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THE CITRICOLA SCALE

BY

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THE CITRICOLA SCALE*

By H. J. QUAYLE

INJURY

The citricola scale is one of the most injurious scales on citrus trees in California. It not only necessitates the washing of the fruit because of the sooty mold fungus but it seriously impairs the vigor of the tree and consequently greatly reduces fruit production. Some groves have been seen during the past year where the crop was reduced as much as 50 or 75 per cent because of the attacks of this scale. In a certain grove where a few trees were treated the previous year, and the scale fairly well controlled, these trees bore considerable fruit, while there was practically no crop on the untreated trees surrounding them which had, aside from lack of scale control, the same care. In case of severe attacks by this scale there is therefore not only a very evident shortage of the crop but such fruits as occur are deficient in sweetness and flavor.

A very copious amount of honeydew is given off by this scale, particularly as it matures in the spring and early summer. At this time it is produced in such quantities that the sooty mold fungus is unable to utilize it all as a medium for its growth. In such cases the trees have an oily or greasy appearance, and not infrequently the honeydew occurs in such amounts as to actually drip from the trees. When the honeydew occurs in such quantities it is evident that there is a heavy drain upon the tree through the loss of sap, and the coating of honeydew over the foliage (see fig. 8) interferes with the normal functions of the leaves. The same material on the fruit also necessitates the washing of the fruit in the packing house.

IDENTITY OF THE CITRICOLA SCALE

For a time this scale was confused with the soft brown scale (Coccus hesperidum), which it resembles very closely. That this confusion occurred is not surprising because of the great variation in the soft brown scale, as indicated by the fact that it has been de-

NOTE.—A more technical paper on this insect is in preparation.

* Paper No. 2, Citrus Experiment Station, College of Agriculture, University of California, Riverside, California.

scribed many different times under different names. The probability that there was a different species from the soft brown scale in the orange groves of southern California was first suggested by certain factors of economic bearing, such as resistance to fumigation, a smaller number of parasites attacking it, less attractiveness to ants, and the more general distribution of the scale over the tree and grove.

When the matter of identity was looked into, it was placed under the species of *Coccus longulus,* and later under *Coccus elongatus,* as well as under *Coccus hesperidum.* Certain characters, however, did not seem to agree with the same characters in any of these scales, and an incidental study was started by the writer in 1911. During a part of the year 1913 Mr. Roy E. Campbell was engaged as an assistant to devote his time chiefly to this insect. As a result of Mr. Campbell's studies it was determined as a new species, to which was given the name *Coccus citricola.*[1]

General Differences in Appearance between the Citricola and the Soft Brown Scale.—While the citricola scale and the soft brown scale appear similar to the casual observer, there are certain evident differences upon closer examination. The citricola scale becomes more distinctly gray in color as it approaches maturity, while most of the soft brown scales are brown, as the common name implies. Some of the soft brown scales, however, approach the general color effect of the other species, but usually the color pigment is coalesced in definite areas, instead of being scattered about generally in a peppery effect, as is usually the case with citricola. The citricola scale is also more convex, that is, more rounded, while the soft brown scale is generally very flat. The young of the citricola scale, however, are very flat and are much more transparent than the young of the soft brown scale, which may take on the brown color pigment at an early age.

Differences in Distribution Over the Tree.—In its distribution on the tree the soft brown scale is almost invariably limited to a few twigs or branches. This scale may occur in great numbers over this restricted area, but the rest of the tree may be entirely free from this species. On the other hand, the citricola scale may be very generally distributed over the entire tree, although there is a preference shown for the north side and usually the lower half of the tree. This scale as it matures in the spring and early summer is found almost exclusively on the twigs and smaller branches. Many of the soft brown scales come to maturity on the leaves. The citricola scale, also, occurs largely on the leaves when it is young, but almost invariably migrates back to the twigs to complete its development.

[1] Entomological News, May, 1914.

Differences in Life History.—There are several generations (three or four) of the soft brown scale, while there is but one generation of the citricola scale, or at most a partial second. The citricola scale always deposits eggs, and these may hatch almost immediately or hatching may be prolonged for two or three days. The soft brown scale always gives birth to living young.

Other Differences.—The citricola scale does not possess immunity from the attacks of parasites, as was first supposed, but parasites attack this scale much less than they do the soft brown scale. And, finally, the citricola scale after reaching a certain stage, even though it may still be very small, is much more resistant to fumigation as ordinarily practiced.

ORIGIN

At the present time we are unable to account for the origin of this scale. It seems probable that it is an introduced species, and further studies may place it under some foreign species already described.

PRESENT DISTRIBUTION IN CALIFORNIA

The citricola scale is now widely distributed over the state (see fig. 1), and this wide distribution would seem to indicate that its occurrence here dates considerably further back than its first recorded appearance. It was first found in the vicinity of Claremont in 1909 and at about the same time near Riverside and in certain sections in San Bernardino County. It has been known in the citrus section of Tulare County for the past three or four years, although its occurrence in great numbers there dates back but a year or two.

In the counties south of the Tehachapi the citricola scale is found in Los Angeles, Orange, Riverside, and San Bernardino. Thus far it has not been reported from Santa Barbara, Ventura, San Diego, or Imperial counties. In San Bernardino County infestations occur at Colton, Redlands, Highlands, Rialto, Etiwanda, Cucamonga, Upland, and Ontario. In Riverside County the infested areas are in the vicinity of the city of Riverside and at Highgrove. In Los Angeles County they are at Claremont, Pomona, San Dimas, and Glendora. In Orange County one infestation is found near Fullerton.

In the counties north of the Tehachapi the most general infestation occurs in Tulare County. Practically all of the citrus sections north of Plano have more or less of the scale. The heaviest infestations occur around Porterville, Worth, Globe, Success, Lindsay, Exeter, and

Orosi. In Fresno County the citricola scale occurs in the citrus districts of Mt. Campbell and near Sanger. In Sacramento County it occurs in the Fairoaks and Orangevale districts, and in Placer County at Rocklin. In Yuba and Sutter counties it has been reported from citrus trees growing in the cities of Marysville and Yuba City. In Contra Costa County this scale has been reported from one dooryard tree in Martinez. In Kern County one tree was reported infested

Fig. 1.—Present distribution of citricola scale in California shown by × on the map

near Bakersfield, but eradication treatment was given and the scale has not as yet reappeared.

For the data bearing on the distribution of the scale by counties as given above, in addition to his own inspections, the writer is indebted to the respective county horticultural commissioners. It should be understood that the localities given represent the distribution at the time of this writing. New localities are continually being reported. This is partly due to the spread of the citricola scale, but also because, in many cases no doubt, previous reports referred to it as the soft brown scale.

Fig. 2.—Twig of orange tree showing infestation of the citricola scale as it occurs in the spring and early summer

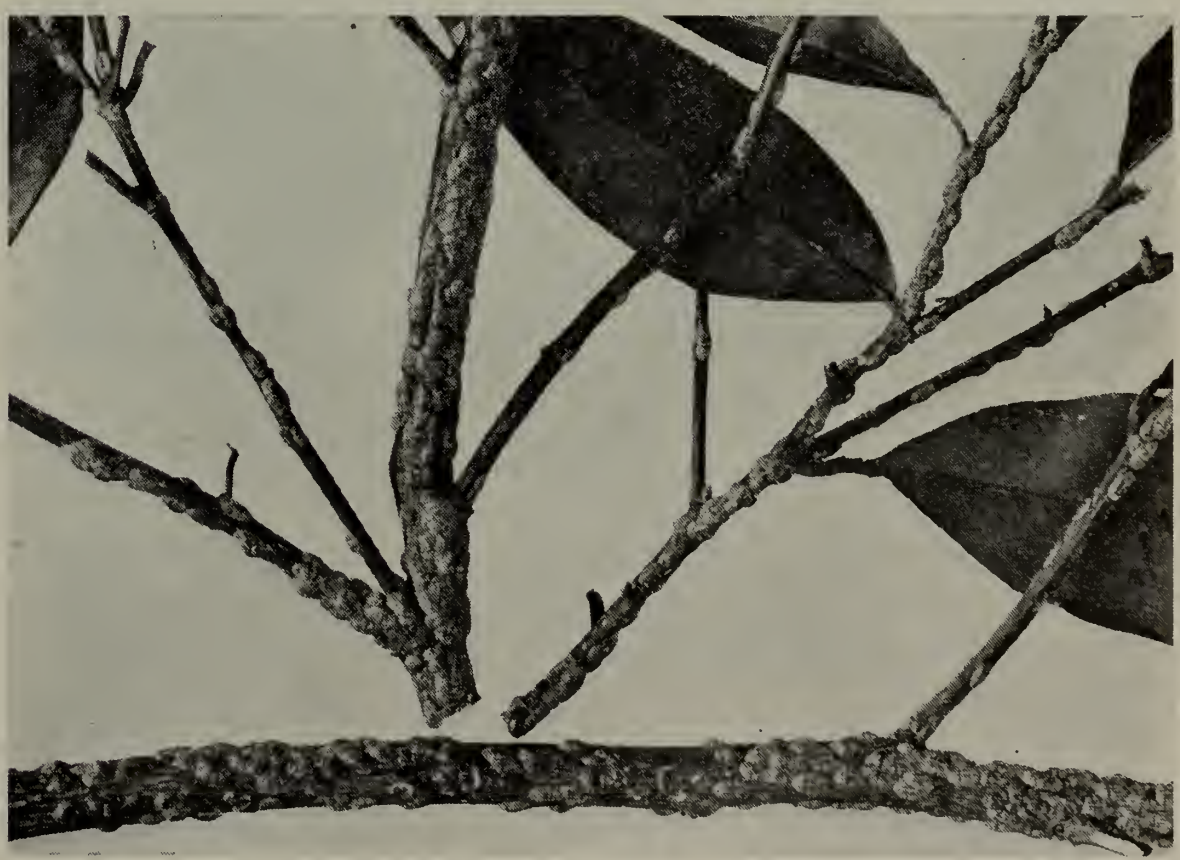

Fig. 3.—Citricola scale on orange twigs, enlarged

FOOD PLANTS

The citricola scale is primarily a pest of citrus trees in California. It has been found on a few other plants, but in all cases these plants were growing in the vicinity of infested citrus trees. These plants include the nightshade, pomegranate, elm, and walnut. The fact that

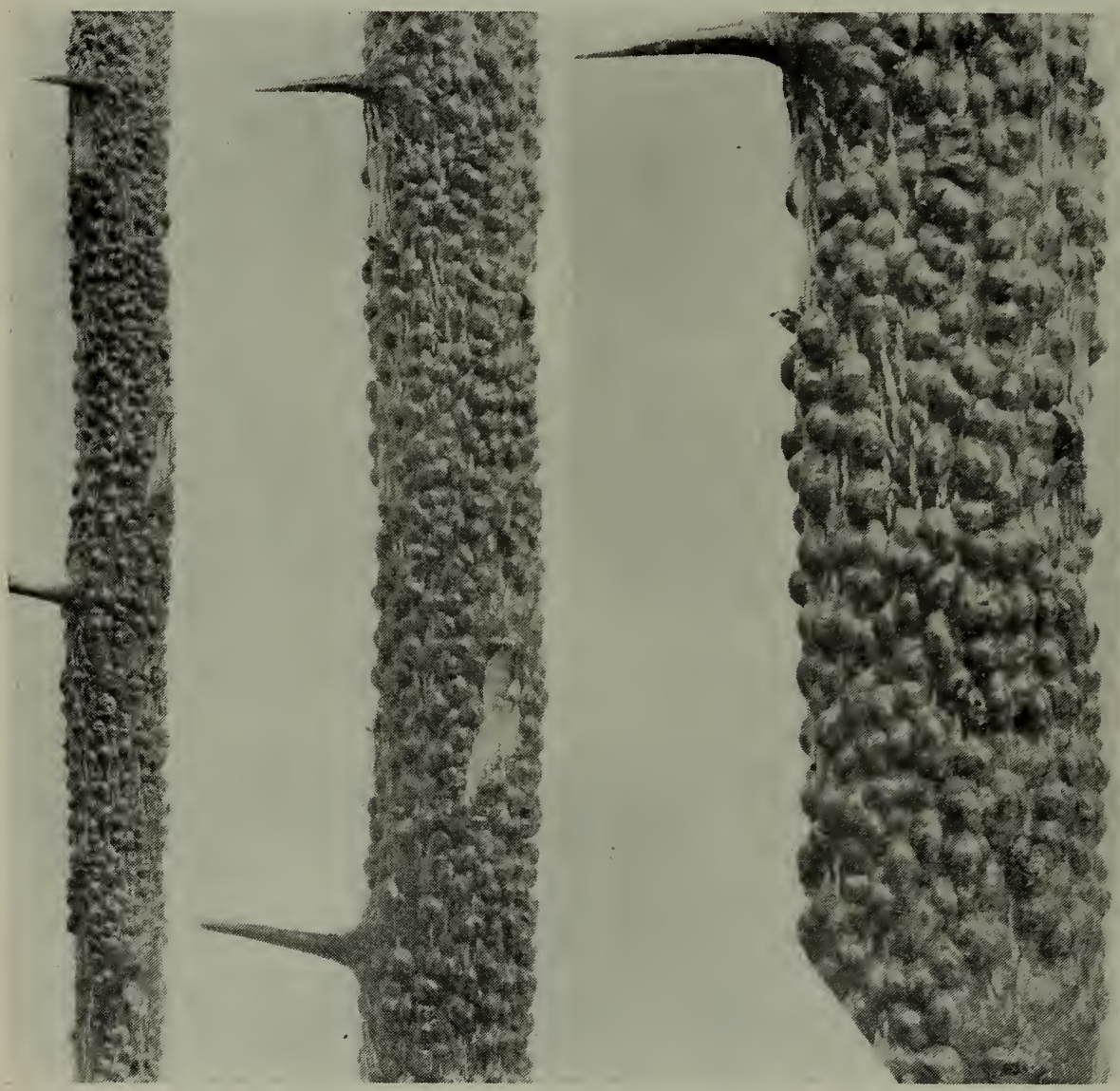

Fig. 4.—The soft brown scale, *Coccus hesperidum*, on branch of orange. This species is the only close relative of the citricola scale in the orange groves of California and the two are often confused.

this scale is, at present at least, practically limited to the citrus tree and has not been found thus far on any native plants seems to indicate that it is an introduced species.

COMMON NAME OF C. CITRICOLA

After the first appearance of this scale it was commonly known as the "longulus scale," because it was placed under the species *longulus*. It has also been called the "False soft brown scale" and the "Gray

scale." Of these names the "Gray scale" may be most appropriate, because the insect is of a grayish color when mature, and there is precedent in color designation since most of our other citrus scales are so named, as the black, red, yellow, and purple. While *Coccus citricola* is of a grayish color, it has this color only a few months in the year. When the scale is small during the summer and fall it is no grayer in color than the soft brown scale, and after the scale matures and dies it is distinctly brown in color. For this reason, and

Fig. 5.—The citricola scale as it appears on the under side of the orange leaves in midsummer and fall. At this season the scales are small and inconspicuous. The photograph is natural size.

because of the fact that the limit in color names has practically been reached already and further additions may be confusing, it has been thought best to call this the *"Citricola scale"* after its specific name.

LIFE HISTORY AND HABITS

The Egg.—Eggs are invariably laid by the citricola scale, and this is one of the important differences between this and the related species, the soft brown scale. In some cases upon first examination it may be thought that eggs do not occur, since upon lifting the parent young scales appear with no evidence of eggs. But in such cases hatching

Fig. 6.—A portion of the same leaf shown in figure 5, enlarged

has already occurred, and not infrequently hatching may occur almost immediately upon the extrusion of the egg. In other cases many eggs will be found beneath the scale and hatching may be prolonged to two or three days.

The number of eggs deposited by this scale will probably range between 1000 and 1500. Actual egg records have been made up to 1205 from a single scale. The 1205 eggs were deposited during a period of thirty days, making a daily average of 40. The individual egg-laying period will average about thirty days, while the maximum period may reach six weeks or possibly two months. The first eggs may be found in the latter half of April and they continue to appear until August.

The triangular white objects that are seen upon turning over the adult scale are the skins of the eggs that are left after the young scales hatch. These increase in numbers until, at the end of the egg period, a great mass of them may be seen beneath the scale. It is possible, though it is a very tedious task, to count these egg skins after all the young have emerged and thus accurately determine the total number of eggs deposited. It is these egg skins, still adhering to the twigs after the old scales are removed, that give the characteristic white or mealy appearance to such twigs.

The Young.—Upon hatching from the egg the young may remain beneath the parent scale for from a few hours to a day or two, depending upon the temperature and the rate at which the eggs are being deposited. The young crawl about actively for a day or two, after which they settle largely upon the under sides of the leaves. In cases of severe infestations a great many also establish themselves on the upper surface of the leaves and a few more on the more tender twigs. The first molt occurs approximately one month after settling and the second and last molt one month after the first. The cast skins may be detected as tubular or cornucopia-like objects (see fig. 7c), usually with indication of the legs extending out at right angles. These skins are not unlike a bit of thread or lint and often remain attached to the posterior end of the scale. Such objects may be first observed on the leaves during the latter part of June and may be seen continuously after that until late in the fall.

The first young appeared during the past year (1914) about April 20th. They were seen at that time in Tulare County and also in Los Angeles County. Only occasional young appear as early as that date, and it may be said that May 1st is approximately the beginning of the appearance of young in any numbers. Young continue to appear through May, June, and July.

During the late summer and early fall the scales, while on the leaves (see figs. 5 and 6), are very flat and more or less transparent. By November there is an appreciable change in size and most of them become darker in color. At this time also migration to the twigs begins. This migration from leaf to twigs continues slowly through the winter, but the great majority migrate to the twigs in March and early April. Their final resting place is on the under side of the twigs and smaller branches and, to some extent, on the leaves. Branches more than a half inch in diameter rarely have scales on them.

During the colder weather of winter the scales grow but little, remaining more or less dormant until the warm weather of spring, when they grow very rapidly and produce eggs before May 1st. It is during this period of rapid growth in the spring and during the egg-producing period that so much of the honeydew is given off.

The Adult.—One criterion that an insect has reached the adult stage is when it has molted the last time. But, while the last molt of the citricola scale occurs in August or September, it does not reach full sexual maturity until the following May. It requires therefore practically one year for this scale to complete its life cycle. We have had a few scales on potted orange trees at Riverside that completed their life cycles in a shorter time. These were liberated on May 27, 1914, and produced a few young the following October. These scales were maintained in small cages on the leaves. Some scales, out of season with the great majority, have been observed also in the field. But with a possible few exceptions this scale has a more uniform life cycle than the black scale and may be said to require a full year.

The general color effect of the scale is dull gray. This is due to a ground color of yellow with dark gray or black markings. These darker markings are rather uniformly distributed, giving the surface a peppery effect. In the case of the soft brown scale this dark pigment is usually coalesced in definite areas, giving a more blotched effect. In the former the ground color of yellow disappears just before the margin is reached, giving way to a dull gray. Around the entire insect, back somewhat from the margin, there is a more or less distinct yellow circle, due to the absence of the dark gray or black markings.

After the adult has deposited its quota of eggs, numbering about 1500, which process is completed in July, it soon dies. After death the scale turns decidedly brown in color and is much more likely to drop off the twig than some of the other scales. In fact, during the fall, the indication that old scales have been present is usually repre-

sented by white areas due to the egg skins which have remained after the adult has dropped off.

The adults of this species occur on the small twigs almost entirely (see fig. 2) and are usually distributed over the entire tree, with the majority occurring on the north side. The character of the honeydew given off appears to be different from that of the black and soft brown scales in that it is more sticky, and it is more difficult to remove from the fruit the growth of sooty-mold fungus on it. That the honeydew of this species differs from the honeydew of the soft brown scale

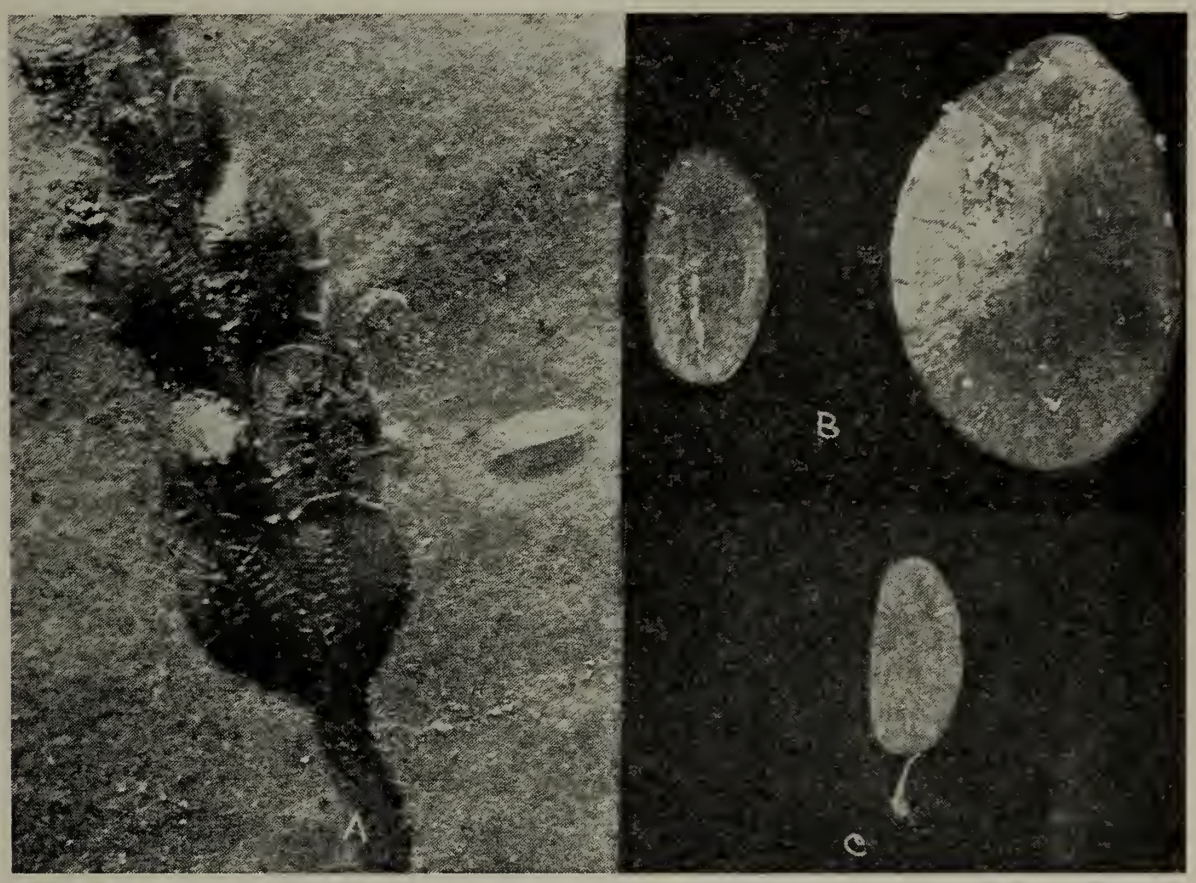

Fig. 7.—A. Partly grown soft brown scales on orange leaf. B. On the left the citricola scale and on the right the soft brown scale of the same age. These two scales emerged on May 27, 1914, and were photographed on August 5, 1914. Age, 2 months 10 days. C. The citricola scale with the second cast skin still attached. This scale hatched on May 27 and molted the second time August 4, 1914.

is also indicated by the fact that ants are not attracted to it in such large numbers.

Summary on Seasonal History.—The first eggs are deposited by the citricola scale during the latter part of April and egg deposition continues until August. The first molt of the majority of the scales occurs about July 1st and the second molt about August 1st. From the time of hatching until the following March the scales are largely on the leaves. During the spring they occur on the twigs and smaller branches. The development requires approximately one year.

NATURAL ENEMIES

As compared with the soft brown scale, the citricola scale is fairly free from the attacks of parasites. While parasites attacking this scale are common, they never occur in large numbers. Most of the parasites attack this scale while they are still small. They occur most abundantly therefore in the summer and fall. One of the commonest parasites of *C. hesperidum, Microterys flavus,* has not been secured thus far from *C. citricola.* We have taken *Coccophagus flavoscutellum* from the citricola scale, while this species was not taken by Mr. Timberlake[2] from the soft brown scale. *Aphycus flavus,* or the species that has been going under this name, has been taken from *C. citricola* as well as *C. hesperidum, Coccophagus lunulatus,* and *C. lecanii* and have also been reared from both species.

The only direct evidence we have of ladybird beetles feeding on the citricola scale is in the case of the twice-stabbed species *Chilocorus bivulnerus* in Fresno County. It is, of course, probable that some of the common species of *Coccinellids* occurring in southern California, particularly *Rhizobius* species, also feed on the citricola scale.

CONTROL*

Spraying.—Because of the denseness of foliage and the growing period of the citrus tree, it is poorly adapted for spraying as a means of controlling scale insects. It is not particularly difficult to kill the young citricola scale with a number of different sprays, but it is exceedingly difficult to apply the spray thoroughly enough to kill all the insects, or even a sufficient percentage to insure clean trees and fruit the following year. It is for this reason that the value of spraying falls far short of fumigation, when the fumigation can be done satisfactorily, but on account of the short period when this scale yields readily to the gas treatment it was thought at the beginning of last season that a spraying programme might be carried on to advantage. Spraying, therefore, has been very generally tried out in the citrus groves of California during the past year not only where the citricola scale occurs but also where the black scale occurs. The most modern power spray machinery has been used in the application of practically all sprays that gave any promise, but the results have not been generally satisfactory.

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[2] Preliminary Report on the Parasites of *Coccus hesperidum* in California, by P. H. Timberlake. Jour. Ec. Ent., Vol. 6, No. 3, p. 293.

* For more details concerning spraying and fumigation see Cal. Ex. Sta. Cir. 129.

In addition to the spray failing to reach a sufficient number of the scales, there is the additional objection that most sprays may, at least under certain weather conditions, do injury to the tree and fruit. Practically all of the sprays tried during the past year were open to this objection in one place or another. When the spray is applied during hot, dry weather, or during "northers," or "Santa Anas," the so-called electrical periods, burning is especially likely to occur. This is particularly true in the case of the oil sprays. Where the soap sprays are applied, injury is just as likely to occur during damp or foggy weather. The soap collects in drops on the under side of the fruit and slowness of evaporation may hold the soap long enough to cause burning. Such burned spots are more likely to occur on fruit in the interior or shady part of the tree. The oil burning, on the other hand, usually occurs as spots on the upper side of the fruit in the direct light.

There are three classes of sprays that include most of the materials that have been used for the control of the citricola scale. These are the oil sprays, the soap sprays, and the combination of oil and soap.

The oil sprays include the kerosene and distillate oils. The distillate that is most used is the tree-distillate of 31 to 32 degrees Beaume, a distillate especially refined for tree use and put out by the Southern Refining Company of Los Angeles. The cost of this oil in Los Angeles is 5 cents per gallon. This is used at a strength of from 2 to 3 per cent and is mixed with the water mechanically by agitation in the spray tank.

This spray is improved by the addition of a small amount of soap which adds to the penetrating and spreading power of the spray. The formula for the distillate and soap is as follows:

DISTILLATE EMULSION

Tree distillate, 31°–32°	4 gals.
Liquid soap	¾ gal.
or	
Hard soap	4 lbs.
Water	200 gals.

To prepare this spray, first place the soap (if hard soap is used, it must first be dissolved in hot water) in the spray tank with 10 or 15 gallons of water. The engine is now started and the emulsion is made by the materials being run through the pump under pressure. After a few moments the rest of the water may be added, with the pump still going, when the spray is ready to be applied to the tree.

Under favorable weather conditions, particularly in the coast counties, this spray should do no appreciable injury to the tree or fruit. During hot or dry weather, however, and in the interior sections, freedom from injury cannot be assured.

The other oil spray that has been used extensively even in the interior sections without injury is the kerosene-water mechanical mixture. This is used at a strength of 8 to 10 per cent and is mixed with water mechanically by the agitation in the spray tank. The oil used in this case has the trade name of "Water white" or "W. W." and is simply a cheap grade of kerosene. The gravity is 42 degrees Beaume and it costs 7 cents per gallon in Los Angeles.

This spray may be improved also, in the opinion of the writer, by the addition of soap making a kerosene emulsion. The formula for this spray is as follows:

KEROSENE EMULSION

"Water white" or "W W" oil, 42°	15 gals.
Liquid soap	¾ gal.
or	
Hard soap	4 lbs.
Water	200 gals.

The materials used are mixed in the same way as explained for the distillate emulsion.

Of all of the sprays that have been applied to citrus trees, and many have been tried during the past year, the kerosene, or kerosene emulsion, has proved to be the safest from the standpoint of injury to the tree or fruit and at the same time effective in killing the scales. In the case of young trees, however, where there is a considerable amount of the spray allowed to run down the trunk there is liable to be injury just below the surface of the ground. This girdling of the small tree-trunks by the kerosene seems especially likely to occur in sandy soils. Where small trees are sprayed and much of the material runs down the trunk, the precaution should be taken to remove three or four inches of the soil immediately around the tree by means of a hoe, and replace the soil thus removed by fresh soil. This should be done immediately after making the spray application, certainly not later than the following day. The distillate or distillate emulsion is much less likely to do this sort of injury to small trees than the kerosene spray, probably because of the higher concentration of the kerosene spray, and also its greater penetrating action. Small trees growing in sandy soil, and bearing fruit which

might not otherwise be spotted, may be most satisfactorily sprayed with the distillate. The important consideration in spraying young trees is to wet them well and allow no more spray to drip on the ground or run down the tree trunk than necessary. Where the ground is thoroughly saturated, the bark on some of the roots that are within two or three inches of the surface may also be injured from the kerosene.

Application of the Spray.—From the discussion in the preceeding pages it will be seen that several different sprays may kill the citricola scale, and also the black scale, while they are still quite small. One of the important considerations in selecting a spray for citrus trees, therefore, is one that will do the least injury to the tree, and probably the most important of all in the spraying programme is the proper application.

Satisfactory results should not be even expected unless the spray is most thoroughly applied to the tree. Since the citricola scale is very largely on the under side of the leaves at the usual time for spraying, the spray should be directed almost entirely from below. Two angle nozzles on a Y at the end of each rod is the best arrangement. These nozzles should not throw too coarse a spray, otherwise too much material will be used if any attempt at thoroughness in covering all parts of the tree is made. The "Bean Mist" and "Bean whirlpool" nozzles are satisfactory, or the "Friend Drive Spray" nozzles when discs with the smaller openings are used. Two applications are necessary; usually the first of these should be made for the citricola scale in August or September, and the second a few weeks later.

FUMIGATION

The most satisfactory treatment for the control of the citricola scale is fumigation. But unlike the black scale this species is susceptible to the gas for a very short period of the general fumigation season (July 15 to January 1). The earliest work in fumigating for this scale where close observations were made on the results was done by Mr. D. Kell, inspector for the Pomona district. This work showed that the best results were secured where the fumigation was done early. That early fumigation is more effective has proved to be true also from the writer's observations and experiments of the last two or three years. Since in Tulare County during the past year a heavier schedule was employed than was customary in Southern California, it was thought that the effective fumigation period might be prolonged. But the experience there was the same as the previous

experience in the south, namely, that after about the middle of September effective work was much less certain.

Season.—The fumigation period for the citricola scale is, therefore, between July 15 and September 15. In several cases satisfactory work has been done as late as October or even November, but at this time there is no positive assurance that satisfactory results will be secured after the middle of September. We cannot say why this scale becomes so much more resistant than others at so early a date, on the basis of any perceptible change occurring in the insect itself. It is true that the scale is constantly getting older and possibly because of that fact more resistant, but judging from the size and appearance of this scale, as we are accustomed to judge the black scale, it ought to succumb readily to fumigation as late as December or January. The citricola scale has almost the same development period as the black scale. It grows very slowly and there is but a slight difference in size during the first three or four months. By the middle of September practically all of the citricola scales have molted the second time, and it is possible that the resistance is largely acquired after this final molt. But the majority have passed through the last molt before the middle of September and thus, on such a basis, poor fumigation results ought to be expected earlier.

During the time the citricola scale is most susceptible to fumigation, between July 15 and September 15, satisfactory work has often been done with the 75 per cent schedule, but we have seen scale survive this dosage. Where it is possible to use it, without injury to the trees or fruit, a 100 per cent schedule is more certain. In the coast counties, however, it is not safe to use the 100 per cent schedule without some danger of doing damage to the trees. In the interior sections, as at Riverside, the full schedule may be used with no bad results. In Tulare County, moreover, a 110 per cent schedule has been generally used during the past year with very little injury to the tree. The drier air and the escape of more gas must account for this variation in the different localities. It was suspected at the beginning of the present season that fumigation would not be possible in the San Joaquin Valley before September on account of the heat. Experimental fumigation was done in that section, however, as early as the middle of June. But at this season the fruit was too small to be sufficiently resistant to the gas. Commercial fumigation, under the general supervision of Mr. R. P. Cundiff, an experienced fumigator of Southern California, was however, started by the middle of July and continued until well into the fall. In

July and August fumigation was carried on up to a temperature of 80 degrees. It must be stated, however, that the summer of 1914 was cooler than the average in Tulare county, and future seasons may be less satisfactory for the process.

SUMMARY

1. The citricola scale is one of the economically important citrus insects of California.

2. It is at present distributed over widely separated localities and in some sections is spreading rapidly.

3. The young appear by the last week in April and continue to appear until August.

4. During the summer, fall and winter the scales are found on the leaves almost exclusively and grow very slowly.

5. In November, and later, a few migrate back to the twigs but the greatest migration occurs in March.

6. With the warm weather of spring they rapidly mature and begin to deposit eggs late in April.

7. One full year is thus required, usually, for the life cycle.

8. Fumigation between July 15 and September 15 is the most satisfactory treatment. Fumigation results are less certain later in the year.

9. Where fumigation is not feasible, spraying, as explained in the text, may be employed.

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1914. Report of the College of Agriculture and the Agricultural Experiment Station, July, 1913–June, 1914.

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170. Studies in Grasshopper Control.
174. A New Wine-Cooling Machine.
177. A New Method of Making Dry Red Wine.
178. Mosquito Control.
182. Analysis of Paris Green and Lead Arsenate. Proposed Insecticide Law.
183. The California Tussock-Moth.
184. Report of the Plant Pathologist to July 1, 1906.
185. Report of Progress in Cereal Investigations.
195. The California Grape Root-worm.
197. Grape Culture in California; Improved Methods of Wine-making; Yeast from California Grapes.
198. The Grape Leaf-Hopper.
203. Report of the Plant Pathologist to July 1, 1909.
207. The Control of the Argentine Ant.
208. The Late Blight of Celery.
211. How to Increase the Yield of Wheat in California.

No.
212. California White Wheats.
213. The Principles of Wine-making.
216. A Progress Report upon Soil and Climatic Factors Influencing the Composition of Wheat.
220. Dosage Tables.
225. Tolerance of Eucalyptus for Alkali.
227. Grape Vinegar.
230. Enological Investigations.
234. Red Spiders and Mites of Citrus Trees.
240. Commercial Fertilizers.
241. Vine Pruning in California. Part I.
242. Humus in California Soils.
243. The Intradermal Test for Tuberculosis in Cattle and Hogs.
244. Utilization of Waste Oranges.
246. Vine Pruning in California. Part II.
248. The Economic Value of Pacific Coast Kelps.
249. Stock Poisoning Plants of California.
250. The Loquat.
251. The Utilization of the Nitrogen and Organic Matter in Septic and Imhoff Tank Sludges.
252. The Deterioration of Lumber.

CIRCULARS

No.
65. The California Insecticide Law.
69. The Extermination of Morning-Glory.
70. Observations on the Status of Corn Growing in California.
76. Hot Room Callusing.
79. List of Insecticide Dealers
80. Boys' and Girls' Clubs.
82. The Common Ground Squirrels of California.
83. Potato Growing Clubs.
84. Mushrooms and Toadstools.
87. Alfalfa.
88. Advantages to the Breeder in Testing his Pure-bred Cows for the Register of Merit.
91. Disinfection on the Farm.
92. Infectious Abortion and Sterility in Cows.
100. Pruning Frosted Citrus Trees.
101. Codling Moth Control in the Sacramento Valley.
102. The Woolly Aphis.
106. Directions for using Anti-Hog-Cholera Serum.
107. Spraying Walnut Trees for Blight and Aphis Control.

No.
108. Grape Juice.
109. Community or Local Extension Work by the High School Agricultural Department.
110. Green Manuring in California.
111. The Use of Lime and Gypsum on California Soils.
13. Correspondence Courses in Agriculture.
114. Increasing the Duty of Water.
115. Grafting Vinifera Vineyards.
117. The Selection and Cost of a Small Pumping Plant.
118. The County Farm Bureau.
119. Winery Directions.
121. Some Things the Prospective Settler Should Know.
122. The Management of Strawberry Soils in Pajaro Valley.
123. Fundamental Principles of Co-operation in Agriculture.
124. Alfalfa Silage for Fattening Steers.
125. Aphids on Grain and Cantaloupes.
126. Spraying for the Grape Leaf-Hopper.
127. House Fumigation.
128. Insecticide Formulas.