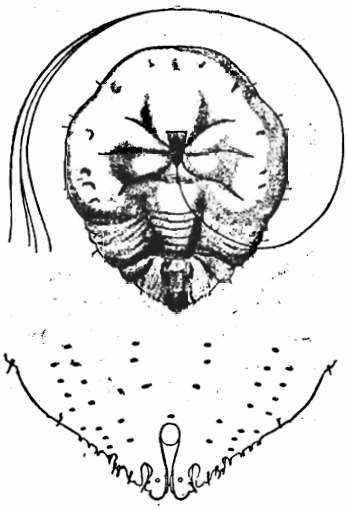


FIG. 2. *Female San Jose Scale.*

are produced the female dies. The fully grown male instead of being motionless and without appendages, as is the female, is a minute active creature with two broad wings, long antennae, six legs, well developed eyes but no mouth parts.

Distribution of San Jose Scale.

Of all scale insects that attack our deciduous fruit and forest trees the San Jose scale is by far the worst. Dr. Howard, United States Entomologist, writes that "there is perhaps no insect capable of causing greater damage to fruit interests in the United States, or perhaps in the world, than the San Jose scale."

This pest was discovered at San Jose, California, about 1870. Where it came from is not definitely known, but at the present time it is pretty well distributed throughout the states of California, Oregon and Washington, and in British Columbia. It has also invaded Idaho on the north and Arizona and New Mexico on the south, and within the last few years has become widely distributed over the Eastern States, where it seems equally at home and equally as injurious as on the Pacific Coast. In Oregon it it is found at Ashland, Rogue River valley, Umpqua Ferry, and at several localities in the Willamette valley in the western part of the state, and at The Dalles, Walla Walla valley and Union in the eastern part. Everywhere it infests the apple, pear, peach, plum, prune, cherry, currant, rose, willow, and numerous other deciduous trees and is a serious pest of each, occuring as it does on all parts of the plant, the limbs, the leaves and the fruit. It does not attack coniferous trees nor does it breed upon rocks, as has been several times reported by observers in different parts of the state.

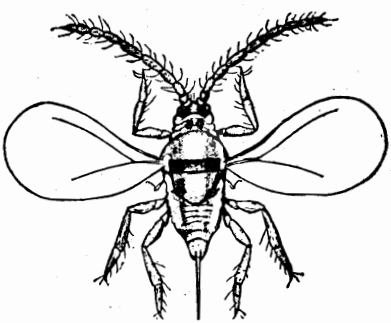


FIG. 3. *Male San Jose Scale.*

General Appearance of San Jose Scale.

The worst feature of an attack by this pest, is the fact that the insect is so small and inconspicuous that it often remains un-

noticed, while at the same time it spreads so rapidly over the branches, leaves and fruit that it is rarely a tree can survive an unchecked attack for more than two or three years. The tree may be seen to lack vigor but often the cause of the disease is overlooked. And yet the San Jose scale is easily recognized when once seen. On badly infested plants the small, nearly circular, grey scales lie close together, even overlapping one another, and give the appearance of a grey scurfy deposit on the infested part. The natural, rich red, or brown color of the branch is obscured and appears as though covered with fine ashes. If this scurfy covering be scraped, so as to crush the insects under the scales, a yellowish oily appearance is produced. When present in comparatively small numbers on smooth bark, or on the fruit, the appearance of the scale is even more characteristic since each individual scale is surrounded by a distinct reddish discoloration. This is so conspicuous that it is of great use in enabling one to recognize, at the beginning, an attack which otherwise might remain unnoticed for some time.

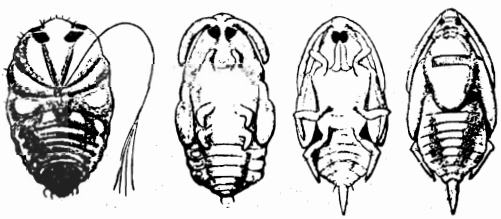


FIG. 4. *Stages of Development of Male San Jose Scale.*

Life-History.

Although the San Jose scale has been known as a fruit pest for more than twenty years, its full life-history, which has an important bearing on the subject of remedies to be used, was not worked out until three years ago. At that time Dr. Howard, aided by Mr. Pergande, demonstrated that the insect develops as follows:

"The winter is passed by the nearly full-grown insects under the protection of the scale. Early in April in this latitude (Washington, D. C.) the hibernating males emerge, and by the middle of May the over-wintered females mature and begin to give birth to a new generation, continuing to produce young for a period of upward of six weeks, when they reach the limit of production of young and perish.

"The adult gives birth immediately to living young, differing in this respect from most other scale insects. Ordinarily eggs are deposited beneath the scale, which in the course of a longer or shorter time hatch, and the young larvae make their escape and migrate to different parts of the

plant. In the case of some scale insects the female fills its scale with eggs in the fall and perishes, the eggs wintering over and hatching the following spring. In others the insect hibernates in the nearly mature condition, as does the San Jose scale, and deposits eggs in the spring or early summer. The viviparous habit, or the giving birth to living young, possessed by the San Jose scale, finds a parallel in many other insects and frequently in plant lice." * * * * *

"The newly born larva, Fig. 3, is an almost microscopic creature of pale orange yellow color, with long oval body, and with the customary six legs and two feelers The long thread-like proboscis with which the juices of the plant are sucked up is doubled on itself and lies in an invagination of the body wall, the tips only projecting.

"After crawling about for a few hours the young larva settles down and slowly works its long bristle-like sucking beak through the bark, folds its antennae and legs beneath its body and contracts to a nearly circular form. The development of the scale begins even before the larva becomes fixed. The secretion starts in the form of very minute white fibrous waxy filaments, which spring from all parts of the body and rapidly become more numerous and dense. * * * The scale is formed by the slow matting and melting together of the filaments of wax. * * *

"The male and female scales are exactly similar in size, color, and shape until after the first molt which occurs twelve days after the emergance of the larva. With this molt, however, the insects beneath the scales lose all resemblance to each other." * * *

Fig. 4. Page 114, illustrates the different stages in the development of the male which emerges as the adult shown at Fig. 3, Page 113, early in April. Fig. 2, page 112, shows the adult female.

"The length of a generation is determined by the female, and covers a period of from thirty-three to forty days. Successive generations were followed carefully throughout the summer, and it was found that at Washington four full generations are regularly developed, with the possibility of a partial fifth generation."

It was further shown that among the wintering individuals the males greatly predominate and that

"The numbers of both sexes are insignificant compared with the progeny of the later generations. The males still predominate in the second generation, but in the third and fourth generations the females considerably outnumber the males, in one instance the females from a single mother reaching the astonishing number of 464, which, with 122 males from the same parent, makes the progeny of this female 586 insects. Taking 200 females as an average of the different generations for the year, the product of a single individual from spring to fall amounts to 1,608,040,200 females. * * * The males may be estimated at the same number, giving a total of 3,216,080,400 descendants from a single insect in a single season. It is not to be expected, of course, that all the individuals from a scale survive and perform their function in life, but under favorable conditions, or in the case of a tree newly infested or not heavily incrusted, the vast majority undoubtedly go through their existence without accident. Neither the rapidity with which trees become infested nor the fatal effect which so early follows the appearance of this scale insect is therefore to be wondered at.

"Owing to the long period during which the female is continually producing young, the different generations or broods in the course of the

summer are not distinctly marked and merge insensibly into each other—so much so that at almost any time there will be found young larvae running about over the trees and scales in all stages of development. * *

* In this latitude the first young appear, as noted, by the middle of May. * * The larvae are continuously present on the trees until further hatching is prevented by severe frosts.

"In autumn, or when further development is stopped by cold weather, hibernation is begun by scales in all stages of development, from the white, minute, down-covered recently hatched young to the mature and full-grown females and males. Unquestionably many young perish during the winter, and normally in spring quite a percentage of the smaller or half-grown scales will be found to have perished. It is very probable that many females have union with the males in the fall, but the majority of them are unquestionably immature, and are fertilized in this latitude early in April by overwintered males which, as we have noted, appear nearly a month before the first young of the spring brood."

How the Scale Spreads.

Since the female scale is motionless and permanently fixed to the branch on which it feeds, it is frequently asked how it is that the scale has spread so rapidly over such a vast territory. Observation has shown that even in its active larval stage the insect is incapable by its own exertions of getting more than a few feet from the tree on which it was born. But by crawling upon birds, insects or other animals, or by being wafted short distances by the wind, it is readily transported from tree to tree in the same or neighboring orchards. From one locality to another it is invariably carried upon infested fruit or nursery stock. It would therefore seem that the State Board of Horticulture, the nurserymen of the state, and everyone else should be encouraged in every way possible to continue the efforts to prevent the sale or shipment of nursery stock, except under a certificate of inspection, and to prevent the sale of infested fruit. A strict enforcement of the law would undoubtedly cause serious inconvenience and loss to a few individuals, but considered from the point of view of the growing horticultural interests of the state, it is seen to be essential.

Enemies of the San Jose Scale.

In our warfare against this insect we are aided by several minute parasitic insects and by some predaceous ones.

The most important of the latter is perhaps the twice-stabbed lady bug, *Chilocorus bivulnerus*. This is a shining black species, a little more than one-eighth of an inch long and nearly as wide, and with a bright red spot on each wing cover.

In the east the most useful of these lady-bugs is a minute

black species known as *Pentilia misella*. It is scarcely as large as a pinhead and is shining black in color. Until recently it was supposed to be a distinctly eastern species but in 1894 it was found at Marysville, California, and in March, 1896, Mr. H. E. Dosch, Horticultural Commissioner of the first district, sent me for identification specimens he had observed feeding upon the scale at Hillsdale. I immediatly wrote Mr. Dosch as follows:

"The small beetle * * is evidently *Pentilia misella* a little coccinellid beetle which is one of the most efficient enemies of the San Jose scale in the east. * * * I would suggest that specimens be sent to each of the other commissioners to enable them to recognize the species, and that they search for it in their localities. If it should prove to be not very widely distributed in the state, undoubtedly much good could be done by introducing it in the localities in which it does not exist."

Later my identification of the species was verified by Dr. Howard.

Remedies.

The most satisfactory remedy for the San Jose scale is to thoroughly spray the trees in winter with the lime, salt and sulphur wash. Summer sprays are almost entirely useless against this particular insect. This is due to the fact that the female insect, herself protected under a scale that is practically impervious to any spray that the tree can endure when in leaf, continues to give birth to living young for a period of several weeks; and the young scales, which at first are easily destroyed, inside of two or three days secrete a covering that is also practically impervious to any washes that can be applied. Hence to eradicate the insect by summer spraying would require an application every two or three days for several weeks.

The lime, salt and sulphur wash is best prepared as follows: Slake fifty pounds of lime, then add fifty pounds of sulphur, and fifty to seventy-five gallons of water. Boil the mixture for an hour or more, or until the ingredients are practically all dissolved. Then dilute to one hundred and fifty gallons. This formula is based upon results obtained by Mr. Emile Schanno in his extensive experiments in the Fourth Horticultural District.

The best results are obtained by applying the mixture while still warm, and by applying it with considerable force in the form of a rather coarse spray. The insects multiply with such astonishing rapidity that it is essential, if one hopes to satisfactorily control them, to destroy nearly every specimen. It is therefore necessary that the spray be dashed upon the infested

branches with such force that it will drench every part. One such thorough application of the above wash each year will prove entirely satisfactory in keeping the scale in check in the worst infested orchard.

No. 6. The Bud Moth.

Tmetocera ocellana Schrif.

I am not aware that this destructive insect has before been recorded as present in this state, although it has been present in the Eastern States for more than half a century and has come to be recognized as one of the most destructive of orchard pests as well as one of the very hardest insects to combat.

Present at Portland.

April 21st of this year, I received from Mr. J. J. Borg, of Portland, a quantity of cherry leaves that were being seriously injured by numerous small dark-colored Tortricid larvae. I at once suspected that these larvae represented the skirmish line of the bud moth, but to be certain I sent a few of them to Dr. Howard, who under date of May 7th replied that "there is little doubt that the larvae which you send are the larvae of the eye-spotted bud moth, *Tmetocera ocellana*." May 24th all doubt as to the true nature of the pest was removed by the issuing of several moths of this species.

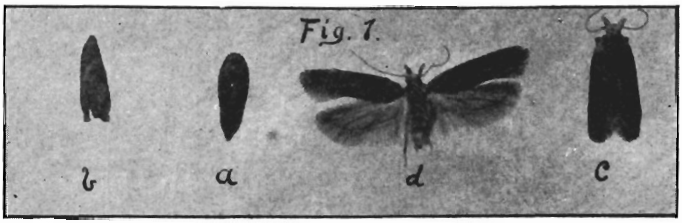
Distribution.

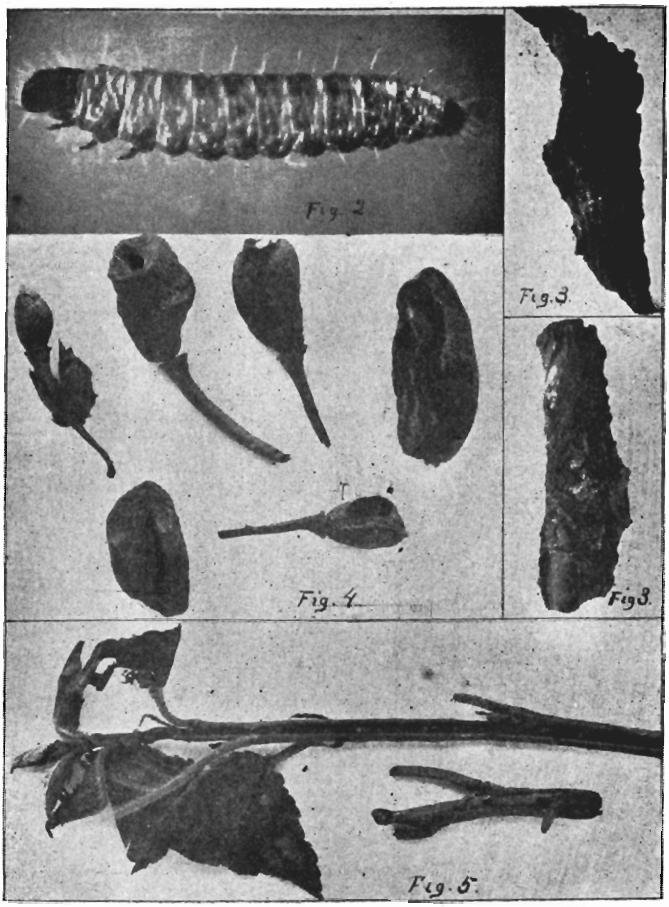
This insect is of European origin and was first described more than a century ago. In this country it first attracted attention as an injurious species about 1840, the first account of its work apparently being the one published by Dr. Harris in 1841. Since then it has spread over the New England States, the Middle States, and Canada, and has been reported from Washington, D. C., Michigan and Missouri. In 1893 it was introduced at Genesee, Idaho, on nursery stock from Rochester, N. Y.,* and now it has obtained a foothold in Oregon. Whether the Portland specimens have spread from the Idaho importation or whether they have been introduced from the East on infested nursery stock I do not know.

Nature of the Injury.

The small, brown, half-grown larvae of this insect pass the winter in minute inconspicuous cocoons on the twigs and branches

*C. V. Piper, Bul. 17, Wash. Expt, Sta., p. 24.





THE TWIG-BORER AND ITS WORK.
PLATE VII.

or in small clusters upon the leaves. In from seven to ten days these eggs hatch. The young larva, which is at first green, at once begins to feed, usually upon the lower epidermis of the leaf. It soon spins for itself a silken tube open at both ends, and usually located beside the midrib. Fig. 4, Plate VI shows a leaf that has been partially destroyed. Throughout the summer the larvae work upon the leaves in this manner, but towards fall they retreat upon the twigs and branches and construct the temporary cocoons in which they pass the winter as before described.

Food Plants.

So far I have received only specimens that were attacking cherry leaves. It is, therefore, somewhat early to consider this insect as a prune pest, but in the Eastern States it has been known to attack the buds on apple, pear, peach, cherry, quince and plum trees, and blackberry bushes, and there can be little doubt that, since it is now present in the state, it will soon attack our prunes.

Remedies.

In the East this pest is proving an exceedingly hard one to combat. No satisfactory results have been obtained in destroying the larvae in their winter quarters, but it is possible that in this climate a winter spraying with strong kerosene emulsion, or lime, salt and sulphur wash would be effective. It is also possible to destroy a very large proportion of the larvae by spraying the trees with Paris green just before the flowers open. The opening buds should be kept coated with the poison so that the larvae may be killed before entering within their protecting cover. We are also of the opinion that a thorough under-spraying of the leaves with Paris green, between June 1st and June 10th, would prove effective. In either case one pound of the poison should be used in two hundred gallons of bordeaux mixture.

Most of our information regarding this insect has been derived from the publications of Mr. Mark Vernon Slingerland who first worked out its complete life-history.*

No. 8. The Clover Mite.

Bryobia pratensis Garman.

In this state this mite is generally known as the "red spider." The pest was first recorded as present in Oregon in 1889. Since then it has spread rapidly until now it is present in nearly all

*Bul. 50 and 107, Cornell Univ. Expt. Sta.

the fruit-growing regions of our state, but has so far done no serious injury. During the winter of 1895–6 the extraordinary abundance of the eggs, principally on prune trees, attracted general attention throughout the state.

The eggs are shining red and are so small that when placed singly they are difficult to find. When at all abundant, however, they are deposited in masses, preferably at the base of the buds, or in other protected places on the bark, and give to such spots the appearance of being "rusty."

Our observations show that these eggs under favorable conditions begin to hatch as early as March 20th and continue to hatch for at least six weeks. By April 21st, '96, the young mites in all stages of development were present in unlimited numbers upon the leaves of various fruit trees. Even at this early date the leaves on the worst infested trees began to look pale and sickly and there was every indication that the attack was to be a serious one; but the long continued cold rains following that date were so fatal to the young mites that by June 1st only a few adults could be found.

Remedies.

Mr. C. P. Gillette, of the Colorado Experiment Station, has shown that the eggs are effectively destroyed by spraying the trees in winter with a solution of whale-oil soap, one pound to four gallons of water, or one part of kerosene emulsion diluted with four parts of water. We have also shown that the mites in all stages may be perfectly destroyed in summer by spraying the infested trees with one part of kerosene emulsion in fifteen parts of water.

No. 9. The Red Spider.

Tetranychus Sp.

This mite is probably the well known "red spider" of the greenhouse *Tetranychus telarius*. At Corvallis it is even more abundant upon prune trees than is the clover mite, but it does not seem to have attracted such general attention in other parts of the state. To the unaided eye it appears very similar to that mite and the general appearance of infested trees is the same. The clover mite, however, is rarely found in the adult stage upon the leaves, and the eggs are always deposited upon the branches or trunk, while the "red spiders" may be found in all stages upon

the leaves,—the eggs, the young in all stages and the adults being protected under a delicate web on the undersides of the leaves.

The winter eggs, are deposited upon the trunk and branches, as are those of the clover mite and when abundant give the bark the same "rusty" appearance. The remedies for the pest are the same as those used for the clover mite.

No. 10. The Prune-Leaf Weevil.

Tricolepis inornata Horn.

The unpublished notes of Prof. F. L. Washburn, record this little grey weevil as feeding upon the leaves of prune trees at Corvallis, May 17th, 1891. May 12th of the same year, Mr. J. H. Albert, of Salem, Oregon, sent specimens of the same insect to the United States Department of Agriculture, with the report that they were "eating the foliage of young prune trees, stripping them in a short time." No other reports of injury from this insect have been received.

No. 11. Plant Lice or Aphids.

Two or more species of plant lice occur upon prunes in this state. Early in November, 1896, a small prune tree was observed on the College grounds, the leaves and twigs of which were completely covered with rather dark wingless and winged aphids which we somewhat doubtfully determined as the plum aphis, *Apis prunifoliae* Fitch. May 31st leaves of the French prune were received from Halsey, Oregon, which were badly infested with the hop louse, *Phorodon humuli*. The report accompanying them stated that the aphids were very thick on French prunes, but that the Italians had not been attacked. When received they were fast acquiring wings and, no doubt, a few days later all had migrated from the prunes to the hops.

In their early stages these plant lice are pale green in color and are found on the undersides of the leaves. They winter in the egg state on the twigs, and the young lice appear upon the leaves principally in spring and fall. When abundant they cause the leaves to become curled or twisted and discolored.

The best remedy is to under-spray the leaves with kerosene emulsion, using one part of the emulsion to 12 or 15 parts of water. The spray should be very fine and mist-like so that it will, if possible, touch every insect.

No. 12. The Peach-Twig Moth.

Anarsia lineatella (?) Zeller.

June 9th, 1895, Mr. Hugo Garbers, of Hugo, Or., reported to this department that the twigs on his peach trees were being destroyed by a small worm boring in at the tip. A few days later, Mr. H. E. Dosch, Horticultural Commissioner for the First District, reported the same injury to prunes as very common throughout his district. Up to and including the 18th of June many similar reports were received, some of which were accompanied by injured twigs each of which contained a single larva.

These larvae were reddish-pink in color with the head and shield of the first segment pale brown, and corresponded in every particular with Mr. William Saunder's description of the larvae of *A. lineatella* as quoted by Dr. Lintner in his first report on the "Injurious and Other Insects of New York."

June 22d, 1896, some of these larvae were observed to have left the twigs and to have pupated in various parts of the breeding jars, the pupae being held in position by a very slight cocoon consisting only of a few silken threads. July 3d four moths issued from these pupae. These moths agreed perfectly with the description of *A. lineatella* as quoted by Dr. Lintner in the article referred to above.

No further reports of injury to prune trees were received, and nothing more was observed concerning this insect until Oct. 2, 1896, when the strawberry plants on the College grounds, and in a neighboring patch were found to be very badly infested by reddish-pink larvae which were not to be distinguished from those that had attacked peach and prune twigs in June. Several infested plants were removed to the insectary, and together with plants out of doors, were examined from time to time throughout the winter, with the result that it was found that the larvae pass the winter in their burrows in the strawberry crowns in a nearly dormant condition. During the winter infested strawberry crowns were received from several localities and in every case the burrows were found to contain the larvae.

May 19th, 1897, one moth issued in a cage in the insectary, although an examination of plants out of doors showed that the larvae were just beginning to pupate, and it was June 1st before any considerable number of pupae could be found. At the

present time, June 15th, moths are still continuing to issue. These moths are exceedingly similar to, if not identical with those reared from peach and prune twigs last July.

From the fact that there was a somewhat extensive attack by the twig-borer last June, and still no evidence throughout the summer, fall, and early winter months, of any attack on prune trees by a second brood of these larvae, and since in early fall strawberry plants were so generally attacked by great numbers, of apparantly identical larvae, I have been led to infer that the July brood of moths deposits its eggs almost entirely upon the strawberry, although that inference is somewhat opposed to the statement made by Professor Comstock that "the fruit-inhabiting larvae are found [in peaches] during the latter part of July and August and mature during September."* and is entirely opposed to the statement of two prominent California authorities, that the small larvae bore into the bark of infested trees and there pass the winter in the larval stage.†

April 20th, larvae of a twig-borer were received from Halsey, Or., and between that time and May 25th, when the last specimens were received, the work of this insect was reported from Halsey, Hugo, Lookingglass, Oakland, Dundee, Yoncalla, Junction, Bellefontaine and Granger and were observed at Corvallis, Liberty and Rosedale. Mr. H. E. Dosch, Horticultural Commissioner for the First District, also writes me that he has numerous letters regarding this pest from various parts, and Mr. C. L. Duiley, Commissioner of the Second District, writes that the "pest is everwhere and small trees are literally denuded of terminal buds."

The first larvae received were slightly more than one-fourth inch long, and were o a dirty brown or dull greyish black color, with head, first and last segments, and true legs shining black. In general appearance they so closely resembled the larvae of the bud moth that at first I mistook them for that insect. I soon noticed, however, that the habits of the two species were entirely different and that every larva o the twig-borer was readily distinguished by its shining black terminal segment. But this character, together with the general color of the larvae, rendered

*Rept. Com. Agri. 1879, p. 255.
†Alexander Craw, Fourth Biennial Rept. Cal. Bd o Hort.
†C. W. Woodworth, Rept. Cal. Expt. Sta. 1894-5, p. 244.

them so unlike the larvae of *Anarsia lineatella* (?) as described, and as seen in strawberry plants, and in prune twigs last June, that it did not occur to me that they could belong to that species, until May 17th when four of the moths issued. One of these moths was at once sent to Dr. C. H. Fernald who wrote that it is *Anarsia lineatella*.

If this determination is correct, and there can be no reasonable doubt of its accuracy since Dr. Fernald is without doubt the best American authority on the microlepidoptera, we are brought face to face with the peculiar phenomenon of a well known insect—one which was described in Europe nearly sixty years ago and which has been an important insect pest in this country for nearly forty years—being bred, in May, from larvae which are entirely different from those which are supposed to produce it; while on the other hand a very similar but evidently quite distinct insect is bred from apparently normal larvae of *A. lineatella* which winter in strawberry crowns, and the second brood of which occasionally attacks the twigs of peach, prune and plum trees in June. Either two species must be involved in this phenomenon or the larvae of *A. lineatella* must exhibit a *double dimorphism* due to different food plants and seasons. It appears to us very probable that hitherto two very similar but entirely distinct species have been united under the name *Anarsia lineatella*; that one of these species breeds normally in strawberry plants but may occasionally attack young shoots of the genus Prunus in June and July; while the other so far as known breeds only upon trees of the same genus, wintering in the half-grown larval condition in shallow burrows in the bark. If this supposition proves true, the interesting question arises, which of the two is *Anarsia lineatella* and what is the other species? May it not after all be the *A. pruinella* Clem, which has been discarded, as a synonym o *A. lineatella* Zeller. The proper answers to these questions are of considerable scientific and economic importance since they may have a direct bearing on the efficiency of certain remedial measures.

Description and Life-History.

The twig-borer moth is shown at *c* and *d*, Fig. 1, Plate VII, enlarged two diameters. The fore wings are dark grey, almost black in color, and are splashed with a few short black lines or

streaks. The mounted specimens greatly resemble the moths reared from the larvae in strawberry crowns, but are slightly larger, and darker in color. The habits of the living moths are quite different. Those reared from the strawberry crowns crawl down among the vines even into crevices in the soil, apparently for the purpose of depositing eggs upon the crowns, and when disturbed run or flutter about with wings half spread. On the other hand the moths of the twig-borer invariably take an elevated position in the breeding cage, and with the fore part of the body slightly raised, and the labial palpi held rigidly upright in front of the face, they present a very characteristic and alert appearance. When disturbed they dart rapidly about, suddenly alighting again in the same characteristic attitude upon another portion of the cage. When out of doors upon the trees, it must be nearly impossible to distinguish them from buds. The moths began to appear in our breeding cage May 17th, and continued to emerge until June 5th.

The larva is shown greatly enlarged at Fig. 2, Plate VII. It is brownish black or dull dirty black in color, with head, shield, anal segment and true legs black, and is covered sparsely with light colored hairs which arise from minute elevations. When full-grown the larvae are nearly one-half inch long. They then spin a very loose silken cocoon, wherever they may be feeding, in which they pupate. The first pupa was seen May 8th, and since the first moths appeared May 17th, the pupal stage lasts about ten days. The pupa and empty pupal case are shown at *a* and *b*, Fig. 1, Plate VII.

Injury Done.

The half-grown larvae pass the winter in minute burrows in the bark of infested trees. See Fig. 3, Plate VII. In spring soon after the buds begin to open, some of the larvae leave their winter quarters and bore directly into the center of the buds in such a manner as to destroy the terminal ones. The shoot, therefore, fails to develop although often the dead terminal leaves may be surrounded by a whorl of well developed leaves. Later they attack the rapidly growing shoots, entering them either at the tip, or in the axil of a leaf, and boring in the pith as shown in Fig. V, Plate VII. As soon as the fruit begins to develop, it is also attacked, the larvae usually boring directly to the pit upon which they seem to prefer to feed. See Fig. 4, Plate VII.

Other Generations.

During the summer we shall attempt to determine where the moths deposit their eggs, how many generations of larvae there are and how they feed. It is probable, however, that the one or more summer broods of larvae feed upon the leaves of the prune and that unless very numerous they do but little injury. As fall approaches the half-grown larvae probably retreat upon the branches, where they burrow into the bark and pass the winter, ready to emerge and attack the young shoots as soon as they begin to develop in spring.

Remedies.

It is possible that a winter spraying with strong kerosene emulsion, or lime, salt and sulphur wash would prove effective in destroying the half-grown larvae in their winter quarters; but since they must be exceedingly well protected in their burrows, we are strongly of the opinion that the best and cheapest remedy is to spray the trees just when the leaf buds are unfolding with Paris green, so that the larva's first meal in the spring will be a poisonous one. The best results will be obtained by applying the poison in bordeaux mixture, using one pound to each 200 gallons. It is also possible that a more complete knowledge of its life history will show that this insect may be successfully controlled by spraying at other times.

No. 13. The Box-Elder Plant Bug.

Leptocoris trivittatus Say.

This insect, which in a general way resembles an ordinary squash bug with fine red markings, is quite generally distributed throughout the state. Mr. Emile Shanno, Horticultural Commissioner for the Fifth District, has reported them as being exceedingly abundant in some old orchards at The Dalles, and that they seem fond of sweet plums, etc., clustering upon them in great numbers and sucking the juice.

Probably there is no better remedy than to spray them with strong kerosene emulsion or to jar them on to a sheet or blanket and quickly throw them into a tub of water to which a little kerosene oil has been added.

The cuts illustrating these articles have been prepared by Prof. E. F. Pernot of the Department of Photography and Engraving. Fig. 1 is after Riley; Figs. 2, 3, and 4 are after Howard; *b*, Fig. 1, Plate V is after Marlatt; and Figs. 2, 3 and 4, Plate VI are after Slingerland. All others are original and are from material prepared by the author.