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NEW MEXICO

College of Agriculture

AND THE MECHANIC ARTS.

Agricultural Experiment Station.

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Scale-Insects in New Mexico.

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SCALE-INSECTS IN NEW MEXICO.

By C. H. Tyler Townsend.

The question of scale-insects is a vital one to the fruit-grower. A considerable number of scales infest our fruit and shade trees, as well as our various native ornamental shrubs and plants; and in view of the recent recognition and quite rapid spread of the San Jose scale in the southern part of this territory, it becomes very desirable that accounts of our species be embodied in a bulletin for the benefit of the horticultural public. The people of southern California years ago set the example of arousing public opinion and securing valid legislation for the suppression of scale-insects and other pests, and it is gratifying to note that we have had in this territory, for one year, a similar law which compels fruit-owners to rid their orchards of all such pests. Being practically in close proximity to southern California, it is rather to be wondered at that we have not more of the fruit enemies which abound there, and which may at any time make their appearance within our limits. It is only by the greatest vigilance, and by measures of the utmost precaution on the part of all concerned, that such a contingency can be prevented. The action which California has taken in the matter is commendable, and demonstrates the entire practicability of proper legislation on this point. We may well follow the example set us, and no pains should be spared, nor any feasible means neglected, to accomplish the suppression of such insects as the San Jose scale and kindred species.

CLASSIFICATION OF SCALE-INSECTS.

In order that the fruit-grower may be better enabled to recognize the various genera and species of scale-insects, a few paragraphs are devoted to their classification.

They constitute the family known as the Coccidae, and belong to the Homoptera, which is generally accepted by entomologists as a division of the order Hemiptera. Other familiar examples of the Homoptera are the plant-lice (Aphididae), the seventeen-year Cicada, the vine leaf-hopper, and the tree-hoppers. The cochineal and lac insects belong to the Coccidae.

As there is considerable diversity of structure among the species of Coccidae, this family has been divided into five sub-families. One of these, the *Brachyscelinae*, includes species which live in galls, and are wholly confined to Australia. The four remaining sub-families may be ordinarily distinguished by the following table:

1. Scale composed partly of molted skins, and partly of a secretion of the insect *Diaspinae*.
 Scale composed of a secretion of the insect alone, or else absent; never in part composed of molted skins 2
2. Individuals usually fixed to plant on which they live; the body of the female scale-like or rather globular, with segmentation absent or indistinct *Lecaninae*.
 Individuals usually retaining the power of motion; the body of female usually distinctly segmented 3
3. Abdomen never terminating in two long caudal filaments
 *Monophloeinae*.
 Abdomen always terminating in two long caudal filaments
 *Coccinae*.

Diaspinae.—Examples are the various species of *Aspidiotus*, to which belong the San Jose scale, the greedy scale, and the red scale of the orange in California. The genus *Aspidiotus* is distinguished by the female scale being circular, or nearly so, with the exuviae either central or more or less marginal; and the male scale somewhat elongated, with the exuvia more or less central. The female scale may be distinguished by having two cast skins or exuviae beneath it, while the scale of the male has but one. Near the center of the scale, or between the center and the margin, will be seen

a small dot of a darker color than the rest of the scale. This marks the location of the cast skin or skins (exuviae) lying beneath the scale, and its position serves as a character for distinguishing different species and even genera of this sub-family.

Lecaninae.—Examples are the various species of *Lecanium*, to which belong the black scale of California; the cottony maple-scale (*Pulvinaria innumerabilis* Rathv.); and the lac insect (*Carteria lacca* Ker.). In the genus *Lecanium* the female lays her eggs beneath the scale, and secretes no cottony material. In the genus *Pulvinaria* the female secretes a mass of cottony material, in which the eggs are deposited.

Monophloeobinae.—Examples are the various species of *Icerya*, to which belongs the famous fluted scale, so destructive to the orange in California and originally brought from Australia; also the mesquite scale mentioned in this bulletin, and which will probably form a new genus. There are some gigantic species of this sub-family in Australia, some of them reaching the length of nearly two inches!

Coccinae.—Examples are the cochineal insect (*Coccus cacti* L.); and the mealy bugs (*Dactylopius*).

GENERAL HABITS OF SCALE-INSECTS.

The female scale-insect is always wingless, and does not undergo a complete metamorphosis. She fixes her beak in the bark, stem, leaf, or fruit while young, and becomes stationary (except the *Monophloeobinae* and *Coccinae*), excreting and forming her scale as she grows.

The male, however, of all scale-insects undergoes a complete metamorphosis, and is furnished in the adult state with a single pair of wings. The hind pair is wanting, but is represented by a pair of club-like appendages called halteres or balancers. Each of these appendages is furnished with a hooked bristle, which fits into a pocket on the margin of the wing of the same side, and doubtless serves to brace and strengthen the flight. The adult male has no organs for obtaining food, and takes no nourishment, his sole

object in life being to impregnate the female, which is soon accomplished. The mouth parts are lost during the metamorphosis, and what is strange enough, their place is supplied by a second pair of eyes!

As soon as the female scale-insect is fertilized, her body increases in size and becomes distended with eggs. These are deposited either beneath the scale, the body of the female meantime shriveling until it remains but a shrunken skin beside the mass of eggs; or a cottony sac is excreted by the female posteriorly to contain the eggs, and in which they hatch.

When the young insects hatch, they may be seen with a lens crawling over the surface of the bark or leaf, preparatory to settling down and fixing their beaks therein (except the two sub-families above mentioned, which do not become stationary). At this time, their bodies are very tender, but shortly after fixing themselves they begin to exude a scaly covering to serve as a protection to themselves.

Scale-insects can spread from one orchard to another by the female crawling, or being carried by birds or the wind. She may even be carried by attaching herself to bees, and other insects. The larger species of scales more frequently spread by crawling; but the smaller ones, such as the species of *Aspidiotus*, are no doubt often spread by the other means referred to.

NO. I. THE SAN JOSE SCALE (*Aspidiotus perniciosus* Comstock).

Plate I, fig. 1.

Scale of Female.—The female scale is flat and circular, with the exuviae central or nearly so. It is grayish in color, except the exuvial spot which varies from yellowish to blackish. In some specimens, according to Comstock, the outer part of the scale is marked with radiating ridges. Diameter, 2 mm. (.08 inch).

Female.—Body yellowish and nearly circular in outline, segmentation distinct. The last segment presents the following characters: Only two pairs of lobes visible, first pair converging at tip, notched

about midway their length on lateral margin, and often bearing a slight second marginal notch near tip. Second pair notched once on lateral margin.

Scale of Male.—Smaller, quite different in appearance, being somewhat elongated instead of circular, blackish in color, and with the exuvia between the center and the anterior margin.

Egg.—According to Comstock, the eggs are white; but according to my own observation, they turn to an orange-yellow color in the spring. They hatch here about the first or second week in May.

Food-plants.—Found here on apple, pear, plum, peach, quince, and rose. Attacks bark, leaves, and fruit. It has not yet occurred here on the apricot, but has been reported on this fruit in California. It also infests the cherry; in fact, all the deciduous fruits are liable to its attacks.

This species is also known as the pernicious scale, and has been brought into New Mexico on young trees from California. It was first noticed as injurious in San Jose, whence the popular name. In California, it has proven to be the most destructive scale known on deciduous fruits, and also the most difficult to kill. It spreads rapidly.

A reliable characteristic by which this scale may be recognized, when numerous, consists in the red discoloration of the bark occasioned by its attacks. The discoloration appears in reddish blotches over the bark, and when the latter is badly infested, extends through the bark and into the sapwood. It seems that the weather during the past winter has had some effect on the scales, many of them appearing winter-killed.

Parasites.—Three species of minute hymenopterous parasites of this scale are known in California. They are:

Aphelinus mytilaspidis Le Baron (Plate I, fig. 4): This is a little four-winged fly, the female of which is about 0.64 of a millimeter in length, with a wing expanse of 1.28 mm. Its general color is bright lemon-yellow; the base of the antennae or feelers is more or less dusky, the eyes blackish, the ocelli or simple eyes carmine, mandibles or

jaws brown, and legs and wing-veins bright yellow. The wings are delicate and hyaline, but sometimes with a pale yellowish shade. The males average slightly smaller in size, and the club of antennae is a little more truncate at tip. With these exceptions they can hardly be distinguished from the female. (Drawn from Howard's description.)

This species has been found parasitic on *Mytilaspis pomorum* (in Ill., Mo., N. Y. ?, Calif.); *Chionaspis pinifoliae* (in Mo. ?, D.C.); *Mytilaspis* sp. on linden (D. C.); *Diaspis carueli* on juniper (D.C.); and *Aspidiotus perniciosus*. It was bred from the last scale by Mr. E. M. Ehrhorn, of California (see *Insect Life*, vol. iii, p. 487).

In order to show the efficiency of this parasite, Mr Howard has compiled the following table from Dr. Le Baron's tables, showing that it alone destroyed more than 63 per cent. of the whole number of scales.

Whole number of scales collected from apple in different gardens.....	844
Number with round holes through which this parasite had escaped	289
Number having larvae of this parasite under them.....	244
Number destroyed by mites or unknown cause.....	254
Number of healthy and sound scales.....	57
Whole number.....	844

Aphelinus fuscipennis Howard: This is a very much smaller parasite, only 0.06 of a millimeter in length, and with a wing expanse of 1.3 mm. Its general color is dull honey-yellow; the antennae are smoky, blackish at tip; eyes blackish, ocelli dark crimson; a distinct transverse black band on occiput behind eyes, scutellum somewhat blackish at tip, abdomen with five dusky transverse lateral bands, legs and wing-veins honey-yellow. Front wings with an indefinite smoky patch below the stigma (spot near front border of wing), and another darker crescent-shaped streak near base of wing, convex on

inside. (Drawn from Howard's description.) The male was unknown to Mr. Howard.

This species is also widespread and quite a general feeder. It has been bred from *Aspidiotus perniciosus* (Cal.); *Chionaspis euonymi* (Fla.); *Mytilaspis gloverii* on orange (D.C.); and *Mytilaspis pomorum* (Cal.). Mr. E. M. Ehrhorn suspects that it is also parasitic on the greedy scale (*Aspidiotus rapax*). See *Insect Life*, vol. iii, p. 487.

Coccophagus citrinus Craw MS.: This parasite has apparently never been described. It is 0.03 of an inch in length. Regarding the value of this species as a parasite, the following letter from Mr. D. W. Coquillett, published in the "California Fruit Grower," Sept. 1889, is quoted:

Concerning the parasite of the red scale in the San Gabriel Valley, Acting Entomologist Howard writes me that it is probably a new species belonging to the genus *Coccophagus*. It is a minute four-winged fly scarcely as large as the head of a small pin; its eggs are laid singly in or upon the scales, and the larva or grub that hatches from this egg feeds upon the scale insect, and after completing its growth and passing through its preparatory stage, it gnaws a round hole through the scale and thus makes its escape. This parasite occurs in nearly all of the orange groves in the San Gabriel Valley, and in some of them its work is very noticeable. This is especially the case in the large Chapman groves, in which I detected this parasite two years ago. During a visit to this grove a few days ago it was almost impossible to find any young red scales on the infested trees, while in other localities where this parasite does not occur, almost every leaf contains one or more of the young scales, this being the season of the year when they are most abundant. Mr. A. B. Chapman informs me that there is less red scale on his fruit this year than there has been since first his trees became so seriously infested with these pests. I have taken the necessary steps for introducing this parasite into a locality where it did not previously exist, but it will be several months yet before the result of this experiment can be determined.

This parasite destroys the red scale of the orange (*Aspidiotus aurantii*), and its yellow variety (*A. citrinus*) in California; and Mr. E. M. Ehrhorn has also bred it in California from the San Jose Scale (*A. perniciosus*). See *Insect Life*, vol. iii, p. 487.

NO. II. THE WHITE PEAR SCALE (*Aspidiotus rapax* Comstock).

Plate I, fig. 2.

Scale of Female.—Very convex; exuviae between center and one side, and covered with secretion. Scale is gray, somewhat trans-

parent so that it appears yellowish when covering a living female; prominence covering exuviae is dark brown or black, usually with a central dot and concentric ring which are white. Ventral scale snowy white, usually entire. Diameter 1.5 mm.(0.06 inch).

Female.—Body nearly circular in outline, bright yellow in color with more or less translucent blotches. The last segment presents the following characters: Groups of spinnerets wanting. Only one pair of well-developed lobes, the median, present. These are prominent, and each one is furnished with a notch on each side. Second and third pairs of lobes represented by minute pointed projections of margin of body.

Egg.—The eggs and newly hatched larvae are yellow. (From Comstock's description.)

Food-plants.—This scale attacks a great number of plants, trees and shrubs. In California it has been found on olive, mountain laurel (*Umbellularia californica*), almond, quince, fig, willow, eucalyptus, acacia, apple, pear, and others. In Florida, on *Euonymus japonicus*. It has been found here on apple, pear, and peach. Like the preceding scale, it affects not only the bark of the trunk and limbs but the leaves and fruit as well.

This species is also known as the greedy scale. It sometimes occurs in a locality in great numbers, when it becomes very destructive, but as a rule it does not spread rapidly and is not to be compared with the San Jose scale. If, however, it is allowed to gain a good foothold, it will be troublesome to exterminate it, owing to the large number of plants upon which it subsists.

Parasites.—*Aphelinus fuscipennis* Howard, mentioned under San Jose scale, is suspected by Mr. E. M. Ehrhorn of being a parasite of this species also. (See *Insect Life*, vol. iii, p. 487.)

NO. III. THE CONVEX SCALE (*Aspidiotus convexus* Comstock).

Plate I, fig. 3.

This species very closely resembles *A. rapax* in the shape and color of its scale. It is only by a careful study and comparison of the two forms that it can be distinguished. A careful examination

of their structure shows them to be specifically distinct. This species may be distinguished from *A. rapax* by the following characters of the last abdominal segment of the female: Four groups of spinnerets (none in *A. rapax*); the superior lateral groups consist of about seven, and the inferior lateral groups of about four spinnerets.

Food-plants.—Very common in California on the bark of the trunk and limbs of the native willows. It has been found in great numbers here on the bark of trunk and branches of our native cottonwood (*Populus fremontii*). The bark of the trunk of one tree was entirely covered. It has also been found here in great numbers on the limbs and twigs of an ash (*Fraxinus* sp.).

Parasites.—Great numbers of the scales on cottonwood showed minute holes from which some hymenopterous parasite had emerged. There were no living insects under such scales, showing that the parasite had done much good work in keeping the scales in check. Those on ash were also well parasitized.

NO. IV. CHILOPSIS SCALE (*Aspidiotus* n. sp.?).

This species bears some resemblance to *Aspidiotus nerii* Bouche, but is probably a new species. Professor Comstock, after an examination of specimens, writes that it is an *Aspidiotus* unknown to him, and probably undescribed. Further material is necessary before a description can be drawn up, therefore nothing more than a mere notice of its occurrence is given here.

Food-plants.—This species was found plentifully infesting the leaves, mostly on the upper side, of a bush of *Chilopsis saligna* in the yard of Hon. A. L. Christy, of Las Cruces, who first called my attention to this scale. At date of examination, August 25, 1891, the scales were nearly all very small, and some orange-yellow young were seen outside. There were a few larger scales, containing eggs beneath them. The scales seemed to be confined to the leaves.

NO. V. THE LOCUST SCALE (*Lecanium robiniae* Riley MS.).

This is an entirely different scale, in appearance and size, from all of the preceding species, which belong to the genus *Aspidiotus*.

It is a brown, or reddish-brown scale, hemispherical in form, hard in texture, and varies from 3 to 5 mm. in breadth and 4 to 6 mm. in length. Some of them are very dark brown in color. Beneath this scale, as in the preceding species, is to be found either the soft insect or the eggs. The species has not been described, and I will not attempt to give other than the above brief description here. Professor Riley, who has seen specimens, has furnished the above manuscript name to be used in referring to the species. The short description and the food-plant will doubtless enable its recognition.

Egg.—The eggs are pale reddish-pink in color, very small, and a great many are to be found under one scale. They were observed to be hatching May 22.

Food-plants.—This scale has been found here only on imported trees of black locust (*Robinia pseudacacia*), the branches and twigs of which it very plentifully infests. It is more or less unnoticeable on account of its color being much the same as that of the twigs upon which it occurs.

Parasites.—No true parasites have been observed. A locust tree which was infested with the scale was found to be well stocked with the California *Coccinella oculata*, and its ashy gray variety (*C. abdominalis*). These undoubtedly prey upon this and other scales. The variety seemed to predominate, and though all stages from eggs to adults were to be found May 22, the pupae were by far the most abundant.

NO. VI. SOFT PEACH SCALE (*Lecanium* sp.).

A single specimen of a soft, brownish, more or less hemispherical scale-insect, about 5 mm. in length, was found April 11, on a branch of the peach. No others were found, and it is simply mentioned here so it may be looked for by fruit-growers. We shall be glad to receive any specimens of it that may be found. Unlike all the preceding species, it is simply the bare, soft insect that must be looked for, as it apparently does not cover itself with a scale.

NO. VII. THE YUCCA SCALE (*Lecanodiaspis yuccae* Riley MS.).

This is a round, hemispherical, whitish scale, about 3 to 4 mm. in diameter, and of hard texture. The scale bears a median longitudinal carina or keel above, and is a little narrower than long. This species is also undescribed, and the above manuscript name was furnished by Professor Riley. It can be easily recognized when seen.

Egg.—The eggs under dried scales are pale yellowish or whitish, and a considerable number occur under one scale.

Food-plants.—This scale was found on leaves of *Dasykirion wheeleri*, March 14, 1891, in the Organ mountains. It was later found on the large-leaved yuccas (probably *Yucca macrocarpa*), in the same mountains. In both plants, it infests the upper side of the leaves very plentifully, chiefly at and near their bases. These plants are highly ornamental, and the yuccas especially may be used to advantage on lawns. Therefore this scale becomes of considerable importance from an economic standpoint.

Parasites.—Some of the scales which have been collected were found infested with a hymenopterous parasite, the black perfect insect of which could be seen inside the scale through a small round hole where it was about to emerge.

NO. VIII. THE LARREA SCALE (*Signoretia* sp. ?).

This scale is enclosed in a white felted or cottony covering. The insect itself is of a light reddish-brown, with the legs and antennae concolorous. The adult female has apparently 8 joints in the antennae, and the legs are present. The first antennal joint is short. The larva has only six antennal joints. The dimensions are as follows: Length of adult female, about 4 mm; width, 2 mm. Length of felted sac, 5 to 6 mm; width, 2 to 2.5 mm.

Egg.—The eggs are whitish in color and are enclosed in the end of the felted sac, behind the body of the female, the head of the female being usually more or less thrust through the anterior end of the sac.

Food-plants.—Found abundantly, May 13, on leaves of the creosote bush (*Larrea mexicana*); occasionally on the stems also. It is usually on the underside of the leaf, which is small and very nearly covered by the felted sac. Young specimens were also found this date, which were beginning to exude a sac, though the eggs found in the sacs of adult females were unhatched. It was observed that the whitish sacs were likely to escape notice among the young fruit of the *Larrea*, which was just setting and was covered with a whitish, woolly pubescence.

NO. IX. PALMER'S ICERYA (*Iceerya palmeri* Riley and Howard).

Plate II, figs. 1 and 2.

This scale does not, so far as the writer is aware, occur in New Mexico. As will be seen, however, it becomes very desirable to treat it here, since it is not unlikely that it may some day reach us. The adult stages are as yet unknown to science, and consequently can not be described. A description of the first and second larval stages will be found in *Insect Life*, vol. iii, pp. 104-5, but is too technical to be inserted here. The larvae are apparently reddish-yellow in color, but their cast skins are white.

Food-plants.—This species was found by Dr. Edward Palmer July 30, 1887, on the Muscat of Alexandria grape, at San Jose de Guaymas, nine miles north of Guaymas proper, in Sonora, Mexico. The specimens found were only the younger stages, and were fixed along the main ribs of the leaf, principally on the under side. This would prove a new and most undesirable pest to our Muscat grapes if introduced here, and with the Santa Fe R. R. connections between Guaymas and this territory it is by no means an impossibility. All vines brought from Old Mexico should be most thoroughly overhauled before they are allowed to enter American territory.

Parasites.—It is reported in *Insect Life*, l. c., that the puparium of a dipterous parasite, apparently of the family *Phoridae*, was plainly to be seen within one of the mounted larvae of the second stage.

NO. X. COTTONY MESQUITE SCALE (n. gen. et n. sp.).

This is a large, soft scale, red or brick-red in color, and bearing a snow-white, more or less distinctly fluted, cotton-like, but compact egg-sac, which is attached to the postero-ventral portion of the insect, and is cylindrical in general form. The insect is entirely red, except the legs, antennae and proboscis, which are black; and the egg-sac, which is white. Pinned specimens usually become reddish-yellow in color, while alcoholic specimens acquire a reddish-brown color. This scale also exudes, particularly around the edge of its body, a certain number of curled white cottony filaments, in addition to the egg-sac. The dimensions of the larger specimens collected in July, 1891, and May, 1892, are as follows: Length of body, 5 to 7 mm.; anterior width of body, 2 to 3 mm.; posterior width 4 to 5 mm. Length of egg-case, 5 to 6 mm.; width, about 4 mm. Specimens collected June 8, 1892, measure 12 to 13 mm. in length, including egg-sac; sac measures 10 mm.

This scale will probably form a new genus, according to Professor Riley who has examined specimens. It is nearly related to the *Icerya* of California, though somewhat more removed from it than the preceding species, which is a member of the same genus.

Egg.—In color the eggs are orange-red. They were just beginning to hatch within the sacs, June 8.

Food-plants.—Found on twigs and branches of mesquite (*Prosopis juliflora*) rather plentifully, July 28, 1891, many of them being at this time small. Found more sparingly, but in larger specimens, May 13 to 18, 1892; though two or three smaller ones without egg-sacs were also seen. A good number of large specimens were found June 8. This scale, it is possible, may some day take to certain cultivated plants, in which case it will prove a serious enemy.

Parasites.—No true parasites have been found, but the two species of lady-birds, previously mentioned, frequented the mesquite branches where the scales were found, and doubtless prey upon them. In the same connection, it may be mentioned that two species of

ants, one of moderate size and the other very small, were seen attending these scale-insects, from which they obtain a honey-like exudation. The ants rather serve to protect the scales by warding off parasites and predaceous insects. This scale-insect was noticed to exude a drop of a clear honey-like fluid from the back posteriorly, upon which the ants fed.

PARASITES AND OTHER ENEMIES OF SCALE-INSECTS.

The insect enemies of scale-insects may be divided into two categories: True parasites, which live internally in the host insect, and predaceous insects, which attack the scales externally and devour them bodily.

The true parasites are very small members of the orders Hymenoptera and Diptera, more particularly the former in the case of scale parasites. The hymenopterous parasites belong principally to the families *Chalcididae* and *Proctotrupidae*, two or three species of which have been more or less briefly described in the preceding pages. The dipterous parasites belong principally to the *Ochthiphilidae*, a family of acalyptrate Muscidae, and perhaps to some other families of the same division. These parasites deposit their eggs in or upon the scale-insects, and the newly-hatched parasite lives within the body of its host until full grown, when it transforms and issues as a perfect insect.

The chief predaceous insects, which are useful in destroying scales, are the following: *Coccinellidae*, or lady-birds; and certain predaceous lepidopterous larvae, belonging to the families *Noctuidae*, *Phycitidae*, *Tineidae*, and *Pyralidae*. The predaceous enemies have proven of more value in California than the true parasites,

Of the *Coccinellidae*, or lady-birds, we have here two very efficient forms, which are mentioned in the preceding pages. They are *Coccinella oculata*, and its ashy-gray variety (*C. abdominalis*, which looks like an entirely different species. The former is black with a yellow spot on each wing-cover, and the head and forward margin of thorax whitish. The variety is entirely creamy-gray, with eight

spots normally on each wing-cover, seven on thorax with two fainter ones on front margin, while the eyes look like two black spots on the head. These lady-birds are California forms, and have not before been reported from New Mexico.

To the true dipterous parasites belongs the *Lestophonus iceryae*, which was found parasitic on *Icerya* in Australia, and was imported under Professor Riley's direction into California. It has, however, been superseded in usefulness by the *Vedalia*, and some other coccinellid beetles which were imported later.

REMEDIES FOR SCALE-INSECTS.

Summer Washes.—As a summer wash for the San Jose scale, and other species of *Aspidiotus* infesting deciduous trees, the following should be applied at various times after the young scales have hatched and are seen crawling on the bark:

No. 1.	Caustic soda (98 per cent.)	10 lbs.
	Potash	10 lbs.
	Tallow	40 lbs.
	Resin	40 lbs.
	Water to make	50 gals.

The above forms a soap which will fill a barrel of 50 gallons measure, and will weigh about 450 to 500 pounds. It must be prepared as follows:

First, dissolve the soda and potash in ten gallons of water, then place the whole in a 50-gallon barrel. Second, dissolve the tallow and resin together by heating it over a fire, add it to the soda and potash in the barrel, and stir well for about five minutes. Let it stand now for about two hours, when the barrel may be filled up with water, but the mixture must be well stirred as every bucket of water is added. It will be ready for use the following day, and should be applied warm in strength of one pound of soap to a gallon of water. This remedy is preferable for apples and pears, and was originally recommended, I believe, by Mr. Sol. Runyon, of Courtland, Cal.

The following is recommended in California for same purpose, but for use on the peach:

No. 2.	Potash	14 lbs.
	Caustic soda (98 per cent.)	8 lbs.
	Unslacked lime	5 lbs.
	Fish oil, polar or seal	10 gals.
	Water to make	50 gals.

Prepare as follows: First, dissolve the soda and potash in ten gallons of water, as with the preceding formula. Then slack the lime with two gallons of water in the 50-gallon barrel to be used, add the fish oil and stir well until the lime and oil form a thick batter. Now pour the soda and potash solution, boiling hot, into the barrel containing the batter, and stir well with a dasher for five minutes. Leave standing from 4 to 6 hours; after this length of time the barrel may be filled up with cold water, about two buckets full at a time, stirring well to prevent lumps. Use the following day and apply cold, in strength of one pound to a gallon of water.

In dissolving this soap for use do not boil, but weigh amount to be used, place in barrel and pour hot water thereon, in proportion of one pailful to every one hundred pounds of material; then stir briskly with a dasher until entirely dissolved. It can now be reduced with cold water as above directed, making as many gallons of wash as there were pounds of soap dissolved. After being well stirred, it is ready for use. This wash is also recommended in California for *Icerya* on citrus trees and evergreens, and for *Lecaniums* on deciduous or other trees.

Another summer resin wash, recommended by Professor Riley for the red scale on the orange in California, differs from the above washes by containing no potash, and proportionally more than twice as much resin. It will doubtless be efficient for all species of *Aspidiotus*, except the San Jose scale, but if used on deciduous trees it should be experimented with first to determine effect on the foliage. If the foliage is injured, more water can be added. The formula is as follows:

No. 3.	Resin	18 lbs.
	Caustic soda (70 per cent.) . . .	5 lbs.
	Fish oil	2½ pints.
	Water to make	100 gals.

It also differs from the preceding resin washes in the manner of preparation, and in being ready for application when mixed according to the above formula, instead of forming a soap to be dissolved again in water. It is prepared as follows:

Place all the ingredients in a large boiler with enough cold water to cover them. Boil until dissolved, occasionally stirring, and continue boiling for about an hour after the materials are dissolved, employing sufficient heat to keep the mixture in a constant state of ebullition, and adding hot water when it is in danger of boiling over. When sufficiently boiled it will assimilate perfectly with water, which should then be added hot up to 50 gallons, slowly at first and stirring occasionally, and then cold water until a sufficient amount is added to make 100 gallons of the mixture. Before the water is added the preparation is of a pale yellow color, but after adding it becomes dark brown. It must be strained through a fine wire sieve, or a piece of Swiss muslin, before applying to the trees.

Virtually the same remedy as the above, only in a little greater strength and with the addition of a little kerosene, is recommended by the California State Board of Horticulture for the red scale on orange, and other scales on evergreen trees; while the same thing, only a little stronger and without the kerosene, is recommended for *Icerya* on the orange.

The following is the Riley-Hubbard formula for the kerosene emulsion, which at proper strength will be found a very efficient remedy for scales:

No. 4.	Kerosene oil	2 gals.
	Common soap	½ lb.
	Water	1 gal.

Prepare by boiling the water and soap together until dissolved, and then pouring it, while boiling hot, into the kerosene. The

mixture must now be pumped through a force pump for about five minutes, directing the stream back into the pail, until it forms a perfect emulsion. As a summer wash for San Jose and other scales on apple, pear, etc., dilute nine times with cold water. For use on peach, dilute fifteen times.

The following summer wash for San Jose scale on deciduous trees is recommended by the California State Board of Horticulture:

No. 5.	Whale oil soap (80 per cent.)	20 lbs.
	Sulphur.....	3 lbs.
	Caustic soda (98 per cent.)....	1 lb.
	Commercial potash.....	1 lb.
	Water to make.....	100 lbs.

Boil the sulphur, soda and potash in two gallons of water for one hour, or until thoroughly dissolved. Dissolve the soap by boiling it in water, then add to the other, mix and boil for a short time when it may be applied hot.

Winter Washes.—In order to thoroughly destroy the San Jose scale, it will be necessary to use the following winter wash, which is much stronger than any of the preceding and must be applied only when the tree is dormant. If applied in the growing season, it will cause the loss of both foliage and fruit. It is recommended by Professor Riley as giving the best results of all for use as a winter wash against this particular scale. It therefore needs no further commendation:

No. 6.	Resin.....	30 lbs.
	Caustic soda (70 per cent.)....	9 lbs.
	Fish oil.....	4½ pints.
	Water to make.....	100 gals.

Prepare by placing all the ingredients in a large boiler, and pouring over them about 20 gallons of water. Boil briskly for three hours, or until the compound is perfectly soluble in water. The boiler must now be slowly filled up with hot water, care being taken to stir well, until it makes 50 gallons of hot solution. This should

be strained through a fine wire seive or a piece of muslin, when it can be diluted with an equal quantity of cold water as needed for spraying. It is recommended in California for *Lecaniums*, as well as San Jose scale, for winter use on deciduous trees.

In the application of this wash a very fine spray is not essential, as the object to be attained, that of thoroughly coating the tree with the compound, can be best accomplished by the use of a rather coarse spray, to be thrown on the tree with considerable force.

The California State Board of Horticulture recommend the following as a winter wash against the San Jose and congeneric scales. It is claimed, and I believe with reason, that the addition of potash to the wash is necessary to prevent the dry atmosphere from exhausting the caustic properties of the soda. This is especially important to us in New Mexico, as our atmosphere is much dryer than that of California. If soda lye alone is sprayed on trees in sunny weather, it will often be found within an hour to have crystallized into solid carbonate of soda, and its action, so far as insects are concerned, is at an end. If sprayed in moist weather, its action is prolonged. The addition of the potash, however, maintains the corrosive action of the soda in the driest atmosphere, by preventing the rapid evaporation and solidification which would otherwise put an end to it. Besides the potash ultimately reaches the soil, and acts as a fertilizer when needed. The above statements are on the authority of Professor Hilgard.

No. 7.	Solid concentrated American lye (80 per cent.)..	1 lb., or
	Powdered caustic soda (98 per cent.).....	0.8 lb., or
	Powdered caustic soda (76 per cent.).....	1 lb., or
	Powdered caustic soda (63 per cent.).....	1 $\frac{1}{4}$ lbs., to
	Commercial potash (52 per cent.).....	1 lb., and
	Water.....	2 $\frac{1}{2}$ gals.

Simply dissolve the soda and potash in the water. First recommended by Mr. M. Cooke.

The following formula, recommended by Professor Hilgard, is

undoubtedly equally as good as the last, and costs one cent less per gallon.

- No. 8. Solid concentrated American lye (80 per cent.) . . 1 lb., or
 any one of the sodas in preceding formula, to
 Commercial potash (52 per cent.) $\frac{1}{2}$ lb.
 Water 2 gals.

Simply dissolve. This is just a little more than one half the strength of potash that is given in the preceding formula.

Comments.—The above 8 washes are given so as to allow some latitude in choice. They have been carefully selected, and will doubtless all prove more or less efficient. Those which will be of use for species of *Aspidiotus* and *Lecanium*, are mentioned above. The last two formulas mentioned would, I believe, be especially adapted to our climate.

For *Lecanodiaspis*, or other scales on *Dasyllirion* and *Yucca*, I would recommend formula No. 6, to be applied at any time of the year. No. 4 diluted five times would also be of service, and would in all probability not affect the plants.

As far as the scale on *Larrea* goes, it will probably not spread to any other plant, and doubtless the creosote bush is not valuable enough here to call for any protection. However, No. 6 and No. 4, as above recommended, would be the proper remedies.

For species of *Icerya*, and for cottony scale on mesquite, No. 3 is the formula which should be used, but the caution given above as to trying the wash first to get the strength which will not injure such foliage as grape or mesquite, must be heeded.

No mention is made in this bulletin of the hydrocyanic acid gas method of destroying scale-insects, which is at the present time unnecessary in this territory.

EXPLANATION OF PLATES.

Plate I.

(All much enlarged.)

Fig. 1.—San Jose scale, *Aspidiotus perniciosus*, last abdominal segment of female showing specific characters.

- Fig. 2.—White pear scale, *Aspidiotus rapax*, last abdominal segment of female showing same.
- Fig. 3.—Convex scale, *Aspidiotus convexus*, last abdominal segment of female showing same.
- Fig. 4.—San Jose scale parasite, *Aphelinus mytilaspidis*.

Plate II.

Palmer's *Icerya*, *Icerya palmeri*.

- Fig. 1.—*a*, newly hatched larva; *b*, larva, second stage (both greatly enlarged—hair lines indicate natural size); *c*, antenna of *b* (still more enlarged).
- Fig. 2.—*a*, cast skins of larvae of second stage (much enlarged); *b*, same clustered on ribs of grape leaf, on underside (natural size).

Plate III.

This plate shows a spraying outfit in operation, as used in orange groves in California against the fluted scale.

NOTE.—The above plates were all received from the Agricultural Department in Washington, and appeared either in *Insect Life* or in the reports of the U. S. Entomologist.

