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L. O. HOWARD, Entomologist and Chief of Bureau.

THE OYSTER-SHELL SCALE AND
THE SCURFY SCALE.

BY

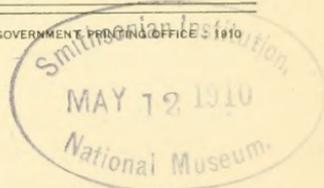
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Insect Investigations,*

AND

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[Cir. 121]

United States Department of Agriculture,

BUREAU OF ENTOMOLOGY.

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THE OYSTER-SHELL SCALE AND THE SCURFY SCALE.*(Lepidosaphes ulmi* L. and *Chionaspis furfura* Fitch.)

By

A. L. QUAINANCE, *In Charge of Deciduous Fruit Insect Investigations,*

and

E. R. SASSCER, *Scientific Assistant.***INTRODUCTION.**

The oyster-shell scale (*Lepidosaphes ulmi* L.) and the scurfy scale (*Chionaspis furfura* Fitch) are, with the exception of the San Jose or Chinese scale (*Aspidiotus perniciosus* Comst.), more frequently the subject of inquiry by orchardists than all other species of scale insects combined. These two scale pests are now very generally distributed throughout the country, and from their relatively conspicuous appearance are often detected by observant fruit growers who frequently believe them to be the more serious San Jose scale. The oyster-shell and scurfy scales, while not dangerous in the sense of generally causing the death of infested trees, are, however, of considerable economic importance. The complete killing of individual branches of apple trees by either species is a matter of frequent observation, and trees so badly infested are frequently greatly stunted and retarded in their growth, resulting perhaps in extreme cases in the death of the trees. Of the two species considered, the oyster-shell scale has been and is at the present time the more important. Its injuries to certain shade trees, especially poplar and maple, have been the cause of much complaint during recent years. Such shade trees are ordinarily not sprayed for scale insects, and the increase of these pests from year to year is thus checked only by their natural enemies. The writers have frequently seen maple and poplar trees literally incrustated from top to bottom with the oyster-shell scale, many of the limbs killed, and in rarer instances the trees quite dead—without doubt owing to the attack of this scale insect.

THE OYSTER-SHELL SCALE.

(*Lepidosaphes ulmi* L.)

ORIGIN AND DISTRIBUTION.

The origin of the oyster-shell scale is a matter of some uncertainty. It has a world-wide distribution, and was introduced into the New England colonies at an early date. The first American account of this pest was written by Enoch Perley in 1794, in which he stated that it was doing considerable damage to the apple in Cumberland County, Maine. In the early sixties it had reached the Mississippi River, and at the present writing (April, 1910) occurs in every State of the Union with the possible exception of South Dakota, Oklahoma, and Texas. Its occurrence in these States is practically certain, but there appear to be no records in literature to this effect, and it has not been received from these States by the Bureau of Entomology. The insect is very troublesome in the Northern States and is especially common in the New England States and those bordering the Great Lakes.

DESCRIPTION AND LIFE HISTORY.

This insect has received the common name "oyster-shell scale," owing to the resemblance of its scale or covering to a long, narrow oyster shell, as may be seen by reference to figure 1. The adult female scales are about one-eighth of an inch in length, usually brown to dark brown in color, though occasionally they have a grayish appearance which is due to bleaching over winter. If present in large numbers, for want of room they assume various more or less curved shapes. The scale of the male in shape and color resembles that of the female, but is smaller and possesses at the posterior extremity a small hinge or flap which permits the exit of the adult male.

If during winter or early spring one of the female scales be removed, numerous small, oval, white eggs varying in number from 40 to 100 will be revealed, and at the anterior portion can be seen the dead and shriveled body of the female.

In Canada and the Northern States there is thought to be but one full brood annually, whereas in the Middle and Southern States the species is double brooded.

The following records from literature and from the Bureau of Entomology will indicate the time in the spring of hatching of the eggs of this insect, in various localities. This time will, of course, vary with the season, but, in general, as long ago stated by Doctor Mygatt, in Illinois, will for any locality be shortly after the time of the falling of the blossoms of the apple.

Ontario: Eggs hatch about first week of June (Jarvis).

New York: Eggs hatch latter part of May to early June (Felt).

New Hampshire: Eggs hatch in late May to early June (Sanderson).

Vermont: Eggs hatch in late June (Stewart).

Maine: Eggs hatch about middle of June or later, depending upon the season (Hitchings).

Michigan: In specimens received June 18, 1909, from Stittsville, Mich., nearly all eggs had hatched (Sasscer).

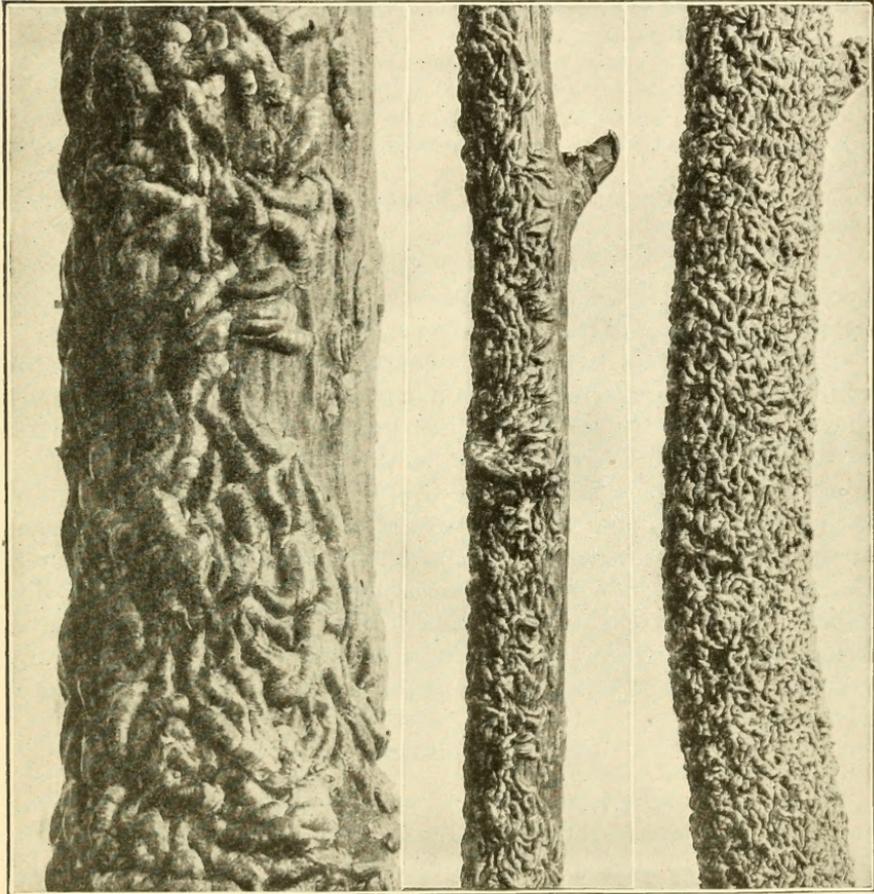


FIG. 1.—The oyster-shell scale (*Lepidosaphes ulmi*). All enlarged. (Original.)

Minnesota: In specimens received May 24, 1909, from Lamoille, Minn., eggs were hatching in numbers when received (Sasscer).

Indiana: In specimens received from Elwood, May 14, 1909, eggs were hatching in numbers when received (Sasscer).

Ohio: Eggs hatch in late May to early June (Gossard).

Second-brood eggs were found under many scales August 22, and a few young crawling at Cleveland (Quaintance).

West Virginia: In specimens received April 30, 1908, from Parkersburg, W. Va., young were crawling in numbers (Sasscer).

Missouri (Wright County): Eggs hatch early in May. Insect double brooded according to a Mr. Wright (Riley).

Olden, Mo., eggs hatched March 29, 1907; apple trees bloomed March 24 (Girault).

Ozark region, Missouri, eggs hatch about April 25 to middle of May (Taylor).

Illinois (Cook County): Eggs hatch about June 6, females reach full growth by August 1, and oviposit August 12-28 (Riley).

District of Columbia: Eggs hatch May 5-14 (Quaintance).

July 4, eggs already deposited by most females and young crawling (Quaintance).

Maryland: Eggs hatch early in May (Symons).

Eggs of first brood hatch in May; eggs of second brood hatch last week of July to first week of August (Johnson).

College Park, many recently settled scales in evidence May 21 (S. W. Foster).

Delaware: Eggs usually hatch in early May (Houghton).

New Jersey: Eggs hatch during early June (Smith).

Tennessee: In eastern Tennessee eggs hatch during first two weeks of April (Chambliss).

Eggs begin to hatch in April and those of the second brood along in July and August (Bentley).

This information as to the period of hatching of eggs in various parts of the country is of importance as bearing on the time to spray for the destruction of the young larvæ.

The female molts twice in the course of her growth, and in the adult condition is entirely without legs or eyes, being nothing more than a reproductive sack with her sucking mouth parts, through which the food is taken, inserted in the tissues of the plant. The adult male differs radically from the female in that it is provided with antennæ and one pair of wings, the second pair being present in the form of club-shaped organs known as balancers or halteres. During the process of metamorphosis the mouth parts entirely disappear, and a second pair of rudimentary eyes assumes their place. Being without any means of taking in food the male is naturally very short lived, its only mission appearing to be the fertilization of the female.

MEANS OF DISTRIBUTION.

Transportation by nursery stock, scions, or by grafting or budding material is perhaps the only way this insect is carried from one section of the country to another, and this in a large measure accounts for its wide distribution. Locally it can be transferred from plant to plant only while in the young or crawling stage. The young are often seen crawling on other insects, such as beetles, or upon the feet of birds, and may in this way be carried some distance. Man and domestic animals may also assist in their dissemination, and it is possible that the winds blow them from plant to plant.

FOOD PLANTS.

The oyster-shell scale has a wide range of food plants, but is commonly found on apple, maple, horse-chestnut, poplar, willow, and

lilac. The following is a list of the plants on which it is known to occur:

- Alder (*Alnus rugosa* Spreng.).
 Almond (*Prunus* sp.), China.
 American aspen (*Populus tremuloides* Michx.).
 American bladdernut (*Staphylea trifolia* Linn.).
Amorpha sp., exotic.
 Apple (*Pyrus malus* Linn.).
 Apple, crab (*Pyrus* sp.).
 Apricot (*Prunus armeniaca* Linn.).
 Arrow-wood (*Viburnum* spp.).
 Ash (*Fraxinus americana* Linn.), (*F. excelsior* Linn.), (*Fraxinus* spp.).
 Balm of Gilead (*Populus balsamifera* Linn.).
 Basswood (*Tilia americana* Linn.), (*T. angustifolia*, from Germany).
 Beech (*Fagus atropinicea* Sudw.).
 Bilberry (*Vaccinium myrtillus* Linn.).
 Birch, white (*Betula populifolia* Ait.).
 Birch, river (*Betula nigra* Linn.).
 Bittersweet (*Celastrus* sp.).
 Blackthorn (*Prunus spinosa* Linn.).
 Box (*Buxus sempervirens* Linn.).
 Boxelder (*Acer negundo* Linn.).
 Broom (*Cytisus scoparius* Link.), Gurnsey. (*C. nubigenus* Link.), from Gurnsey (?).
 Buckeye (*Æsculus glabra* Wild.).
 Buckthorn (*Rhamnus cathartica* Linn.).
 Butternut (*Juglans cinerea* Linn.).
Calluna sp., Sweden.
Camellia sp.
 Camphor tree (*Camphora officinalis* Steud.).
Cassia sp., in greenhouse.
 Cherry (*Prunus* sp.).
 Chestnut (*Castanea americana* Raf.).
Clematis paniculata Thunb.
 Cocoa palm from Barbados.
Cotoneaster sp.
 Cranberry (*Vaccinium* sp.).
 Currant, black (*Ribes nigrum* Linn.).
 Currant, red (*Ribes rubrum* Linn.).
 Dogwood (*Cornus alba* Linn.), (*C. alba* var. *sibirica* Lodd.), (?*C. alternata* Marsh.), (*C. californica* C. A. Mey.), (*C. sanguinea* Linn.).
 Elm, English (*Ulmus campestris* Smith).
 Elm, purple-leaved (*Ulmus scabra*, var. *purpurea* Koch).
 ? *Euphorbia palustris* Linn., Germany.
- False bittersweet (*Celastrus scandens* Linn.).
 Fig (*Ficus carica* Linn.).
 Filbert (*Corylus* sp.).
 Ginseng (*Panax quinquefolium* Linn.).
 Gooseberry (*Ribes cynosbati* Linn.).
 Goatsbeard (*Aruncus sylvestris* Kost.).
 Grape (*Vitis vinifera* Linn.).
 Hackberry (*Celtis occidentalis* Linn.).
 Hawthorn (*Crataegus crus-galli* Linn.), (*C. oxyacantha* Linn.).
Helianthemum chamæcistus Mill., England.
 Heath (*Erica* sp.), England and Sweden.
 Heather (*Calluna* sp.).
 Holly (*Ilex crenata* Thunb.).
 Honeysuckle (*Lonicera* sp.).
 Hop tree (*Ptelea trifoliata* Linn.).
 Horse-chestnut (*Æsculus hippocastanum* Linn.).
Horena dulcis Thunb.
 June-berry (*Amelanchier* spp.).
 Leather leaf (*Chamædaphne calyculata* Moench).
 Lilac (*Syringa persica* Linn.), (*S. vulgaris* Linn.).
 Lime (*Citrus* sp.).
 Linden. (See Basswood.)
 Locust, cultivated (*Robinia pseudacacia* Linn.).
 Locust, water (*Gleditsia aquatica* Marsh).
 Maple, striped (*Acer pennsylvanicum* Linn.).
 Maple, sugar (*Acer saccharinum* Linn.).
 Maple, mountain (*Acer spicatum* Lam.).
Mespilus cuneata Miq., Japan.
 Mosse-wood (*Dirca palustris* Linn.).
 Mountain ash (*Sorbus americana* Marsh).
 Mountain ash, European (*Sorbus aucuparia* Linn.).
 Myrtle (*Myrtus* sp.), Egypt.
 Nectarine (*Prunus* sp.).
 New Jersey tea (*Ceanothus americanus* Linn.).
 Oak (*Quercus pedunculata* Ehrh.), (*Quercus* spp.), Germany.
 Orchid.
Pachysandra terminalis Sieb. & Zucc.
 Peach (*Prunus persica* Sieb. & Zucc.).
 Pear (*Pyrus communis* Linn.).
 Pear, Sickle.

Peony (<i>Pæonia</i> sp.).	Tamarisk (<i>Tamarix africana</i> Poir.).
Peppergrass (<i>Lepidium suffruticosum</i> Linn., Cav.), France.	Tree of Heaven (<i>Ailanthus glandulosa</i> Desf.).
<i>Planera keakei</i> C. Koch.	Tulip-tree (<i>Liriodendron tulipifera</i> Linn.).
Plum (<i>Prunus domestica</i> Linn.).	Umbrella tree (<i>Magnolia tripetala</i> Linn.).
Poplar, Lombardy (<i>Populus nigra</i> var. <i>italica</i> Du Roi).	<i>Viburnum</i> sp.
Poplar, white (<i>Populus alba</i> Linn.).	Virginia creeper (<i>Ampelopsis quinquefolia</i> Michx.).
Quince (<i>Cydonia vulgaris</i> Pers.).	Willow, goat (<i>Salix caprea</i> Linn.).
Raspberry (<i>Rubus idæus</i> Linn.).	Willow, Napoleon (<i>Salix babylonica</i> Linn.).
Rose (<i>Rosa rugosa</i> Thunb.).	Willow, osier (<i>Salix viminalis</i> Linn.).
Sassafras (<i>Sassafras sassafras</i> Karst.).	Willow, (<i>Salix ægyptiaca</i> Forsk.).
Silverberry (<i>Elæagnus argentea</i> Pursh.).	Willow, (<i>Salix pedicellata</i> Desf.).
<i>Spiræa</i> spp.	Walnut, English (<i>Juglans regia</i> Linn.).
Spruce (<i>Abies firma</i> Sieb. & Zucc.).	Walnut (<i>Juglans</i> sp.).
Sycamore (<i>Platanus</i> sp.).	Yucca (<i>Yucca</i> sp.).
Tallow tree (<i>Sapium sebiferum</i> Roxb.).	

PARASITIC AND PREDACEOUS ENEMIES.

Minute parasitic Hymenoptera are often efficient enemies of this scale, and in some localities they apparently hold the insect in check. If these little friends are present, small round holes can be seen on the dorsal part of the scale showing where the adult escaped. Those more commonly found are *Aphelinus mytilaspidis* Le B., *A. abnormis* How., *A. fuscipennis* How., *A. diaspidis* How., *Aspidiotiphagus citrinus* How., *Anaphes gracilis* How., and *Cheiloneurus diaspidinarum* How.

The larvæ of coccinellids, or ladybeetles, are sometimes found feeding on these insects, and certain species of mites assist in their destruction. Birds are also credited with doing service, the most efficient being the titmice and tree creepers.

THE SCURFY SCALE.

(*Chionaspis furfura* Fitch.)

The scurfy scale, while infesting a considerable number of plants, is a less general feeder than is the preceding species. It occurs principally upon rosaceous plants, such as the apple, peach, pear, plum, cherry, etc., and also on currant and gooseberry among cultivated plants, but seldom becomes so abundant as to cause particular injury or to require specific treatment. The insect may be recognized from the accompanying illustration (fig. 2), much enlarged. The scale of the female is dirty gray in color, irregularly pear-shaped, as shown in the picture. The male scales are much smaller, elongate, snowy white, with three distinct keels extending longitudinally along the back. Unlike the former species, the scurfy scale is a native North American insect, and appears to be less adaptable to

the various conditions throughout the country, and has thus a more restricted distribution.

LIFE HISTORY AND HABITS.

The scurfy scale, like the oyster-shell scale, winters in the egg condition under the scales. The number which may be deposited



FIG. 2.—The scurfy scale (*Chionaspis furfura*). Male at right, female at left. All enlarged. (Original.)

by a given female, as may be easily verified by examination, varies considerably. The following records show the number of eggs from each of twenty individuals:

Number of eggs deposited by the scurfy scale. (Material collected on apple sprouts from base of apple stump March 31, 1905, at Arlington Farm, Virginia.)

Scale No.	Eggs.						
1	61	6	74	11	54	16	82
2	18	7	78	12	61	17	23
3	78	8	70	13	48	18	83
4	98	9	19	14	68	19	21
5	53	10	41	15	78	20	33

Average number of eggs per scale, 57.5.

The following records from literature and from the Bureau of Entomology will indicate the times of hatching of the eggs of this insect in the spring for several localities:

Ontario: Eggs hatch about June 1 (Jarvis).

Connecticut: Eggs hatch usually between May 20 and June 1 (Britton).

New York: Eggs hatch at about same time as those of oyster-shell scale.

Ohio: Eggs hatch, and young are crawling, during latter part of May or in early June (Houser).

Illinois: Eggs hatch from June 5 to 12 (Walsh).

Missouri: Eggs hatch soon after the formation of the young apples, the date depending upon locality and upon forwardness of the spring (Taylor).

District of Columbia: Eggs hatch from May 15 to June 1 (Howard).

Delaware: Eggs hatch about same time as those of oyster-shell scale, which is usually early in May (Houghton).

Tennessee: Eggs hatch in April, and there are two broods annually (Bentley).

Georgia: In 1906 eggs hatched March 11 to 22. Eggs for second brood hatched beginning about June 2.

In the more northern States there is but one brood each year, but in the South, as in Tennessee and in Georgia, there are evidently two full broods, and in the latter State there is a strong probability of a third. Thus, at Myrtle, Ga., in 1906, the eggs were hatching March 11, and hatching had probably ceased by March 22. Males of the new brood appeared May 15, and eggs had been deposited by the female May 28, the hatching beginning June 2.

DISTRIBUTION.

The following records of distribution have been compiled from various publications and from data collected by the Bureau of Entomology:

California, Colorado, Connecticut, Delaware, District of Columbia, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Utah, Virginia, Washington, West Virginia, and Wisconsin. In Canada it is recorded from New Brunswick, Nova Scotia, Ontario, and Prince Edward Island.

FOOD PLANTS.

The following list includes all plants upon which this species has been found, so far as it has been possible to determine from records in literature and from those in the Bureau of Entomology:

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Apple (<i>Pyrus malus</i> Linn.).	Elm (<i>Ulmus</i> sp.).
Apple, Chinese flowering (<i>Pyrus spectabilis</i> Ait.).	Gooseberry (<i>Ribes</i> sp.).
Apple, crab (<i>Pyrus</i> sp.).	Hawthorn (<i>Crataegus oxyacantha</i> Linn.).
Ash, European mountain (<i>Sorbus aucuparia</i> Linn.).	Hickory, big bud (<i>Hicoria alba</i> Britt.).
Ash, mountain (<i>Sorbus americana</i> Ait.).	Horse chestnut (<i>Æsculus hippocastanum</i> Linn.).
Ash, prickly (<i>Xanthoxylon americanum</i> Mill.).	Peach (<i>Prunus persica</i> Sieb. & Zucc.).
Ash, white (<i>Fraxinus americana</i> Linn.).	Pear (<i>Pyrus communis</i> Linn.), (<i>P. heterophylla</i> Dur.).
Aspen, largetooth (<i>Populus grandidentata</i> Michx.).	Plum (<i>Prunus pissardi</i> Hort.).
Buckthorn (<i>Rhamnus cathartica</i> Linn.).	Plum, common garden (<i>Prunus domestica</i> Linn.).
Cherry, choke (<i>Prunus virginiana</i> Linn.).	Quince (<i>Cydonia vulgaris</i> Pers.).
Cherry, wild black (<i>Prunus serotina</i> Ehrh.).	Quince, Japanese (<i>Cydonia japonica</i> Pers.).
Cherry, wild red (<i>Prunus pennsylvanica</i> Linn.).	Raspberry, black cap (<i>Rubus occidentalis</i> Pers.).
Chokeberry (<i>Pyrus floribunda</i> Lindl.).	Red-twigged dogwood (doubtful record).
Chokeberry, black (<i>Sorbus melanocarpa</i> C. Koch).	Shad-bush (<i>Amelanchier canadensis</i> Medic.).
Chokeberry, red (<i>Sorbus arbutifolia</i> C. Koch).	Sweet gum (<i>Liquidambar</i> sp.).
“Cherry currant.”	Sweet pepper bush (<i>Clethra alnifolia</i> Linn.).
Currant, red flowered (<i>Ribes sanguineum</i> Pursh.), England.	Walnut, black (<i>Juglans nigra</i> Linn.).
	Willow, white (<i>Salix alba</i> Linn.).

The scurfy scale is especially common on apple and pear, less usually so on cherry and peach, on which latter host in the South, in certain cases which have come under the writers' observations, it proved very destructive, greatly stunting the trees, although none had actually been killed.

PARASITIC AND PREDACEOUS ENEMIES.

This species is apparently not so subject to attack of parasitic and predaceous insects as the preceding, or else attention has not been directed to this phase of the insect's economy to an equal extent. The following predaceous species are recorded as feeding upon the scurfy scale: *Troglyphus malus* (Shimer), *Chilocorus bivulvurus* Muls., and *Hyperaspidis* sp.

Among the parasitic Hymenoptera, *Ablerus clisiocampæ* (Ashm.) has been reared from this species, as well as *Physecus varicornis* How., and a species of the genus *Prospaltella*.

METHODS OF CONTROL FOR BOTH SPECIES.

Preparatory to spraying orchard, shade, and ornamental trees and plants for scale insects, they should be carefully gone over and any dead and weakened parts pruned out. The presence of such dead and dying wood is a distinct detriment, and its removal will greatly simplify the work of spraying.

TREATMENT OF ORCHARDS.

In orchards well sprayed during the dormant period for the San Jose scale each year, the oyster-shell and scurfy scales will rarely prove troublesome. While these insects, by reason of wintering in the egg stage under the protecting female scales, are less susceptible to washes effective against the San Jose scale, yet the treatments will in most cases keep them reduced below injurious numbers.

In orchards where spraying for the San Jose scale is unnecessary and where the oyster-shell or scurfy scales are troublesome, specific treatments become necessary. There is considerable difference of opinion among entomologists as to the effectiveness of sprays applied during the dormant season to effect the destruction of the eggs, but there is greater uniformity as to the effectiveness of spraying shortly after the young have hatched and before there has been time for the formation of a thick protecting scale.

Thus Messrs. Parrott, Beach, and Serrine,^a referring to the scurfy scale, state:

During the work of the past two years opportunities have been given to note the effects of the sulphur washes upon this species. In several instances where the infestation was moderate, such treatment has usually checked the further development of the scales. When the incrustation was heavy, the results attending the application of the washes have shown some variation in the amount of reduction of the scales, but there has usually been a very appreciable destruction of the insects.

Writing of the oyster-shell scale, Mr. William Stuart says:^b

Early spring applications do not appear to be a practicable method of eradicating the oyster-shell scale. Summer treatment of infested trees, soon after the young have hatched, with dilute kerosene emulsion, whale-oil soap, or tobacco infusions affords a much more effective means of combating this pest.

Experiments were made by Mr. Stuart in the use of the cooked lime-sulphur wash in 1904, and the kerosene-limoid mixture in 1905. In 1906 tests were made of the cooked lime-sulphur sprays. All applications were made during the dormant period of the trees.

The Rev. Chas. J. S. Bethune states:^c

Owing to the large number of applicants who were desirous of obtaining information on the best methods of combating the oyster-shell bark louse, it was decided to carry on a number of experiments here, to test the efficiency of the various insecticides commonly used against scale insects.

Of all the spray mixtures tried, the well-known lime, salt, and sulphur wash gave the best results.

The lime, sulphur, and caustic soda, and the lime, sulphur, and sal soda were also tried, but without quite such good results. The lime, sulphur, and caustic soda proved to be a little superior to the lime-sulphur and sal soda, owing to its apparent power of better penetration.

^a Bul. 262, N. Y. Agr. Exp. Sta. (Geneva), 1905.

^b 19th Ann. Rep., Vermont Agr. Exp. Sta., p. 294, 1907.

^c 32d Ann. Rep. Ont. Agr. Coll. and Exp. Farm, p. 48, 1906.

Soaps.—Various soaps were also tried, and of these the whale-oil-soap emulsion gave the best results, many of the scales being killed. The whale-oil soap gave good results also, but not equal to the emulsion.

Kerosene emulsion.—Kerosene emulsion was also tried, and this proved of more value than the whale-oil-soap emulsion, but not so effective as the lime, salt, and sulphur wash.

Lime.—Quick slaked lime, $1\frac{1}{2}$ pounds to 1 gallon of water, proved very effective applied as a winter wash, and equaled the results obtained by the lime, salt, and sulphur.

Kerosene lime.—This was also tried, but did not prove superior to the kerosene emulsion, and therefore is not to be preferred to it.

Prof. T. B. Symons,^a as a result of tests of sprays upon the oyster-shell scale on shade trees in 1906, concludes:

That maple trees infested with the oyster-shell scale can be treated both in the fall and early spring with the lime-sulphur and salt wash with satisfactory results as regards controlling the pest, and without injury to the trees.

That where one application is made these tests showed the fall treatment to be preferable. It is the writer's belief, however, that when the wash is applied thoroughly in early spring equally good or even better results can be obtained.

The Duke of Bedford and Spencer U. Pickering^b report results of detailed experiments with various washes in the destruction of the eggs of this insect, and found that a 3 per cent caustic soda wash gave 100 per cent efficiency in killing the eggs. A 2.5 per cent caustic soda wash with soap also gave excellent results, but difficulty was experienced in handling the wash on account of its becoming semisolid. Results of tests of other washes are presented, as caustic soda and potash, paraffin emulsion, emulsion soda washes, emulsions with lime, lime-sulphur soda washes, etc.

Concerning the scurfy scale, Mr. J. S. Houser^c states:

That the lime-sulphur wash applied during the winter is effective, as are also contact sprays applied at hatching time.

The same author (l. c.), in speaking of the oyster-shell scale, states:

The lime-sulphur wash is undoubtedly the control method to be used against this scale, but in the author's experience, it has proven somewhat of a disappointment. From observations made upon hundreds of trees and shrubs, sprayed with a mixture made by experienced men and applied thoroughly, it is apparent that only when conditions are the most favorable are the results following its use satisfactory. A slight dampness, such as a light fog at the time of application, a somewhat weakened spraying mixture, an extra case of infestation, where several scales are piled upon one another, a temperature below 32 degrees—any of these unfavorable conditions is sufficient to give poor results.

Prof. R. A. Cooley^d presents results of extensive tests of sprays for the destruction of the oyster-shell scale: (1) As against the eggs dur-

^a Bul. 111, Md. Agr. Exp. Sta., 1906.

^b 8th Rep. Woburn Exp. Fruit Farm, p. 33, 1908.

^c Bul. 194, Ohio Agr. Exp. Sta., 1908.

^d Journ. Econ. Ent., vol. 3, p. 57, 1910.

ing dormant period of trees: (2) early during hatching period of eggs, and (3) late during hatching period of eggs. The results were not entirely consistent, and further experiments are promised. The two following points, however, are emphasized:

(A) Eggs of the oyster-shell scale are unaffected by the application of lime-sulphur solutions made previous to the opening of the buds. On trees so sprayed the young were killed very soon after hatching. The intervention of rain storms before the hatching of the eggs may more or less affect the value of the treatment.

(B) It is indicated that emulsions of linseed oil and cottonseed oil may be useful for the treatment of this insect while in the egg stage and during the hatching period.

On the whole, therefore, it would appear preferable, where the destruction of these insects alone is to be considered, to spray as the young insects are hatching in the spring. The table of dates of hatching given under the remarks on life history for each species will indicate approximately when the young insects may be expected to appear, but this time may be accurately determined by frequent examinations of the infested trees. The very small, yellow insects will be seen in numbers crawling over the limbs and branches in their efforts to find a suitable place for settling.

The data on the dates of hatching of the two species, considered in connection with blooming dates of fruit trees, indicate that for any locality the young of both species will have hatched and settled, and may be effectively treated during the period of from one to three weeks following the blooming period of the apple; and from two to four weeks after the period of blooming of the peach. It will be preferable, however, positively to determine the time of crawling of the young for the particular locality and food plant, by actual observations.

In spraying for the young insects when the trees are in foliage, the presence of the leaves will render thorough work more difficult, and especial care will be necessary to reach all limbs and branches, treating every portion of the tree from top to bottom, as only those insects actually hit are destroyed. A weaker wash must also be employed than during the dormant season, as will be indicated later under the head of formulas, or else injury to the foliage and fruit may result.

TREATMENT OF SHADE TREES.

The oyster-shell scale will often require treatment on maples, Lombardy and Carolina poplars, ash, and willow. As these trees will be rarely sprayed during the dormant period for other scale pests, it will be advisable to give the treatment just after the hatching of the young, as already explained. Effective spraying of shade trees, when these are of some size, will require painstaking work. In many cases it will be necessary for the man handling the nozzle to climb

into the trees to reach the higher limbs and branches and a long extension or bamboo rod is indispensable. The length of hose must be adapted to the height of the trees to be treated, and a coarse nozzle, such as the Bordeaux, will be preferable, as enabling the operator to throw the spray some distance to inaccessible branches. A high-pressure pump, from 150 to 200 pounds, is especially desirable, though the writers have seen good work accomplished with an ordinary barrel outfit.

Spraying during the dormant season, however, may be practiced, if the work may be more conveniently accomplished during this time, using one of the winter sprays later mentioned, as lime-sulphur wash, kerosene or crude petroleum emulsion (20 to 25 per cent strength), or some of the miscible oils.

TREATMENT OF CURRANTS, GOOSEBERRIES, ORNAMENTAL SHRUBS, AND OTHER LOW-GROWING PLANTS.

After proper pruning, shrubs and bushes infested with these two scale pests should be thoroughly sprayed, preferably as the young are hatching in the spring, using the summer-strength kerosene or crude-petroleum emulsion or whale-oil soap wash. A knapsack or bucket pump will be suitable for treating a few plants in yards, and in view of the small amount of labor involved, a supplementary application is advisable in a week or ten days to destroy any belated larvæ which escaped the first application. Where infested yard plants are growing close to the wall of a building, this may be protected during the operation of spraying by a piece of tarpaulin or other heavy cloth, or even refuse paper.

SPRAY FORMULAS.

Kerosene emulsion (stock solution, 66 per cent oil).—Kerosene emulsion is made after the following formula:

Kerosene (coal oil, lamp oil)	gallons..	2
Whale-oil or laundry soap (or 1 quart soft soap).....	pound..	$\frac{1}{2}$
Water.....	gallon..	1

The soap should first be dissolved in boiling water; then remove vessel from the fire. Immediately add the kerosene, and thoroughly agitate the mixture until a creamy solution results. The stock emulsion may be more conveniently made by pouring the mixture into the tank of a spray pump, and pumping the liquid through the nozzle back into the tank for some minutes. The stock solution, if well made, will keep for some months, and is to be diluted before using. In order to make a 10 per cent spray (the strength for trees in foliage) add to each 1 gallon of the stock solution about $5\frac{2}{3}$ gallons of water. For 20 and 25 per cent emulsions (for use on dor-

mant trees and plants) use respectively about $2\frac{1}{3}$ and $1\frac{2}{3}$ gallons of water for each 1 gallon of stock emulsion. Agitate the mixture in all cases, after adding the water. The preparation of the emulsion will be simplified by the use of a naphtha soap. No heat will be required, as the kerosene will combine readily with the naphtha soap, in water, when thoroughly agitated. Double the quantity of naphtha soap given in the above formula, however, will be required, and soft or rain water should be used in making the emulsion. In regions where the water is "hard," this should first be broken with a little caustic potash or soda, as common lye, before use for dilution, to prevent the soap from combining with the lime or magnesia present, thus liberating some of the kerosene, or rain water may be employed.

Crude petroleum emulsion.—Crude petroleum emulsion may be prepared in identically the same way as described for kerosene emulsion, substituting crude petroleum for kerosene. The grade of crude petroleum employed in the East is that known as "insecticide oil," having a specific gravity of 43° to 45° Baumé. The same dilutions for winter and summer spraying should be observed as stated for kerosene emulsion, but it should be noted that for summer treatments of trees in foliage the kerosene emulsion is preferable, as it is less likely to cause injury.

Whale-oil soap wash.—There are several brands of whale-oil soap on the market. Potash soap is preferable, and it should not contain over 30 per cent of water. For spraying dormant trees the soap is dissolved in hot water at the rate of 2 pounds to each 1 gallon, and spraying should be done before the wash cools, otherwise it is forced through the nozzle with difficulty. For spraying trees in foliage use the soap at the rate of 1 pound to 3 or 4 gallons of water, or even weaker.

Lime-sulphur wash.—Lime-sulphur has become the main reliance in spraying orchards infested with the San Jose scale, and is effective in controlling numerous other insects and is valuable for certain fungous troubles. The following formula is used only on dormant trees:

Stone lime.....	pounds..	20
Sulphur (flour or flowers).....	do.....	15
Water to make.....	gallons..	50

Heat in a cooking barrel or vessel about one-third of the total quantity of water required. When the water is hot add all the lime and at once add all the sulphur, which previously should have been made into a thick paste with water. After the lime has slaked, about another third of the water should be added, preferably hot, and the cooking should be continued for an hour, when the final dilution may be made, using either hot or cold water, as is most con-

venient. The boiling due to the slaking of the lime thoroughly mixes the ingredients at the start, but subsequent stirring is necessary if the wash is cooked by direct heat in kettles. If cooked by steam no stirring will be necessary. After the wash has been prepared it must be well strained as it is being run into the spray pump or tank. The wash may be cooked in large kettles or preferably by steam in barrels or tanks.

Miscible oils.—Under the head of miscible oils are designated several commercial insecticides coming into considerable use as sprays for scale insects during the dormant period of the trees, and their use will often be advantageous, especially where but a few trees are to be treated. Miscible oils should be used on dormant trees at the strength recommended by the manufacturers.

Commercial lime-sulphur washes.—There are on the market several brands of concentrated lime-sulphur solutions, designed to replace the homemade lime-sulphur wash, mentioned above. These washes in general have proved to be satisfactory for the control of the San Jose scale, and will doubtless be about as effective against the oyster-shell and scurfy scales as the homemade wash, the preparation of which may thus be avoided if desired. These may be used on dormant trees, or, much more dilute, on trees in foliage.

Approved:

JAMES WILSON,
Secretary of Agriculture.

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