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Some Injurious Scale Insects.
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Some Injurious Scale Insects.

BY WILMON NEWELL.

Owing to the prevalence of a number of scale insects in various parts of the state, and as the majority of inquiries regarding insect pests which now reach the Experiment Station are concerning members of this group, a brief bulletin on them has been deemed advisable. Scale insects, or bark-lice as they are commonly called, are well known to all fruit growers. Papers and works which enable one familiar with entomological terms to distinguish the different species are readily obtainable. However, an article which will describe in as simple and ordinary terms as possible the more economically important species of our state will, it is hoped, be a material aid to horticulturists and others interested in the cultivation of fruits and ornamental trees and shrubs.

An extended examination of orchards throughout the state the past summer by persons from the Experiment Station showed the presence of some scale insect in almost every important orchard.

The method of treating the various species and the order of their arrangement is not strictly in accordance with their scientific classification. The table or key for determining species is arranged for convenient reference, and under each species only slight attention is paid to those characters which determine with absolute certainty the species. Such characters are of interest only to entomologists. The "divisions" and "groups" made use of are entirely arbitrary, having no particular reference to natural relationships. For example, the "Mealy Bug Group" is made to include the mealy bugs alone. The Sub-family Coccinae, to which the mealy bugs belong, includes also the genus Kermes, gall like insects with hard body coverings. These insects are of very rare occurrence in Iowa and hence are not included in the table, as they would tend to confuse those not actually familiar with the insects.
The drawings we believe can be relied upon in all cases to
give the true microscopical characters. Except where other­
wise expressly stated they have been made with much care
from series of specimens, by Miss Charlotte M. King, under
supervision of the writer.

Thanks are due Prof. T. D. A. Cockerell of the New Mex­
ico Experiment Station for the positive identification of the
Lecaniums and for many other favors shown.

The family of scale insects, the Coccidae, comprises some
of the most destructive pests known. All are sucking insects
and parasitic upon vegetation. The appearance of the ordi­
nary scale insects is familiar to almost everyone. The family
naturally divides itself into definite divisions, although insects
included in the family as a whole may differ widely from each
other. For the present purpose only three divisions need be
considered, the Armored Scales, the Naked Scales or Lecan­
iums, and the Mealy Bugs.

By far the greater number of species are included within
the first named division. These insects are active in the larval
stage but early in life become fixed, insert their tubular mouth
parts into the plant tissue, and secrete by means of dorsal
glands a waxy covering which with the shed larval skins com­
poses the scale. These scales serve as an effective protection
for both males and females. The males when maturity is
reached leave their scales in the form of winged insects. The
females remain for life beneath their scales and in the case of
most species deposit their eggs beneath the same scales they
occupy. The native forms of this latitude all pass the winter
in the egg stage. The San Jose Scale alone hibernates, the
female remaining dormant through the winter and depositing
eggs in the spring.

The naked scale insects, of which all species except one oc­
curring in our state belong to the genus Lecanium, are of
slight importance except in greenhouses. The insects of this
genus have no scale covering them, are usually of an oval or
hemispherical shape, of a dark color, and capable of very lit­
tle motion in the adult stage. A number of species occur
upon the native deciduous trees but are seldom noticed because kept in check by parasites. One insect of this subfamily which does not belong to the genus Lecanium is the Maple Pulvinaria, which secretes a downy sac to contain the eggs. This species is described on a subsequent page.

The mealy bugs are found only in greenhouses and can move with considerable freedom. The body is covered with a white waxy covering which gives the insect the appearance of having been dusted over with flour.

KEY TO COMMON SPECIES.

Keys to common species follow. These are intended for use without a compound microscope, but a small magnifying glass is very helpful and in some cases necessary. These keys are not scientifically accurate but rather are based upon probabilities. That is, an insect traced to a place in any one of the keys in accordance with its characters and the plant upon which it occurs will in all probability be the insect there noted. However, positive determination cannot be made in any case without a high power microscope. The species in the genus Aspidiotus, which includes all those species in group 3 of the key, cannot be distinguished by an unskilled person and it is useless to make the attempt. The separation of these species is made entirely upon the form and size of the appendages on the last segment of the female. In the description of each species a brief note is made regarding the characters of this segment for the benefit of those having a good microscope available.

Where scale insects are traced to Group 3 they should be sent to the Experiment Station for positive determination. The entomological force will be glad at any time to answer inquiries and determine all specimens sent in. In Group 3 is included the San Jose Scale, which closely resembles several native scales not nearly so destructive, hence specimens traced to this group should be regarded with suspicion.

The method of using the key is simple. The method can best be shown by an example. Suppose the specimen to be determined is a white scale upon apple, having a dingy or
scurfy appearance if taken in the fall, winter or spring, and
is about 1-7 of an inch in diameter. If, when the edge of the
scale is lifted up, a small purple oblong object is detected,
the adult female insect, this places it at once with the Armored
Scales. Turn then to the table headed “The Armored
Scales.” The white scale and the fact that it exceeds 1-10
of an inch in diameter places it in Group 1. Refer now to
the brief paragraphs preceding the different species under
Group 1. The insect at hand occurs on apple, which with its
dingy appearance places it with the description of the Scurfy
Scale. Suppose now that the insect to be identified is one of
the Armored Scales, but only about 1-20 of an inch in diame­
ter, is dark colored with a central orange colored spot, and
may be upon apple, cherry, or other deciduous tree or shrub.
It will fail to correspond with the characters given for Group
1. Neither will it agree with the characters of Group 2, for
it is round, not long, and must therefore fall in Group 3.

Unless it has been taken upon maple away from fruit trees
it is useless to try to trace it further by means of the host
plant or characters of the scale, for it may be the San Jose or
any one of a number of related scales. The determination of
the species in this case can only be made by microscopic ex­
amination.

Insects covered with a definite scale or shield which
 can be raised with a pin or knife point, showing the
minute insect underneath...... THE ARMORED SCALES.

Insects without a scale covering, the insect itself be­
ing oval or hemispherical, smooth, and of a dark brown
or black color; one species occurring on maple, has at
the posterior end of the body a large cottony mass
which contains the eggs..................
.................... THE LECANIUMS AND PULVINARIA.

Insects showing plainly the divisions of the body into
segments, entire body white, covered with a downy
substance. Insects move quite readily. Occur al­
most exclusively in greenhouses..... THE MEALY BUGS.

THE ARMORED SCALES.

GROUP 1. Scale white, irregular in outline or longer than
wide. About 1-10 of an inch or more in diameter. Scat-
tered among these large female scales are often seen minute oblong scales, male scales, about 1-30 of an inch in length and having three longitudinal ridges.

Scale dingy white, dirty looking and with the edges often frayed, occurring on apple, pear, hawthorn, quince, cherry, currant, or plum...SCURFY SCALE.

Scale similar in appearance to above but occurring on elm..................AMERICAN ELM SCALE.

Scale white, about same size as above and with margin well defined, occurring on cottonwood...............COTTONWOOD CHIONASPIS.

Scale similar to that of the Cottonwood Chionaspis but occurring on willow.......................EITHER WILLOW OR COTTONWOOD CHIONASPIS.

Occurring on pine leaves, scale white and elongated to fit groove in the pine leaf........PINE LEAF SCALE.

Scale nearly round, but large and white, occurring on rose, blackberry or raspberry...ROSE LEAF SCALE.

GROUP 2. Scale brown or dark, much longer than wide, not scurfy in appearance, curved, tapering evenly to one end, looking like a much elongated miniature oyster shell................OYSTER SHELL BARK LOUSE.

GROUP 3. Scale small, not over 1½ of an inch in diameter and round with a minute dot or nipple in the center or near it, usually dark colored.

Occurring on maple, situated away from fruit trees, nearly color of bark and difficult to detect in most cases, scale rather flat.........PUTNAM'S SCALE.

Occurring on cherry, plum or apple, more convex than Putnam's Scale and with the nipple distinct and of an orange color...............CHERRY SCALE.

Scales gray and closely packed together giving the twig appearance of being covered with fine dandruff. Scales small and not easily separated without a magnifying glass. May occur on any deciduous tree........SAN JOSE SCALE.

Occurring on white oak or ironwood, scale minute, not over 1-20 inch in diameter, dark...OSBORN'S SCALE.
Living in greenhouses on *Ficus* and other plants, very dark brown scale with prominent nipple .................. FLORIDA RED SCALE.

Very convex and smooth, almost transparent, showing color of living insect through the scale, appearing yellowish, in greenhouses............GREEDY SCALE.

Scale white, nearly round or slightly oblong, nipple not prominent, on oleander, Cycas, and other pot greenhouse and plants...................BOUChÉ'S SCALE.

THE SCURFY SCALE.

(*Chionaspis furfurua* Fitch.)

This scale is of very common occurrence on apple trees, and as will be noted in the table, occurs on a number of other hosts.

The scale when first formed during the summer, has a definite outline and is almost pure white. During the autumn and winter it becomes scurfy and minutely spotted in appearance and older ones show the edges considerably frayed. The enlarged scale is shown in the figure. The direction of the curvature may be either right or left in this as in other species of the genus. The amount of curvature also varies considerably. The male scale is oblong and has three distinct ridges running in a longitudinal direction. The female scale is about 1-9 of an inch (2½ m. m. to 3 m. m.) in diameter; the male scale is about 1-30 of an inch long by 1-80 of an inch wide (5-6 m. m. x 5-16 m. m.)

The eggs are of a purple color and are deposited in the latter part of summer. They are deposited beneath the female scale and vary from fifteen to twenty to as high as sixty-five or seventy. The females die at the approach of winter but the eggs remain beneath the scale and hatch the latter part of May or first of June following. The larvae are minute lice-like insects and crawl readily about on the bark and leaves of the host plant. At an early period they become fixed and secrete the scales which cover them. The shape and form of the adult female is shown, much enlarged, in the left hand figure of the cut and is the form which is characteristic
of the adult females of all insects belonging to the genus *Chionaspis*.

The characters of the last segment of the female are shown in the figure. Principal among these characters should be noting the flaring appearance of the median lobes, the elongated pores upon the margin, and the number of ventral grouped glands which vary within certain limits. The median, or anterior group, contains from 8 to 13 of these glands; the cephalolateral or anterolateral, 19 to 30; and the caudolateral or posterolateral group 18 to 31.

This species is pretty well distributed over the state and is probably more often encountered than any other. An examination of orchards in every county of the western tier, from Sioux City to Hamburg, was made during the summer of 1898, and in none of these orchards which were on the loess soil of these counties, was this insect found. This is a remarkable contrast to the rest of the state, where almost every orchard
of any considerable age is found to be infested. However, in these apparently exempt counties the scurfy scale seemed to be replaced by the oyster shell bark louse. This would seem to indicate that whatever were the conditions that were unfavorable to the existence of the scurfy scale they were insufficient to reduce the numbers of the oyster shell bark louse. In fact, in some cases it seemed that the absence of the former made conditions even more favorable for the spread and thriftiness of the latter.

When this species is sufficiently numerous to cause serious damage or where it is desired to rid an orchard of them, the most certain remedy is to spray thoroughly the infested trees with kerosene emulsion, diluted at the rate of 10 to 1, or with pure kerosene mechanically mixed with water as described below, at the time of egg hatching. As the time may vary somewhat with the season, it is best to watch closely for the young lice before spraying.

In most cases two sprayings, the first one two or three days after the young lice appear, and the other about a week later, will be sufficient.

At the end of this bulletin will be found a brief note of the principal insecticides used, with directions for their preparation.

**THE AMERICAN ELM SCALE.**

*(Chionaspis americana Johns.)*

This scale occurs quite abundantly in the central part of the state upon both the slippery elm, *Ulmus fulva*, and the white elm, *U. americana*, and has been reported as doing damage at a number of other points. Apparently this insect is confined to the elms. and so far as known no other scale of this genus is known to infest the elms,\(^*\) hence there should be no difficulty in recognizing it wherever it occurs.

The scales appear not only on the small limbs but even upon the small twigs and bark of the trunk. The female scale

\(^*\)With the exception of *C. furfur us* (Fitch) var. *ulmi* Ckll. which occurs on elms in Texas, and *C. furfur us* (Fitch) var. *fulvus* king, which occurs on buckthorn at Lawrence, Mass.
does not show as much of a scurfy and dirty appearance as does that of the scurfy scale and the outline is more definite. As will be noticed from the figure there is also a slight difference in the male scales but owing to their small size this is a feature of little use in classification. There is no perceptible difference in the size of the female scale as compared with the scurfy scale, the former being about 1-10 of an inch in diameter (2 1/2 to 3 m. m.) The male scale is about 1-32 of an inch in length by 1-80 of an inch wide (.7 m. m. x .3 m. m.).

The eggs are purplish in color and massed beneath the adult female scale as in the preceding form. Prof. W. G. Johnson who originally described this insect gives the number of eggs as averaging about one hundred and five to each scale. Observation of Iowa specimens places the number anywhere from forty to ninety, very rarely exceeding the latter number.
The lobes of the female anal segment are particularly characteristic. The first and second lobes are distinctly notched on their outer margins, and the median lobes especially are very erect. The plates, of which there are two between the second and third lobes and one between the third lobe and penultimate segment are characteristic and constant in form and position. Prof. Johnson gives the number of ventral glands as follows: anterior, 20 to 27; anterolaterals, 18 to 28; and posterolaterals, 20 to 25. The glands of Iowa specimens agree with these numbers though rarely reaching the limits given.

This species has not been under examination long enough at the Station to determine exactly its life history, but as Johnson reports it as double brooded in Illinois, the eggs for the first brood hatching about May 1st and for the second about July 1st, it is likely that the time for Iowa will be found to vary but little. Close observation will determine the time of hatching, and applications of kerosene emulsion as directed for the scurfy scale, can be made. If a single treatment does not entirely rid the trees of the pest, a second treatment at the appearance of the second brood of young will doubtless be successful.

THE COTTONWOOD CHIONASPIS.
(Chionaspis ortholobis. Comst.)

Up to the present this is the only American species of this genus found parasitic on cottonwood. Fortunately it does not occur in large numbers.

The female scale is of about the same size as that of the elm scale but is in general whiter and more convex with a very definite outline. The eggs are dark purple and generally number from forty to seventy, but sometimes exceed the latter number.

The median lobes are parallel and close together but separate at a definite angle towards their apex. The second lobes are deeply and the third lobes moderately incised. The median group of glands contains 10 to 16; the cephalolaterals, 18 to 31 and the caudolaterals, 16 to 20.
The specimens studied differ from the original description in having five plates upon the penultimate, and three upon the antepenultimate segment, instead of four and one respectively as figured by Prof. Comstock.

Studies thus far made show this species to occur also on the willow and in fact the species was originally described from willow specimens. The closely related species, the willow Chionaspis, *C. salicis*, has not been found upon cottonwood, hence the white scale upon this tree can be classed as *ortholobis* without much question.

Should this insect be abundant enough to cause much damage, the remedies recommended for the scurfy scale and elm scale can be used. Owing to the large size of the trees it would be more economical to cut out and burn them than to spray, except where such trees are especially desirable as ornamentals.

**THE WILLOW CHIONASPIS.**

*(Chionaspis salicis. Linn.)*

This scale has been taken only upon willow in Iowa, though the ash is given as one of its host plants. Its resemblance to the cottonwood Chionaspis is so marked that no difference in the external appearance of the scale is detectable. Even in microscopic characters considerable care must be used in examination to observe the principal features.

In contrast to the parallel median lobes of *ortholobis*, the median lobes of *salicis* separate rapidly and uniformly from
their bases. Between the first and second lobes, and between the second and third lobes, are elongations of the body bearing pores. These are very marked in the case of *salicis*. The penultimate segment bears from six to nine plates, the antepenultimate about five and the preantepenultimate three to five, usually four. The number of grouped glands is not given in Prof. Comstock's description but examination of the specimens at hand shows the glands to be as follows: median, 16 to 22; cephalolateral, 25 to 30; caudolateral, 25 to 32, 30 being about the average number for the latter group.

The eggs are purplish in color and exceed in number those of the cottonwood scale. Each scale usually has under it from one hundred and ten to one hundred and thirty.

Fortunately this species is kept well in check by parasites. Where it threatens to become a serious pest, the total destruction of infested trees would, without doubt, be the most economical way of dealing with it, though kerosene emulsion or whale oil soap could be used.
THE PINE LEAF SCALE.
(Chionaspis pinifolii Fitch.)

This insect has been taken at several points in the eastern part of the state and at Des Moines by Miss Charlotte King. The scales are easy of detection as their white color forms a marked contrast with the dark green of the pine leaves. They are generally numerous and situated close together as shown in the figure. The scales invariably occur on the grooved or inner side of the leaf and are elongated so that they fit more readily in the groove or on its margin. Correspondingly the body of the insect is more elongated than that of the other species of Chionaspis.

The median lobes of the female diverge rapidly and are connected at their base by a chitinous band. A distinct pore opens at the base of the mesal lobule of second lobe, and a similar one outside of the third plate. Specimens studied differ from Prof. Comstock's description in having the fourth plate at about one-fourth distance from third lobe to penultimate segment instead of one-half the same distance.

This pest is not widely distributed in Iowa, and from what data is available it appears that a very severe attack is
required to noticeably reduce the vitality of trees in this latitude. On the other hand, the location of the scales in the groove of the leaves would markedly protect them from spraying mixtures that might be applied. Destruction of trees in cases of severe infection might be advised.

**THE ROSE SCALE***

*(*Diaspis rosae, Sand.*)

The rose scale is of occasional occurrence on roses, and especially upon the fine ornamental roses. It is also known to thrive well on raspberry.

The scale presents a very characteristic appearance as will be seen in the upper part of the figure, the large white female scale contrasting well with the dark or reddish color of the host plant.

The female scale is well defined, nearly round, and from 1/11 to 1/6 of an inch (2 to 3 m. m.) in diameter. The scale of the male is very much like that of the preceding species, tricarinated, and 1-20 of an inch (1.25 m. m.) in length. The scales do not show as marked a tendency to cluster as do the species of *Chionaspis*, but are more uniformly distributed over the host.

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*In the absence of good Iowa specimens for illustrating this species, the figures have been made from specimens received through the kindness of Profs. Webster and Mally of the Ohio Experiment Station.*
The margin of the female anal segment presents an unusually even outline and the median lobes are peculiar in their divergence, with inner serrate edges. The ventral grouped glands are: anterior, 18 to 22; cephalolaterals, about 24 to 30.

The rate of increase of this insect is comparatively rapid and under favorable conditions only a short time would be required to ruin the finer cultivated varieties of roses. Its possible attacks upon raspberry (from notes by Prof. C. W. Maily) also make it assume considerable economic importance.

 Destruction of infested plants before the insect has gained much of a foothold, is to be strongly commended.

THE OYSTER SHELL BARK LOUSE.

(Mytilaspis pomorum, Bouche)

This, as well as the scurfy scale, is one of the best known insects in the United States. The popular name of "oyster shell bark louse" has been applied by persons not familiar with the different species, to every white scale appearing up-
on apple trees. The writer has often heard fruit growers refer to the scurfy scale as this species, and yet when shown a genuine sample of the oyster shell, not even recognize it as a scale insect. This indiscriminate use of the name is hardly excusable.

The oyster shell bark louse, as stated in the key, is dark brown or dark in color, oblong, slightly curved and entirely lacks the scurfy appearance of the scales in the genus *Chionaspis*, hence there is no need of confusing them. Also, the eggs of the scurfy scale are a bright purple, while those of the oyster shell are nearly white or light yellow.

This insect is of almost world wide distribution and according to Dr. Howard, is probably a native of Europe. Its spread across the United States has been comparatively rapid, the first record of its occurrence in Iowa being by Riley in 1868.

Perhaps the most common host of this insect is the apple, where it is commonly found on the trunks and branches. A number of other hosts have been recorded, among them pear, plum, cherry, wild grape, etc. The worst case of infestation that has come to our notice is upon lilac bushes. Numbers of these bushes on the college campus at Ames are so thickly covered with the scales as almost to make the bark invisible.

There is but one brood a year, the eggs, according to Dr. Howard, hatching between the middle of May and the first of June. In accordance with this the most, practical remedy is the spraying of the trees with kerosene emulsion about the third week in May, followed by another spraying a week or so later. With this insect, as with the scurfy scales, the time of hatching can be accurately determined by closely watching for the appearance of the young lice.

**PUTNAM'S SCALE.**

*(Aspidiotus ancylius, Putnam.)*

Putnam's scale is a common native of Iowa. It was first described by J. Duncan Putnam in the Proc. of the Davenport Acad. of Nat. Sciences for 1877, from specimens on maple at Davenport. Though occurring most frequently upon maple, it has a number of other host plants, chief among them being
the snowball, apple, plum and willow. Like many insects when found in their native localities, this species is held in check by natural means, principal of which are hymenopterous (wasp or bee-like) parasites.

The scales are small, almost black, and are very hard to see unless occurring in extraordinarily large numbers.

An examination of the anal segment shows the median lobes notched on both the outer and inner margins, though the notch in the latter may at times be very small or wanting in one of the lobes. The second lobes are practically rudimentary, and the third lobes entirely so. The chitinous processes of the first incision are of nearly equal size, the inner one slightly the largest. This closely resembles _A. forbesi_ but the almost straight club-shaped processes of _ancylus_ are readily distinguished from the sharp-pointed, curved, club-shaped processes of _forbesi_. A comparison of the figures will readily show this distinction. The ventral grouped glands are as follows: median, 0 to 6; cephalolateral, 6 to 14; and caudolateral, 5 to 8.

There is but one brood a year. According to Duncan the eggs are laid in late spring or early summer, about thirty or forty being deposited by each female. The growth of the young goes on slowly until the approach of winter, when both sexes enter the pupa stage and thus remain throughout the winter.
Slight infestation of maple trees need not be considered alarming, as the maple appears to be the most natural host of these insects and they are here kept well in check by parasites. Where fruit trees become infested, spraying with kerosene emulsion or whale oil soap is effective, as described in the note on insecticides.

**THE CHERRY SCALE.**

(*Aspidiotus forbesi*, Johns.)

This is a native scale of the central part of the country, having been originally described by Prof. Johnson from Illinois specimens.

It has at times been very destructive in parts of Illinois and it seems very possible that it might become a serious pest in parts of Iowa. However, a recent newspaper report saying that this pest is more injurious than the San Jose scale and that it is at present doing much damage in southern Iowa, is, so far as we can learn, without foundation. It has been taken a number of times at Ames but has never occurred in sufficient numbers to do noticeable damage. Besides occurring on cherry, it is found upon both plum and apple.

In the characters of the female anal segment, *forbesi* bears a close relation to both *ancylus* and *perniciosus*. As compared with the former, *forbesi* has the second lobe with its inner half slightly developed, and the inner chitinous process of the first incision is elongated and narrow at its base, and has its margin towards mesal lobe concave instead of convex, giving a peculiar double-curved or club-shaped appearance. The ventral grouped glands are: median, 1 to 3; cephalolateral, 3 to 7; caudolateral. 3 to 5.

Slight attacks, like those of Putnam's scale, may be remedied by the use of kerosene emulsion or the whale oil soap solution. In severe cases destruction of the trees is advisable, though thorough treatment with hydrogen cyanide gas is possible. It is doubtful if the expense of the latter method would be less than the actual value of the trees.
The San Jose scale is not known to occur in Iowa. This may be ascribed largely to the care and enterprise of the great majority of nurserymen in the state, and to the enforcement of the San Jose Scale law.

Though it has not been found up to the present writing, its presence in several surrounding states makes a brief note concerning it advisable. Many specimens supposed to be San Jose Scale have been sent to the Station, but in all cases they have proved to be some of the native scales, usually the scurfy scale, oyster shell bark louse, or oleander scale (*A. hederae*). So far as careful examination can demonstrate, all the Iowa nurseries are free from this dreaded pest. Owing to its rapid rate of increase, and the fact that it attacks practically all deciduous trees and shrubs, this scale is much more dangerous than the native scales.

On account of this rapid increase, an infested twig or branch is usually so densely covered with the scales as to give
a fine gray scurfy, or dandruff-like appearance. Native scales rarely occur so thickly massed.

An examination of the anal segment shows the median lobes notched on outer side; the second lobes rather pointed at inner angle; and the inner chitinous process of first incision straight, or slightly rounding, never curved as in forbesi. The ventral glands are never present as there is no egg deposition, the young being brought forth alive.

These glands are found only in egg-laying species and their presence in a specimen at once shows it is not perniciosus. On the other hand, their absence does not prove the specimen to be the San Jose Scale as immature females of other species also lack these glands.

Howard (Yearbook U. S. Dept. Agr. for 1894, p. 267 et. seq.) gives the following synopsis regarding life history:

"The females begin giving birth to living young about the middle of May and continue this for six weeks. The young become fixed within forty-eight hours of birth and require but thirty days for growth to maturity. This causes a very complicated state of affairs, insects in all stages of growth
being found at any time in the summer or autumn. It also adds the necessity of constantly repeated treatment if an attempt to destroy them with any spraying mixture is made.

Reported experiments from one or two experiment stations seem to indicate that the scale may be kept in check by continued and careful use of kerosene emulsion. One of the most certain methods of combating this pest and of disinfecting suspected nursery stock is that of treatment with hydrogen cyanide. This is discussed in the final note.

**OSBORN'S SCALE.**

*(Aspidiotus osborni, Newell and Clkl.)*

A small dark colored scale occurring on white oak and ironwood. The scale is minute, about 1-25 to 1-20 of an inch (1 m. m. to 1.25 m. m.) in diameter and of nearly or exactly the color of the bark of the host plant. The male scale is longer and narrower and of same color as the female scale.

The median lobes of the anal segment are long, round, and notched on outer side. The margin of the second lobe is straight or slightly doubly concave. The chitinous processes at the inner bases of the median lobes are rather large, while those of the second incision are about equal. Ventral grouped glands: median, usually none, sometimes 1 or 2; cephalolaterals, 5 to 7; caudolaterals, 3 to 5.
Collections made by Profs. Cockerell, Scott, and Hunter indicate that this species is widely distributed, it being known to occur in Georgia and Kansas as well as in Iowa.

**THE FLORIDA RED SCALE.**

(*Aspidiotus ficus*, Ashm.)

Like the two following species, this is confined in this latitude to greenhouses. The scale is circular and about 1-25 of an inch (2 m. m.) in diameter and very dark brown. Its characteristic appearance is shown at the right in the figure. As will there be noted, scales of all ages are to be found at the same time. Owing to the steady temperature of the greenhouses the insect breeds constantly and there is no distinction of generations. The brown scale readily separates this species from *nerii* with a white scale, and from *rapax* with its transparent scale.

Where small potted plants are attacked, the entire plant can be immersed in a weak solution (1 to 14) of kerosene emulsion or whale oil soap, either of which will effectually rid them of the pest. When this is done it is advisable to thoroughly spray or wash the plant soon afterwards with pure water, to remove the emulsion. When many plants in a greenhouse...
are infested with this, or other scales, the fumigation treatment with hydrogen cyanide is very effectual, killing all insects, regardless of species. The damage to life of this gas must be constantly borne in mind and great care taken in its use.

**THE GREEDY SCALE.**

*Aspidiotus rapax, Comst.*

In many of the southern states and in California this is a pest of considerable importance, infesting many common and important fruit trees. In this latitude there is no danger of its infesting native trees and its ravages will be entirely confined to greenhouses, where, of course, it can be kept under control. Thus far we have not detected it on any other plant than *Osmanthus fragrans*, but it will without doubt thrive on other hot house plants.

The scale is about the same size as that of the Florida red scale, but is very convex, and transparant enough to show the color of the insect beneath. Being yellow or rosy yellow, while the female is alive it appears not unlike a rough drop of resin.

It can be given treatment as recommended for the red scale.

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**"Rapax"** is here retained in place of "*camelliae* Sign" in accordance with Prof. Cockerell's "First Revision to Check List of Coccidae," January, 1899.
BOUCHE'S SCALE.
(Aspidiotus hederae Vall. neri Bouche.)

One of the most studied and best known scales, this insect is of practically world wide distribution and was first described from Europe.

The list of greenhouse and house plants attacked is large. Among them are Acacias, oleander, Yucca Cycas, etc. The scale is always white and on the majority of hosts is round. However, scale occurring on the under grooved side of the leaves of Cycas revoluta, are occasionally so elongated as to appear almost like a Chionaspis.

The figure shows the characteristic appearance of the anal segment. The ventral grouped glands are: median, o; cephalolateral, 8 to 9; caudolateral, 6 to 7.

The same remedies may be recommended for this as for the Florida red scale.

THE LECANIUMS AND PULVINARIA.
Hemispherical in shape, on various greenhouse plants.

HEMISPHERICAL SCALE.
On oleander, adult insect with one longitudinal and transverse ridges on dorsal side. **OLEANDER SCALE.**

On orange, often also on other plants; oval, yellow turning to brown on disk, flattish. **SOFT SCALE.**

On *Howea* or *Trachycarpus* in greenhouses, oval or rather convex; insect slightly lined, checked or tesselate in appearance. **TESSELATE SCALE.**

On maples, at posterior portion of scale a large cottony mass containing eggs. **MAPLE PULVINARIA.**

**THE LECANIUMS.**

This group contains a great number of species, and in the case of many of them, in the adult stage, the resemblance to kindred species is so marked that they cannot be easily distinguished. In classifying these forms accurately, examination and study of the characters of the larvae are necessary.

Practically all forms that are troublesome in our state occur in greenhouses and on indoor plants. The more common ones are readily distinguished by the general form of the adult. Included in the above key are all greenhouse Lecaniums that have come to our notice. The figure gives an idea of their general appearance.

The hemispherical scale (*Lecanium coffeae* Walk.—*hemisphæricum* Targ.) is one of the most common. As the name indicates the adult is almost a perfect hemisphere, smooth,
about \( \frac{3}{8} \) of an inch (3 m. m.) in diameter at the base and about 1-\( \frac{1}{12} \) of an inch (2 m. m.) in height. It occurs on a number of plants.

The oleander scale (Leccanium oleae Bern.) also known as the black scale of California, is of common occurrence. This, or Aspidiotus hederae, or both, is common on oleanders everywhere. It is slightly larger than the preceding species (4 to 5 m. m.) and is nearly black. The two transverse ridges and the one longitudinal connecting ridge are sufficient to distinguish them.

The soft scale or orange scale (L. hesperidum Linn.) is elongate oval in shape, about the size of the preceding species, the color grading from a yellowish margin to a darker color upon the apex of the scale.

The tessellate scale (L. tesslлатum Sign., var. perforatum Newst.) has been taken frequently in the greenhouse at Ames, especially on Howea (Kentia) and Trachycarpus. It is elongate oval, about 1-5 of an inch (5 m. m.) long by \( \frac{3}{8} \) of an inch (3 m. m.) wide. The color is brownish, sometimes almost black, usually more or less blotched with darker color.

The treatment to be given these scales will be the same for all species, hence actual determination is unnecessary when dealing with them from an economic standpoint. Spraying of large trees, or dipping of smaller plants, with subsequent water washing, is recommended. For this purpose, kerosene emulsion, soap solution, or tobacco water may be used. As spoken of in previous paragraphs with reference to other scale insects, fumigation with hydrogen cyanide is the most certain remedy.

**THE MAPLE PULVINARIA.**

*(Pulvinaria innumerabilis Rath.)*

This is the only parasite of maple trees that so far has caused appreciable damage in Iowa. J. Duncan Putnam (Proc. Dav. Acad. Sciences, Vol. II, p. 293.) in 1898 pub-
lished a monograph of this species, his studies having been made on specimens obtained at Davenport, Iowa.

The only case of infestation that came to our notice the past year was at Dubuque on hard maple trees belonging to Col. D. E. Lynn and standing on one of the principal streets. This attack was exceptionally severe.

The adult female is of a dark color, with a slight longitudinal median ridge, but has at the posterior part of the body, during the egg laying season, a large cottony sac exceeding in size the hard portion of the body, and white or light yellow in color.

The eggs are deposited from the latter part of May on into late in June and probably July. They hatch in about four weeks after deposition and the larvae, small lice-like creatures, develop slowly during the summer.

During the winter the females like those of other Coccidae remain dormant. During April or May, or as soon as the flow of sap has begun the egg sacs enlarge and give the females the appearance shown in the figure.

After egg deposition the female dies but the egg sac remains distended and with the dead body of the insect may remain attached to the bark for a year or more.

Treatment of trees during winter with strong kerosene emulsion is effective. The young lice are especially susceptible to the action of soap solutions and kerosene emulsions even when the latter are weak. When used upon the larvae no less than three separate sprayings from the third week in May to the second week in July would be required to practically exterminate the pest, owing to the continued egg hatching at this season.

Col. Lyon of Dubuque the past summer adopted a both novel and efficient plan for fighting this insect. The trees infested were in one of the main streets and water under very

Pulvinaria innumerabilis.
high pressure was available. Col. Lyon simply drenched the thoroughly with cold water, using the full force of the hose stream. At any one treatment most of the insects would be washed away. This treatment has the disadvantage of requiring repetition several times during the summer, and cannot in any case entirely exterminate the insect.

THE MEALY BUGS.

Adult without long threads; about 1-7 to 1-6 inch long by 1-10 inch wide. Appendages around the edge of the body of about equal length. DESTRUCTIVE MEALY BUGS.

Adult with four long filaments or thread like processes from the posterior end of the body. About 1-5 of an inch long by 1-11 inch wide. LONG-THREADED MEALY BUGS.

Of these, two species are of fairly common occurrence in greenhouses.

The destructive mealy bug, *Dactylopius destructor* Comst. is about 1-12 of an inch wide by 1-9 to 1-8 of an inch long (2 m. m. x 3.5 m. m.) The body is plump, brownish yellow on the under side, and above white with a faint indication of a median line. The insect can move about the host plant slowly. The body segments are distinct and the edge of the body bears white filaments, thirty-four in all. The eggs are retained in a cottony sac at the posterior end of the body until hatched.

The long threaded mealy bug (*D. longifilis* Comst.) is of equal or greater length than the preceding species but it is slightly narrower, making it appear much more slender. Like
the preceeding species the body is white and the segments distinct. However, the four posterior filaments of the margin are much the longest, equalling or exceeding the body in length. From this unique character the insect receives its name.

The habits of both these insects are very similar. Like other greenhouse insects the generations become confused and the insect is likely to be found in any or all stages.

Where fumigation of greenhouses is resorted to, it will be especially effective on these insects. Washing with soap solution or emulsion as recommended for the red scale and greedy scale, is also efficient.

INSECTICIDES.

One who has read any number of the preceeding notes upon the various scale insects will not have failed to notice the frequent recommendation of kerosene emulsion and soap solutions. as remedial agents. For similar insects the remedies must of necessity be similar owing to similar conditions and life histories.

Many remedies have been tried and recommended for bark lice, some of them failures, others too expensive for practical use, and a few that may be considered in most cases effective.

Among the most used insecticides for this class of insects may be named the sulphur wash; resin washes made by combinations of caustic soda and fish oil with resin; salt, lime, and sulphur washes; various soap solutions; and fumigation with hydrocyanic gas. Of these the resin, and the lime, salt, and sulphur washes are especially adapted to treatment of extensive plantings, and in a warm latitude.

Their use would hardly be practical in Iowa. As the fumigation with hydrogen cyanide has been used especially for the San Jose Scale extended description of this process is unnecessary. It will be briefly mentioned in connection with greenhouse fumigation.

This leaves, as insecticides for practical use, the soap solutions, and kerosene emulsions, all of which can be prepared equally well in large or small quantities.
The kerosene emulsion is ordinarily prepared from the following materials in the proportions stated:

- Soap (Ivory or Whale-oil) \( \frac{1}{2} \) pound.
- Water (Soft or ‘broken’) 1 gallon.
- Kerosene 2 gallons.

The soap is finely cut up and boiled in the water until thoroughly dissolved. This mixture, boiling hot, is then added to the kerosene, away from the fire. The entire mass is then churned rapidly and vigorously or forced quickly through the force pump back into the tank until a complete mixture is obtained. This may be kept and diluted for use as necessary. Whale-oil soap is much preferable in making the emulsion as it is itself a valuable insecticide and makes a more permanent emulsion.

According to Prof. Marlatt in his bulletin of 1898, (‘‘Farmers’ Bulletin No. 19, Insecticides, their Preparation and Use,’’ which can be had free upon application to the Secretary of Agriculture, Washington, D. C.), the emulsion made by the use of milk is more stable and easier to prepare. The formula given is as follows:

- Kerosene, 2 gallons.
- Milk (sour), 1 gallon.

In the case of this emulsion heating is unnecessary and when the two do not mix readily the addition of a small amount of vinegar will cause rapid emulsion. This emulsion, like the preceding one, is to be diluted for use as directed in the succeeding paragraph.

For the scale insects (Diaspinae) occurring on deciduous trees the spraying can most advantageously be done in May and June at the time of egg-hatching. This time must be determined for each species by observation. When used at this time the emulsions as above given must be diluted at the rate of one part emulsion to 10, 11, 12, 13, or 14 of water. The mixture at 1 to 14 will be found efficient for most species. Use of a greater strength than 1 to 11 while trees are in leaf or bloom may prove injurious. The same emulsion diluted at the rate of 1 to 8 or 9 can be used in late autumn or early winter to kill insects and eggs beneath the scales.
Many automatic spray pumps are now on the market, which have devices for mixing the kerosene and water in definite proportions, thus doing away with the necessity of preparing an emulsion.

Applied in the early summer as directed for kerosene emulsion, solutions of soap at the rate of one-half pound of soap to one gallon of water are quite effective. For this purpose only good soap should be used, whale-oil soap being preferable above all others.

Paris green, hellebore, Bordeaux mixture, and all insecticides intended for biting insects are practically useless when applied to scale insects except as they may be strong enough to kill by direct contact.

In states where the San Jose Scale is abundant fumigation with hydrocyanic gas is largely resorted to. The trees infested are covered with tents of canvas, made air tight by treatment with linseed oil or other solution and the gas generated beneath them by addition of potassium cyanide to sulphuric acid and water. The expense connected with this treatment makes it impracticable for use against present orchard pests of our state. The same gas is extensively used for fumigating suspected nursery stock. By this method the trees are placed in an air tight building and the gas generated as under tents.

In greenhouses, where scale insects of various kinds breed rapidly and continuously, occasional fumigation with hydrogen cyanide, with proper precautions, is profitable. The potassium cyanide used should be 98 per cent pure, and should be used at the rate of 0.075 to 0.15 of a gram for each cubic foot of space in the greenhouse. The cubic contents of the greenhouse should be accurately calculated and the cyanide weighed accordingly. To some plants the gas is very injurious; unfortunately a set of extended experiments along this line has not been made. When used at the above strength the exposure should last from twenty to thirty minutes.*

*Circular No. 37. Second Series, Div. of Ent. U. S. Dept. of Agr. by Woods and Dorsett, from which these directions are taken should be secured by every greenhouse manager who intends fumigation of this kind.
All openings should be thoroughly closed and the fumigation done at night when after the necessary exposure the greenhouse can be opened from the outside and aired several hours before being entered.

It should constantly be borne in mind that this gas, as well as the potassium cyanide, is deadly poison and the greatest care must be taken in its use. Porcelain or earthen dishes should be placed in different parts of the greenhouse and partially filled with water. To this should be added commercial sulphuric acid until steam arises from the water. The cyanide carefully weighed and held in paper sacks is suspended above the dishes by cords which can be loosened from outside the greenhouse after it is thoroughly closed, or if the cyanide is wrapped in paper it may be dropped into the dishes successively, commencing with the one farthest from the entrance, the operator moving rapidly from one to another and leaving the room immediately after dropping the last parcel into the acid and water, and leaving the greenhouse completely closed. Under no circumstances must anyone remain in the greenhouse after the cyanide is placed in the acid, nor must the house be re-entered until after a thorough airing.

For treatment of San Jose Scale strong solutions of whale oil soap are being used in some of the states adjacent to Iowa. The trees are sprayed in the autumn after the leaves have fallen and again in the spring as the buds are swelling but before the foliage is expanded, with a boiling hot solution containing two to two and one-half pounds of soap to each gallon of water. When carefully performed and the weather conditions are favorable this method seems to entirely exterminate the scale on a large proportion of the trees.

Other remedies are used for some scales, among them tobacco solution. This is often injurious to plants and with most species requires frequent repetition of treatment.
Newell: Some injurious scale insects.