SAN JOSE SCALE

By A. B. CORDLEY.

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THE SAN JOSE SCALE.

The San Jose scale is the most destructive of all pests in neglected orchards. Nevertheless, by intelligent effort it can be more easily controlled than any other first class orchard pest; and when we come to realize that the one annual winter application of the lime, sulphur, salt spray, which is all that is necessary to reduce its ravages to the minimum, is also one of the best general "cleaning up" sprays that has yet been devised, we shall, perhaps, be ready to exclaim with J. H. Hale, the veteran peach grower of Connecticut and Georgia, "Blessed be the San Jose scale." It has compelled us to spray with the lime, sulphur and salt.

One application of lime, sulphur, salt each winter will do more for the neglected orchard than can be done in any other way by the same expenditure of cash and energy. It not only destroys San Jose scale, but it also destroys the branch form of wooly-aphis, the eggs of the green-aphis, the pear-leaf blister mite, the hibernating larvae of the prune twig-miner, probably the hibernating larvae of the bud-moth, together with most other insects which may chance to be wintering upon the trees. It is also a good fungicide. If applied in early winter it is nearly or quite equal to Bordeaux for the second application for apple-tree anthracnose; applied to peach trees just before the buds open in spring it is a preventive of peach-leaf-curl; and applied to apple trees under similar conditions it is a satisfactory substitute for the application of Bordeaux which is usually recommended for that time.

With all its good qualities, however, the lime, sulphur, salt spray is not a cure-all. It does not, so far as known, reduce the number of wormy apples in an orchard, nor can it be used as a substitute for Bordeaux while the trees are in foliage. It is a distinctly winter spray and should be used even in winter only upon deciduous trees.

The San Jose scale is very largely responsible for the present enthusiastic crusade against the old neglected, moss-covered orchards. Everyone is pruning and spraying. Why? To destroy the San Jose scale. Yet I find that a very small percentage of our farmers know what this dreaded thing is which they are so earnestly
endeavoring to destroy. If any other spray than the lime, sulphur and salt were being used, a reaction against all spraying would certainly follow the poor results of so much misdirected energy. By using the lime, sulphur, salt spray beneficial results are almost certain to follow whether the scale be present or not. Nevertheless everyone who grows trees or shrubs should learn to know this destructive little pest and be prepared to combat it, since it may at any time appear upon the ornamentals of the city lot as well as the trees of the old home orchard. Dr. L. O. Howard records it upon the following plants:

**LIST OF FOOD PLANTS.**

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<tbody>
<tr>
<td>Pear,</td>
<td>Raspberry,</td>
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<td>Peach,</td>
<td>Gooseberry,</td>
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<td>Apple,</td>
<td>Grape,</td>
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<td>Plum,</td>
<td>Currant,</td>
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<tr>
<td>Cherry,</td>
<td>Flowering Currant,</td>
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<td>Rocky Mountain Dwarf Cherry,</td>
<td>Black Currant.</td>
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<td>Persimmon,</td>
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<td>Quince,</td>
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<tr>
<td>Flowering Quince.</td>
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<tbody>
<tr>
<td>Strawberry.</td>
<td>Almond,</td>
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<td>Chestnut,</td>
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<td></td>
<td>Pecan,</td>
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<td>Black Walnut,</td>
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<td>English Walnut,</td>
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<td>Japan Walnut.</td>
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**Miscellaneous Ornamental Plants—Forest and Shade Trees.**

- Rose,
- Hawthorn,
- Spirea,
- Cotoneaster,
- Euonymus,
- English Huckleberry,
- Linden,
- Acacia,
- Elm,
- Osage Orange,
- Alder,
- Sumac,
- Weeping Willow,
- Red Dogwood,
- Juneberry,
- Laurel.

- English Willow,
- Golden Willow,
- Laurel-leaved Willow,
- Milkweed,
- Catalpa speciosa,
- Lombardy Poplar,
- Carolina Poplar,
- Golden-leaved Poplar,
- Silver Maple,
- Cut-leaved Birch,
- Mountain Ash,
- Japanese Quince,
- Actinidia,
- Citrus trifoliata,
- Snowball,
- Loquat,
- Akebia.
How to Know the San Jose Scale.

Perhaps the worst feature of an attack by San Jose scale is that, owing to its small size and inconspicuous color, it often remains unnoticed until the tree has been seriously injured or even killed. That the tree lacks vigor may be recognized, but the cause of its unthriftness is overlooked. Yet it is not difficult to detect when one really looks for it. In the early stages of infestation a few scales may be found, usually clustered about the buds of the preceding season's growth, or even on two year old wood. The mature scales are grayish in color, being usually but not always somewhat lighter than the bark to which they are so closely attached. The immature half-grown scales which may be found with the mature ones, are at the present time somewhat darker in color.

The mature females are nearly circular in shape, are approximately one-sixteenth inch in diameter and each is somewhat raised in the centre to form a slight protuberance or nipple which is lighter in color than the rest of the scale. (See Fig. 1). If this scale is carefully examined by means of a small magnifier several concentric circles may be observed between the nipple and the outside edge; and if it be carefully raised with the point of a pin or a knife there will be revealed a minute bright yellow object, the insect itself. (See Fig. 3).

On badly infested plants the young scales settle wherever there is room to insert a beak into the bark and as they increase in size they become much crowded and overlapped and have the appearance of a gray scurvy deposit on the bark. The natural color of the bark is obscured and the infested plant appears as though coated with fine ash-colored bran. If the thumb-nail or other object is rubbed over this scurfy covering, thereby crushing the insects beneath the scales, a moist or oily appearance is produced and numerous scales will be overturned and many of the little yellow insects be revealed.

During the early stages of an attack very few if any of the scales will settle upon the leaves or fruit. Later both may be attacked. Upon the leaves, especially of the prune and peach, the young scales may be found on both surfaces, and more particularly clustered along the midrib. Each scale produces a minute purple spot. Upon purple prunes, red apples, etc., the scales appear only as minute gray specks usually clustered about the cavities at either
end, but upon the yellow fruits like pears, peaches, and the yellow plums and apples, each scale produces a bright, reddish discoloration (See Frontispiece). If badly infested, the fruit, particularly of pears and apples, become much pitted, distorted in shape, cracked and unmarketable. (See Fig. 2.)

For the benefit of fruit inspectors in particular, it should be noted that reddish discolorations upon yellow fruits are not always caused by San Jose scale. Upon yellow apples and particularly upon peaches very similar spots are produced by attacks of certain minute fungi. Hence, such spots should not in themselves be taken as proof of infestation by the scale. This can be determined definitely only by a careful examination and the actual detection of the scale. The presence of such blotches may well arouse suspicion of the presence of San Jose scale and should challenge a careful examination alike by growers, buyers and inspector; so also should the presence of dead and shriveled leaves upon the trees in mid-winter invite examination for although their presence is not proof of the presence of the scale it is evidence that the vitality of the tree has been seriously impaired by some cause and in regions where San Jose scale is prevalent that cause in a vast majority of instances is the scale.

**Development of San Jose Scale.**

On the approach of winter scales of various ages and sizes may be found upon infested trees. A very large proportion especially of the immature scales usually perishes during the winter but at the present writing, March 10, practically all are still alive. We may expect, therefore, with normal conditions for the remainder of the season, to witness a very decided increase in scale infestation during the coming summer.

Fig. 1 shows a mature female surrounded by numerous half-grown individuals. The male scales are not circular but somewhat elongate. If one removes one of the large circular scales the little yellow object thereby revealed is a mature female. Under a moderate power of the microscope she proves to be a nearly circular, yellow, sack-like body with long, slender, bristle-like mouth parts. (See Fig. 3.) An examination of the male shows him to be more elongate and to possess the rudiments of legs, wings, eyes, antennae, etc. (See Fig. 4) The females live and die beneath their scales—never leaving them; but in April the males molt for the last time and soon thereafter
emerge from under their scales as minute active creatures with fully developed wings. (See Fig. 5). After mating the males die.

In May, possibly earlier under favorable conditions, the females begin to give birth to living young and may continue to produce for six weeks or longer. The young are minute, light orange-yellow, active creatures with eyes, bristle-like mouth parts, two antennae or feelers, and six legs. (See Fig. 6). After emerging from under the protecting scale of the parent each wanders over the surface of bark, fruit or leaf until a suitable situation is found when the legs and antennae are folded beneath the body, the bristle-like beak is slowly worked through the outer bark into the living tissues beneath, from which it draws its sustenance. At any time during the summer months hundreds of these little pests may be seen, even with the unaided eye, as they crawl about over the bark or fruit of infested trees.

Even before the young insect has attached itself to the bark the secretion of the scale has begun. At first it consists only of a fluffy white mass of fine, waxy threads which for the first day or so of its existence causes the young San Jose scale to appear as a minute downy white speck upon the bark. As these filaments become more abundant they become fused into a more and more compact scale and assume a yellowish color. Later the young scale-insect molts several times during its growth and the fully developed scale is thus made up of fused wax filaments and the several molted skins.

Each female of the over-wintering generation is capable under favorable conditions of producing approximately one hundred young. In the course of but one month these reach maturity and the females begin to produce another generation. There are thus produced some four or five generations during the entire season. Under supposedly favorable conditions single females of the later generations have been observed to produce approximately six hundred young. Basing their estimates upon breeding cage observations, Dr. Howard and Mr. Pergande have shown that it would be possible under the most favorable conditions for the progeny of a single female to reach the astonishing number of 3,216,080,400 individuals in a single season. Should each of these scales reach the largest size, one-tenth of an inch, and were they all placed side by side touching each other in all directions there would be enough of them to cover approximately five acres of surface. It is almost needless
to add that in the intense struggle for existence of organism with organism and with climatic conditions such an astonishing rate of multiplication is not even approximated under natural conditions. Nevertheless, when one realizes the enormous rapidity with which this pest multiplies it is no longer a surprise that careless work in spraying fails to give satisfactory results. A few females here and there upon very small portions of the tree which have not been reached by the spray may during a single season completely reinfect that tree. Satisfactory results are obtained only by the most thorough work. Every square inch of surface of trunk, limbs, branches and twigs should be thoroughly covered. By far the most common cause of unsatisfactory results is the failure of those who spray to do thorough work.

How the San Jose Scale Spreads.

Since the female scale is motionless, and permanently attached throughout life to the branch on which it feeds, it is often asked how is it that the San Jose scale can spread from tree to tree, orchard to orchard, and even for larger distances? It is only during the first few hours of its existence that one of these little pests can emigrate, and observation has shown that even then it is incapable by its own efforts of getting more than a few feet at most from the tree on which it was born. But birds and bees and other insects make good airships for the little creatures, and no doubt many a young scale has crawled upon the foot of a bird or upon some larger insect and thereon voyaged to the distant realm of another tree or orchard. No doubt also strong gusts of wind often tear them loose from the bark on which they are crawling and waft them to the branches of neighboring trees. These are provisions of nature for distributing the species. Through the channels of trade they are carried long distances, even from continent to continent upon infested nursery stock, cuttings, etc., and probably to a lesser extent upon infested fruit. Buds and scions carelessly taken from an infested tree may transmit the pest to the orchard in which they are placed or may infest an entire block of trees in some nursery and thence be distributed to many orchards. It is also probable that many are carried about upon the hands and clothing of the men who prune the trees or pick the fruit or otherwise work about the orchards.
By such means has the scale been brought from China, its native home, to San Jose, Calif., whence in thirty-five years it has spread to practically all the fruit-growing states in the Union and to various foreign countries.

**Remedies.**

There is but one remedy yet discovered which need be considered in this state. That is the lime, sulphur, salt spray. In the east, fairly satisfactory results have been obtained by the use of various prepara­tions of kerosene or other petroleum products, but the high price of kerosene makes it impracticable to use it here in any form for spraying purposes except in a very small way. The San Jose scale has probably been present in this state approximately twenty-five years; and for the past fifteen years the lime, sulphur, salt has been the standard spray for destroying it. During the first few years of its use various formulas were employed and to a less extent this is still true, but since December, 1896, when it was first published in the Biennial Report of the State Board of Horticulture, the formula which has come to be known as the Oregon formula has been the standard one in this state.

**The Oregon Formula.**

This formula was the result of some extensive experiments by the late Emile Schanno of The Dalles, Oregon, and is as follows:

- **Quicklime** ........................................ 50 pounds
- **Sulphur** ........................................ 50 pounds
- **Salt** ........................................ 50 pounds
- **Water** ........................................ 150 gallons

This may be much simplified by designating it as the 1-1-1-3 formula, i.e., 1 pound of lime, 1 pound of sulphur and 1 pound of salt to each 3 gallons of water. West of the Cascades this formula is more efficient than the 1-1-4 formula which is reported to be satisfactory in the Inland Empire. The function of the salt being problematical, I have in the last edition of my bulletin on Insecticides and Fungicides (No. 75) advised using 25 to 50 pounds of salt rather than the full 50 pounds which was originally recommended. I can not, however, recommend that the salt be left out entirely, as is evident from the results of two season’s experiments which are herein recorded.

In preparing this spray it is my plan to put a little water in the bottom of the boiling vat, start the fire, and when the water comes
to a boil pour in the required amount of lime and sulphur. The hot water, together with the heat generated by the slaking lime, will at once set the mass to boiling briskly. This should be kept up for at least an hour, or until the mixture is of a deep blood-red color, and there is but little free sulphur floating upon the surface. The salt can be added at any time since it dissolves readily.

Plate 3 is reproduced from photographs of two simple boiling vats. Fig. 7 is simply a "hog scalding" vat made of "inch and a half" lumber and with galvanized iron bottom. It is 18 inches wide on the bottom, 20 inches wide on top and 10 feet long. The sides should project two or three inches beyond the ends and the galvanized iron of which the bottom is made should project at each end 6 inches beyond the sides and then be turned up and fastened securely thus forming shallow troughs at each end which must be kept filled with water to prevent the ends from burning.

These vats may readily be set up wherever there is a convenient water supply by simply digging a trench of the proper dimensions, placing the vat over it and banking about with earth to prevent the fire from reaching the wooden sides. A better draft is secured by erecting a few feet of stove pipe at the back end. If the vat is to be permanently located it is of course preferable to mount it upon a brick arch. With such an apparatus one can readily prepare the spray as fast as it can be used by a power spraying outfit running two lines of hose.

If one possesses a steam boiler the spray can be most conveniently boiled in a number of barrels or in large wooden vats, the steam being conveyed to the bottom of the barrels or vats. Thus liberated it not only boils the spray but keeps it well stirred the while, thus eliminating much of the drudgery of stirring by hand which is incident to other methods.

**Enemies of the San Jose Scale.**

At present I can offer no encouragement to those who desire to see the San Jose Scale held in check by its natural enemies. In August, 1903, I received through the courtesy of Dr. L. O. Howard, a small consignment of the Chinese Lady-bird Beetle, *Chilicorpus similis*. These were liberated at Jacksonville, Oregon, in an abandoned pear thicket, on the premises of Mayor E. Britt. This thicket was badly infested with scale, Mr. Britt undertook to see that it should not be sprayed or destroyed during the time of the experi-
ment, and strong hopes were entertained that the extremely favorable conditions would result in a flourishing colony from which beetles could later be distributed to other parts of the state. Several months after the beetles were liberated Mr. Brjt and Mr. Chas. Meserve succeeded in finding more than twenty of them still alive and apparently in good condition, but by the following July all had apparently perished as a most thorough search by Mr. Meserve and myself failed to reveal any trace of them or their progeny and similar negative results were obtained from another examination the following year.

A closely related native species, *Chilocorus bivulnerus*, has been reported by Mr. A. H. Carson, Horticultural Commissioner for the third district, to have practically exterminated the San Jose Scale from a small but badly infested orchard near Grants Pass. The late Emile Schanno, The Dalles, Oregon, in 1896, sent me a number of specimens of this species, with the report that they were very abundant upon Fir trees, which were infested with a closely related scale, *Aspidiotus abietis*; but no other reports of such habits have been received and I myself have never observed them.

The much smaller, entirely black, native species, *Pentilia misella*, is much more generally distributed and undoubtedly destroys a great many scales but for some reason it does not increase rapidly enough to keep pace with the increase of the scale, which appears, likewise, to be true of the three or four internal parasites which have been reared from San Jose Scale from various parts of the country.

**Experiments in 1904 and 1905.**

Through the liberality of the Southern Pacific Company which furnished free transportation for myself and such machinery and supplies as were necessary for the work, together with the courtesy extended by Mr. S. D. Evans of Umpqua Ferry, who kindly placed a badly infested apple orchard at my disposal, I was enabled in the spring of 1904, to conduct a series of experiments with various remedies for the San Jose Scale, which a lack of funds would otherwise have made impossible. The following spring, 1905, I was permitted through the courtesy of the Manager, Mr. Robert Johnson, to repeat most of these experiments in the 160 acre prune orchard of the Benton County Prune Co. Since the work of the second season was largely a check upon that of the first, both will be considered together. In 1904, the work was delayed by almost constant rains
and was not finished until April 10, when neighboring prune orchards were in full bloom and the leaves on some of the earliest apple trees were just unfolding. In 1905 spraying began on Feb. 27 and lasted until about the middle of March.

In neither case was any attempt made to determine the exact percent of the overwintering scales which was destroyed by the various sprays since it was thought that the large variation in the relative number of dead and living scales normally present on unsprayed trees would render such estimates misleading and that more reliable and practical results could be obtained by examining the trees during the summer and fall to observe the degree to which they had become reinfested and to what extent the fruit was rendered unmarketable; for after all growers will judge the efficiency of a spray largely by the quality of the fruit. Unfortunately, however, this method of estimating the relative value of the different sprays was to a certain extent disappointing, by reason of the fact that both sprayed and unsprayed trees failed to produce more than an insignificant amount of fruit. However, by examination of the leaves and new growth, on trees which had been the worst infested, results were obtained which it is believed represent very closely the relative value of the different mixtures.

**Experiment No. 1. Dunne's Solid Spray No. 1.**

Dunne's solid sprays, prepared by David M. Dunne & Co., Portland, Oregon, are said to be prepared from strictly firstclass material and in conformity with the formulas which have been recommended by the State Board of Horticulture. No. 1 is a solid preparation of the lime, sulphur, salt spray and came to us in boxes weighing approximately 100 pounds into which it had evidently been poured while warm and then allowed to solidify.

(1904) Dissolved 200 pounds in 200 gallons of water by boiling. Could see no difference between it and No. 2. Color was such as to indicate presence of copper sulphate. Probably through mistake No. 2 was shipped for No. 1. Was prepared and placed in spraying tank on afternoon of April 4. Rained; not used until 48 hours later but still warm. Leaves on four trees the size of "squirrel’s ears." On remainder of trees buds still closed. July 19, 1904, nearly every apple badly spotted by scale—not efficient.

The results in 1905 were more satisfactory but not quite equal to those obtained by standard formulas.
Experiment No. 2. Dunne's Solid Spray No. 2.

This is similar to No. 1, except that copper sulphate is used in place of the salt. It was prepared in the same manner and used at the same strength as No. 1.

(1904) Not efficient but slightly better than No. 1. Most of the fruit badly spotted.

(1905) Many living scales on new growth.

Experiment No. 3. Caustic Soda.

(1904) Dissolved 50 pounds in 50 gallons of water, then diluted to 200 gallons. Very easily prepared but disagreeable to use. Every drop that strikes one's hands or face burns severely. Men declared they would not work for five dollars a day if required to use it. July 19, not at all efficient; fruit badly spotted.

(1905) Used 20 pounds to 100 gallons of water; also 30 pounds to 100 gallons, but results unsatisfactory. Many living scales on new growth.

Experiment 4. Lime-Sulphur.

(1904) Lime 50 pounds, sulphur 50 pounds, water 150 gallons. Slaked the lime in hot water in boiling vat. While slaking added sulphur, covered with water and simmered for six hours. Still considerable uncombined sulphur.

July 19, fairly efficient. Only an occasional apple with a few scales.

Experiment 5. Lime, Sulphur, Caustic Soda.

Lime 50 pounds, sulphur 50 pounds, caustic soda 24 pounds, water 150 gallons. Slaked lime and added sulphur. After boiling from slaking lime had ceased added caustic soda. This produced a vigorous boiling which continued for nearly 30 minutes. Allowed to stand one and one-half hours, then diluted to 150 gallons.

July 19, almost as efficient as No. 4. Fruit slightly more spotted.

Experiment No. 6. Lime, Sulphur, Copper Sulphate.

Lime 50 pounds, sulphur 50 pounds, copper sulphate 15 pounds, water 150 gallons. Slaked lime, added sulphur, covered with water and boiled two hours. Added copper sulphate crystals and kept over fire 5 hours longer, during which time it boiled vigorously for about 1 hour. Sulphur almost completely combined. In the bottom of the vat there appeared to be considerable more sediment, consisting of fine "shotty" pellets than when salt is used.
July 19, apparently not quite so efficient as No. 4 and 5. Difference very slight.

**Experiment No. 7. Lime, Sulphur.**

(1904) Same as No. 4, but boiled more thoroughly.
July 19, a very few spotted apples, but only on branches which were evidently not thoroughly sprayed. Very efficient.
(1905) Results obtained with lime, sulphur alone were not so satisfactory. Young scales became quite abundant on leaves and young growth during summer.

**Experiment No. 8. Lime, Sulphur, Salt.**

(1904) Same as No. 7, except that 50 pounds of salt was added after lime and sulphur had been boiled for 2 hours.
July 19, very efficient. A very few infected apples.
(1905) Very efficient. Leaves and young growth almost absolutely free from scale and no living scales to be found on sprayed wood.

**Experiment No. 9. Lime, Sulphur, Salt.**

(1904) Prepared same as No. 8, but only one-half as strong.
July 19, most of the apples spotted.

**Experiment No. 10. Good's Whale-Oil Soap No. 10.**

(1904) This is a semi-fluid whale-oil soap, which dissolves very readily by stirring, even in cold water. For use 50 pounds were dissolved in 25 gallons of water.
July 19, not efficient, every apple badly infested.

**Experiment No. 11. Con-Sol.**

(1905) This was furnished us by the American Horticultural Distributing Co. of Martinsburg, W. Va., through their agents the Portland Seed Co., Portland, Ore. In a circular letter it is stated that "Our product is a concentrated solution of lime, sulphur and salt, prepared by a process discovered by a German chemist, combining electricity and metallic mercury in extracting the product called Con-Sol, which has proven to be a destroyer of the San Jose Scale." I was advised that it had given good results in the east when used in the proportions of 1 of Con-Sol to 40 of water, but was asked to try the effect of stronger solutions. I used it upon infested prune trees March 1, in the proportion of 1 to 20. Not at all effi-
cient. Many living scales both upon sprayed wood and upon leaves and young growth.

It will be observed that in none of the above experiments were the scales completely eradicated. This is hardly surprising when one considers that the trees, particularly the apple trees were badly infested and had not been pruned for several years. This does not affect the results however; so far as the relative value of the different sprays is concerned, which show that for the two season's work the best results were obtained with the standard lime, sulphur and salt formula. The same formula but with the salt omitted gave practically as good results in 1904, but was not so efficient in 1905.

A. B. CORDLEY.
LIST OF BULLETINS

(In print) published by the Oregon Agricultural Experiment Station to January, 1905.

No. 6, 1890—Chemistry, Zoology .................................................. Washburn
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No. 32, 1894—Five Farmers' Foes .................................................... Craig
No. 33, 1894—Tent Caterpillar ......................................................... Washburn
No. 34, 1895—Fruits and Vegetables ................................................. Coote
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No. 42, 1897—Flax Culture .................................................................. French
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Circular Bulletin concerning Acid Soils in Oregon—1901 ........................ Knisely
No. 65, 1901—The Grape in Oregon .................................................... Lake
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No. 69, 1902—Testing Milk and Cream ................................................ Kent
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Director of Experiment Station. Corvallis, Oregon.