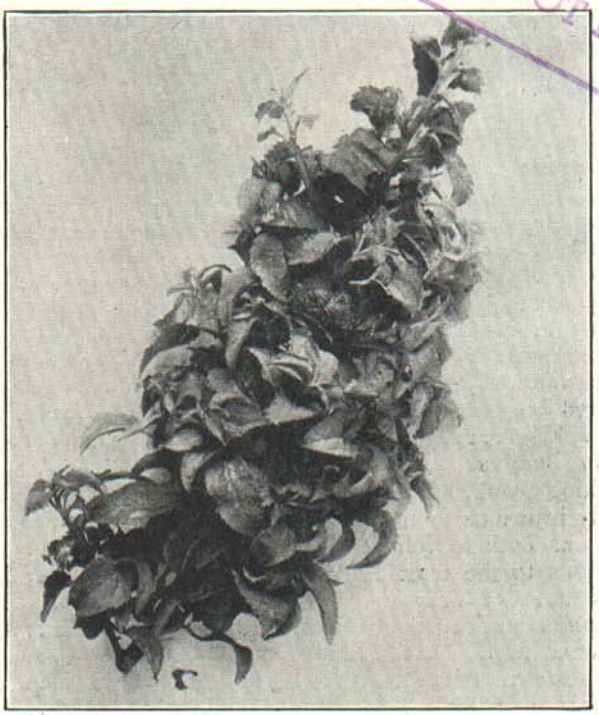
Sucking Insects Infesting Apples and Pears in Michigan
Michigan State University Extension Service
Ray Hutson
Issued April 1936
20 pages

Extension Bulletin No. 161 April, 1936

Sucking Insects Infesting Apples and Pears in Michigan

RAY HUTSON



New growth on apple, stunted by feeding of potato leaf-hopper.

MICHIGAN STATE COLLEGE
Of Agriculture and Applied Science

EXTENSION DIVISION

R. J. Baldwin, Director

Printed and distributed in furtherance of the purposes of the cooperative agricultural extension work provided for in the Act of Congress May 8, 1914, Michigan State College of Agriculture and Applied Science and U. S. Department of Agriculture, cooperating.

INDEX

Sucking Insects Infesting Apples and Pears in Michigan[1]

RAY HUTSON

INSECTS CHIEFLY INJURIOUS TO FOLIAGE

Pear Psylla

(Psylla pyricola)

This tiny pest is believed to be of European origin and to have been introduced into Connecticut about 1832. It now occurs over much of the eastern United States, appearing as far south as Virginia. It has also been reported from California.

It is a pest of pear only.

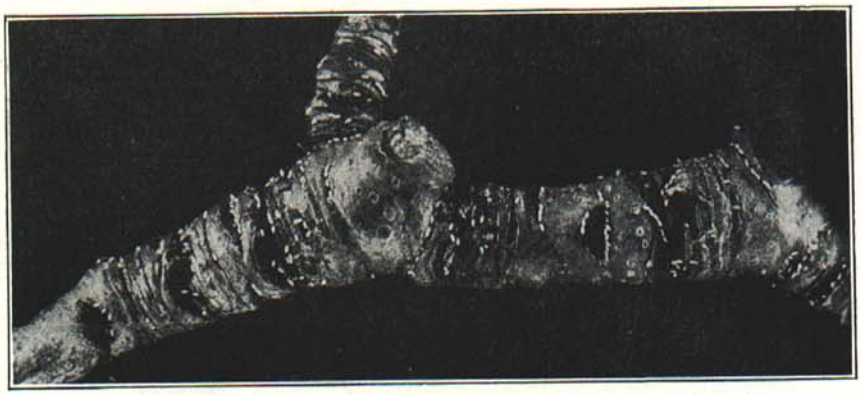


Fig. 1. Eggs of pear psylla on pear twig. Enlarged about 2½ times.

Life-history—The tiny, winged insects measure about one-tenth of an inch in length. They pass the winter under loose bark flakes or in any sheltered place about the pear orchard. They often come out and sun themselves during mild spells but seldom fail to get back under shelter when the weather turns cold.

Some time in late March or in April the adult females lay their orange-colored, pear-shaped eggs on the twigs. The eggs are usually placed near the buds, often on a leaf scar, and each egg is held in place by a small petiole. The eggs usually hatch about the first week in May, and the nymphs, or immature forms, shown in Fig. 2, mature in about a month. Later

[1]Mites are included for convenience.

generations, which occur during the summer, require less time to reach maturity. Three to five generations are produced in a single season.

Habits and type of injury—The presence of psylla is usually discovered by reason of the smears of honeydew which appear on the leaves. Each nymph usually surrounds itself by a small puddle or smear of sirupy honeydew, which reflects light and flickers in the bright sunshine. The honeydew also serves as a sub-stratum for the growth of a sooty fungus, which may become so plentiful as to give the tree a smoky, sooty appearance. The foliage often wilts, and drops to the ground. More serious still is the effect on the fruit, which remains undersized, fails to mature, and falls from the tree while only partially grown. The tree itself may fail to produce sufficient new growth and to set fruit buds for the following year. After a few years of infestation, the tree is more than likely to die outright.

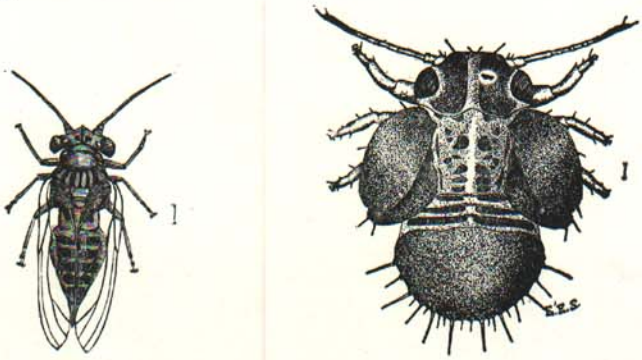


Fig. 2. Pear Psylla, adult and nymph, enlarged, from Slingerland.

Control—At just one time in the life history of the pear psylla, all the individuals congregate in one place. This occurs at the time of egg-laying; therefore, the most logical time to attack the psylla is just before this time. *All of the eggs are laid on the pear tree itself,* and therefore, a spray that will prevent the adult insects from laying their eggs on the tree can be expected to give adequate control. The most satisfactory control yet obtained has been through the use of an oil emulsion applied in early spring while the tree is dormant and just before the eggs are laid. This time usually comes in March after a period of warm weather.

Homemade emulsions made from oils having a viscosity between 175 and 250 seconds Saybolt at 100° F., and an unsulphonated residue of 60 to 70 per cent have given best results in the control of pear psylla. Such oils have worked best at the rate of 3 gallons of actual oil to 100 gallons of spray. Emulsions made with copper sulphate and lime, or casein spreader have proved effective. Certain commercial miscible oils or emulsions have also proved satisfactory. In case commercial preparations are used, directions recommended by the maker should be followed. It is perhaps well to note that any twigs or branches missed by the spray are likely to be sought out by the insect and utilized for egg laying. For this reason, the coverage should be complete.

In case summer sprays are required, as frequently happens under unfavorable weather conditions, add 1 pint of 40 per cent nicotine sulphate

to the arsenical spray used to control the codling moth. In case the outbreak occurs too late to be controlled in this way, apply a special spray of nicotine sulphate, 1 pint with 25 to 30 pounds of fine hydrated lime in 100 gallons of water when honeydew appears, or else employ one of the summer oils, following the directions of the maker.

When summer oil emulsions (75-85 viscosity and 92 per cent unsulphonated residue) and nicotine are used for codling moth control, little trouble will be experienced with pear psylla.

Leaf-hoppers

(*Empoasca fabae,* potato leaf-hopper,)
(*Empoasca rosae,* rose leaf-hopper,)
and others.

There are several species of leaf-hoppers which attack apples. They are variously marked and vary in color through shades of green and greenish-yellow. Their distribution is general, but only in orchards here and there do they become numerous enough to cause serious injury. Leaf-hoppers are small insects, about ⅛ inch long, that have the ability to run rapidly forward or sideways. When they are numerous in orchards and, when disturbed, they sometimes arise from the trees in clouds. Leaf-hoppers are often unnoticed up to the time they acquire wings, although a large proportion of the injury is inflicted by the immature insects.

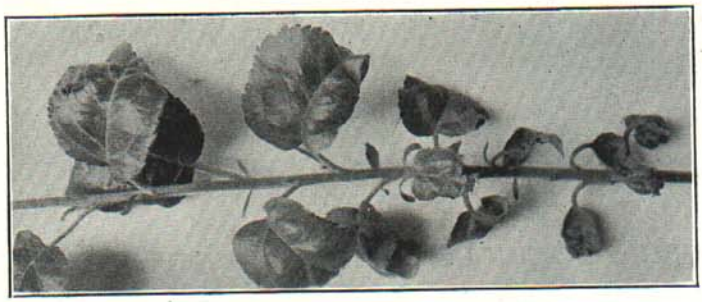


Fig. 3. Leaves of apple curled by potato leaf-hopper.

Other host-plants and life-history—The leaf-hoppers affecting apples feed on many other plants such as shade and forest trees, shrubs, grasses, and vegetable crops. The apple leaf-hopper is also a well-known pest of potato. In mid-spring, the overwintering adults appear, mate, and lay eggs in the veins of the leaves. The young nymphs emerge from the eggs during the late spring. The other leaf-hoppers, commonly occurring on apple, winter as eggs which hatch at about this same time.

Injury—The apple leaf-hopper, *Empoasca fabae,* is responsible for the whitish edges and "burned" tips of curled leaves resulting from most leaf-hopper infestations. Other species stipple the leaves with small whitish dots. A third type of injury becomes apparent, with heavy infestations, in the growth of a sooty fungus in the honeydew, which is excreted.

Control—Control measures for leaf-hopper are dependent upon the application of contact insecticides. Orchards which have been heavily in-

fested the previous year should be examined in late spring or early summer for the presence of the young hoppers. If the nymphs or their whitish cast-skins are numerous, it is reasonable to expect another heavy infestation. Nicotine, in one of the routine sprays at this time, or nicotine dust will usually reduce the infestation to negligible proportions. If the application of control measures is deferred until the leaf-hoppers grow wings, control will necessitate much harder work for although nicotine will still kill them, repeated applications may be needed for a cleanup, because the wing-covers protect the insect. Probably, the best spray to use is 1 pint of nicotine sulphate to 100 gallons of dilute lime sulphur or the same amount of nicotine in 100 gallons of water with 4 or 5 pounds of potash fish oil soap.

When, for any reason, it is inadvisable to use lime-sulphur during summer sprays, the potash fish oil soap-nicotine spray or a spray of ¾ pint or 40 per cent nicotine sulphate with 3 quarts of summer oil emulsion in 100 gallons of spray may be used.

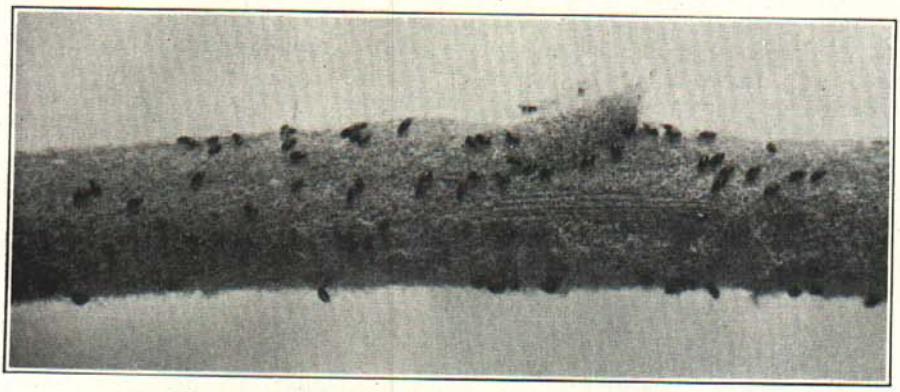


Fig. 4. Eggs of plant lice on apple sprout. Enlarged.

INSECTS INJURIOUS TO BOTH FOLIAGE AND FRUIT

Aphis or Plant Lice of Apples

Four distinct species of plant-lice, or aphis, are common in Michigan apple orchards. Of these, one species, the woolly louse, is normally found on healing wounds on the trunk, limbs and branches above ground, as well as on the roots. The woolly louse is easily distinguished from the other three species by reason of the snow white woolly or cottony growth, which is loosely attached to the body. The remaining three species have naked bodies and are to be found on opening buds, on foliage, and on the fruit.

Aphis Infesting the Fruit and Foliage of Apples

The Eggs—The eggs of all three species are to be found scattered over the branches and twigs during the wintertime. They appear as small, oval, highly-polished, black eggs, which are often glued in depressions and cavities but, if plentiful enough, are fastened most anywhere on the twigs and branches. Here, they remain until about the time the buds burst, when they commence to hatch, and continue to do so for some days or weeks. The winter eggs of all three species are indistinguishable one from another.

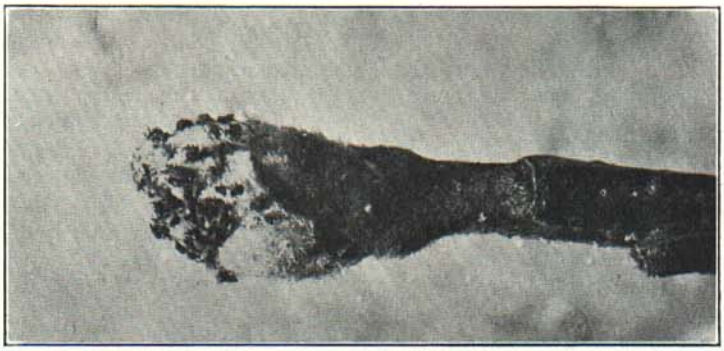


Fig. 5. Young grain aphis on bursting bud of apple. Slightly enlarged.

The first to hatch are the eggs of the apple grain aphis *Rhophalosiphum prunifoliae.*

The Apple Grain Aphis—The aphis coming from these eggs are dark, yellowish-green. They feed on the bursting buds and developing foliage until just about the "pink stage." The first individuals to appear, the stem mothers, are females which bring forth their young, also females, alive and thus start a series of generations which continue through the season until the approach of autumn. About the time of full bloom, they commence to fly away and disappear from the apple trees. They migrate to grasses and grains, where they continue to multiply unless checked by adverse weather conditions or parasites, until in early autumn a generation of winged sexual forms appears. These migrate back to the apple trees and mate, after which each female lays from one to three large polished eggs, which serve to carry the insects over winter. The grain aphis is the least injurious of the three species under consideration because it lives on the tree only a comparatively short time in ordinary seasons. In fact, the orchardist is justified in considering this insect as of slight importance.

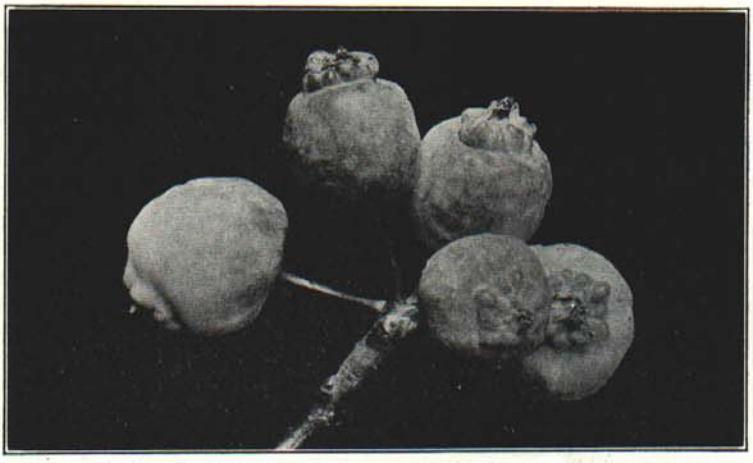


Fig. 6. Spur-borne apples, stunted by the rosy apple aphis.

The Rosy Aphis (*Anuraphis roseus*)—The rosy aphis appears in the spring and slightly later than the grain aphis. The young are green or rosy, but, when full-grown, the stem mothers are dark green with a double row of black spots down their backs. They are further distinguished by having their sides covered by a waxy material, which appears as a white bloom. The migration of the rosy aphis usually takes place after that of the grain aphis, being influenced largely by weather conditions. During cold, wet seasons the rosy aphis may remain on the tree until the weather turns hot and dry. They then migrate to plants belonging to the plantain family, the favorite plant being the common buckhorn plantain which is so plentiful all over Michigan. Just before cold weather, they migrate back to the apple trees to place the overwintering eggs in preparation for the approaching cold season.

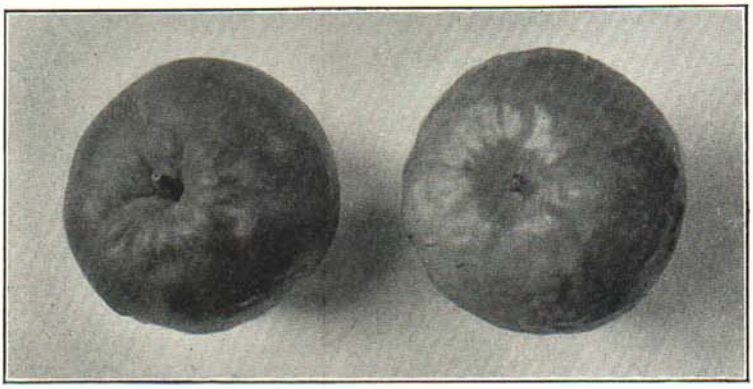


Fig. 7. Work of green apple aphis on fruit.

The Green Apple Aphis—This species, *Aphis pomi,* is so named because the females are dark apple-green in color. The eggs hatch along with those of the rosy aphis or perhaps a little later, and the adult winged females show somewhat less of a tendency to migrate during the summer than is the case with the other two species. During some seasons, practically all of them migrate and live on other plants. At other times, they remain on the apple trees, feed on the foliage as well as on the fruit, and seriously injure the latter. In general, it would appear that warm, dry weather acts as a stimulus to migration, but their activities are so erratic that one is sometimes at a loss to account for their behavior.

Character of Injury—Plant lice in general prefer cool, moist, shady conditions to warm ones. It is natural for them, therefore, to congregate and to do their worst work on the spur clusters of fruits in the center of the tree. Furthermore, the parasites that naturally aid in our attempts to control aphis are less active during cold, wet seasons than at other times.

Plant lice obtain their food by puncturing the foliage and fruit, and sucking out the sap through their slender beaks. It would appear that at least in the case of the rosy aphis and in that of the green apple aphis, the injury produced by these punctures far exceeds that which could be attributed to the mechanical injury resulting from the piercing of the foliage

and fruit. Apples that are borne on spurs in the center of the trees are stunted and never reach a commercial size while both small and large apples all over the trees develop an uneven lumpy surface. This lumpiness or knobby appearance may become very conspicuous and characteristic around the blossom end of the fruit. Apples injured by aphis may be well-colored but are likely to lack symmetry and perfect form and are uniformly of smaller size than normal fruit. No tendency toward the dropping of the fruit is noticeable, but at times half or more of the fruits may be so badly deformed and so stunted as to have very little commercial value.

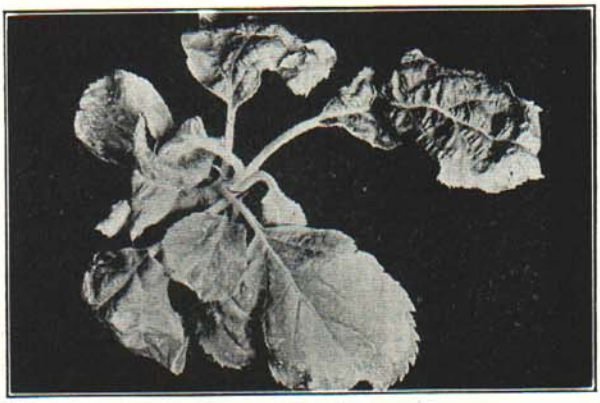


Fig. 8. Leaves of apple curled by green apple aphis.

Control

Sprays—The killing agent in almost universal use in the control of the apple aphis is nicotine, either in the form of a spray or combined with some carrying powder as a dust. The favorite type of nicotine is in the form of a 40 per cent solution of the pure drug combined with sulphuric acid. It is non-volatile and is sold in liquid form as nicotine sulphate. In order to get the fuming effect and therefore the full insecticidal value of this compound, the free volatile nicotine should be released at the time of application. This is usually accomplished by mixing the nicotine sulphate with dilute lime-sulphur, bordeaux mixture, or some other alkaline suspension or solution. The standard dose is 1 pint in 100 gallons of spray mixture. Experience has shown that in seasons when aphis eggs are plentiful during the winter one may reasonably expect aphis to be abundant in the spring. The first spray for aphis should be applied during the delayed dormant period, or, at any rate, not later than the time when the first buds are nicely separated in the cluster. A spray applied at this time affords greater protection than at any other one period, the eggs at this time being practically all hatched, and the foliage so small that a minimum of material will give good coverage. In favorable seasons, this one spray may be sufficient to prevent serious aphis injury. At other times, weather conditions or other influences may necessitate the application of one or more nicotine sprays as occasion seems to indicate or require.

The oil-nicotine spray used as an alternative for lead arsenate against

codling moth will control green apple aphis, which is sometimes a summer pest.

Oil sprays applied during the delayed dormant period for control of aphis have afforded such various results that they are not recommended.

Tar oil sprays will kill aphis eggs. These sprays must be applied according to the manufacturers' recommendations and in the dormant period. Tar oil sprays burn one's skin; hence, when using them some protective material should be used upon the hands and face. Teams must also be protected.

Crescylic acid is also toxic to aphis and is sometimes added to oil sprays going on at the delayed dormant period. It is used at the rate of ½ gallon in 100 gallons of oil spray.

The necessity for thorough coverage is important with all sprays directed against aphis.

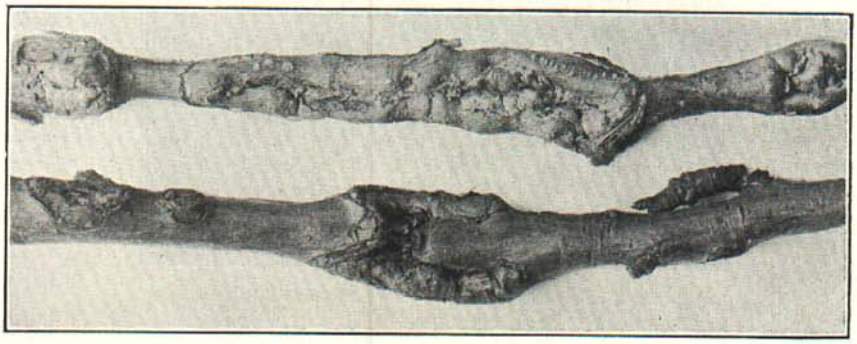


Fig. 9. Damage by woolly aphis of apple on twigs. Slightly enlarged.

Woolly Apple Aphis

(*Eriosoma lanigerum*)

This pest is a serious enemy of young apple trees. It is found frequently on large trees as well and also occurs on pear, quince, hawthorn, and elm. Its distribution is world-wide, and it is known in America as the woolly aphis, in Europe as the American blight, and in Germany as the blood louse. One often sees clumps of these lice, rendered conspicuous by reason of their cottony, snow-white coverings, collected on calluses that are forming on wounds where limbs have been cut off. Sometimes minor wounds on the branches attract them in such numbers that a small twig may be completely covered by their bodies, the injury in such cases usually being sufficient to bring about the death of the branch. At other times, they are found underground where they suck the sap from the roots which develop a knobby or knotty appearance. In the nursery row, woolly aphis are often associated with hairy root and crown gall, and they become major pests in such locations.

The Woolly Apple Aphis on Elm—The discovery that the woolly louse of apple feeds on elm foliage explains the reason for the great difficulty sometimes encountered in controlling the woolly aphis on apples when in

the vicinity of elm trees. It would appear that there is a seasonal interchange of individuals between elm and apple. Among the different varieties of apples grown in Michigan for commercial purposes, the Northern Spy seems to be the least attractive to woolly aphis, although this variety of apple is not by any means exempt from attack.

Control—The woolly aphis, when it occurs above ground on apple trees, can be destroyed by the application of a spray of nicotine applied under high pressure. Rather more care than is ordinarily exercised is required in order to penetrate the wax surrounding the insect. The root-inhabiting forms constitute a special problem, which has been under investigation for at least a century. Various soil fumigants and insecticides have been tried out with varying success. All aphis-infested nursery stock, before being set out, should be dipped or, preferably, soaked in a solution of 40 per cent nicotine sulphate, used at the rate of 1 pint to 100 gallons of water. All infested trees, both young and old, should be kept in the best possible growing condition by the use of fertilizers and cultivation. Vigorous trees are able to withstand attacks that would prove fatal to trees in poor health.

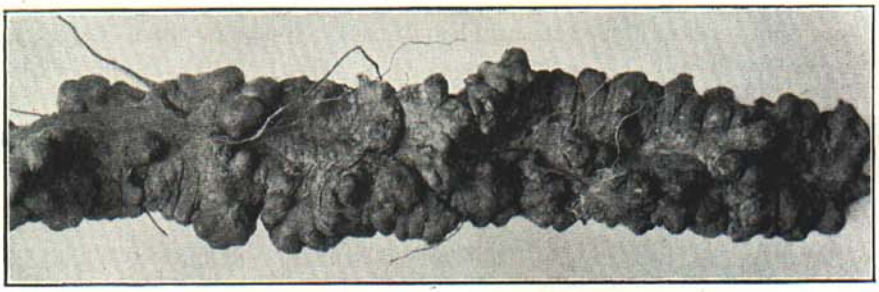


Fig. 10. Woolly aphis of apple, work on roots. Enlarged about twice.

Mites

Three separate species of tiny mites are found on the leaves of apple, pear, and other fruits in Michigan. They are the common red spider of the greenhouse, *Tetranychus telarius;* the clover mite, *Bryobia pretiosa;* and the European red mite, *Paratetranychus pilosus.*

These pests are not insects but they are considered here because their habits and control are somewhat similar to sucking insects.

Greenhouse Red-spider—The greenhouse red-spider has for many years been observed in Michigan, here and there, inflicting its characteristic injury on the under surfaces of the leaves of apple during hot, dry seasons. In habit, this species differs from the two following in that the winter is passed in the adult condition in sheltered places, presumably underground or under rubbish.

The second and third species, the clover mite and the European red mite, both pass the winter in the egg stage. The eggs of the clover mite are deposited on the trunks and branches of all sorts of trees, while those of the European red mite are placed more often on the branches and twigs of fruit trees.

Fig. 11. Eggs of European red mite on spur of apple tree. Greatly enlarged.

Clover Mite—Until recently, this mite has been considered as of little importance in Michigan, although it has been recognized that during dry, hot seasons the clover mite was capable of producing a scorched, curled appearance by working on the under surfaces of apples leaves. At any rate, the fact that it now usually works in company with the European red mite and that the same control measures are applicable to both species makes it unnecessary in most cases to distinguish between the work of the two. During normal seasons, the young clover mites migrate to herbaceous plants, such as clover and weeds, and return to the trees only in the fall, at which time they deposit eggs. Under certain weather conditions, many of the clover mites may remain on the trees during part or all of the summer. At such times, they are often associated with the European red mite and are to be controlled by the same measures.

European red mite—This third species is a comparatively new pest in Michigan, although it is now well-established wherever tree fruits are grown. The minute eggs, often associated with those of the clover mite, are to be seen scattered over the twigs and branches of apples, pears, peaches, plums, and other tree fruits. In Fig. 12 the general characteristics of all

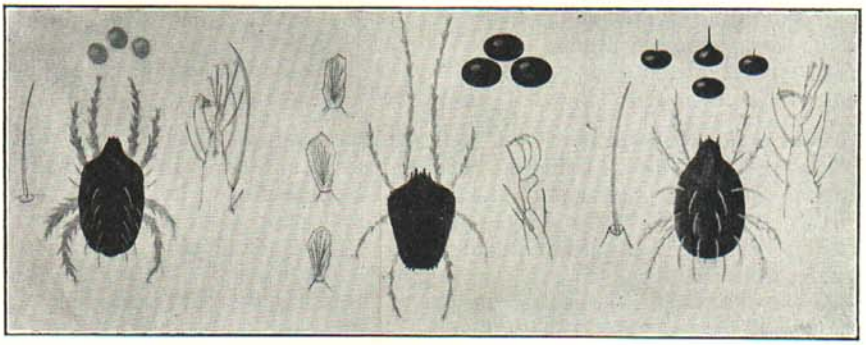


Fig. 12. Greenhouse red-spider (at left), clover mite (center), and European red mite (at right), all greatly enlarged. Redrawn and adapted from works of N. Banks and those of P. Garman.

three species are compared. The illustration shows the presence of a minute needle-like staff projecting from the center of the egg of the European red mite, which distinguishes it from that of the clover mite. A careful microscopic examination of the eggs of these two species will often disclose the presence of this staff, although it is readily broken off, and at times very close scrutiny is required to demonstrate the presence of the broken stub. European red mite eggs hatch just before apple bloom; the mites reach maturity in 2 to 3 weeks and live perhaps 2 weeks thereafter. During her limetime, each female lays 30 to 35 eggs. These facts indicate from four to six generations per year in Michigan.

Control—The most efficient control of European red mite and clover mite is obtained by the oil spray during the dormant period. (In cases of doubt as to the identity of the species concerned, a determination may be had from the Department of Entomology by sending specimens.) Three per cent actual oil is necessary to gain control. The usual precautions when using oils should be observed as to freezing after application. It should be remembered that only those mite eggs which are hit will be killed. In other words, complete coverage is essential for control. Experience indicates that on apples a thorough dormant spraying reduces the mite population to a point where it is usually held in check by the routine summer spraying despite the rapid multiplication of the mites.

Pear Leaf Blister Mite

(*Eriophyes pyri*)

Character of Injury—This close ally of the true insects came from Europe. It is so minute that it ordinarily escapes detection except when subjected to the closest scrutiny. Its work is conspicous on the under surfaces of pear leaves and, to a lesser degree, on the leaves of apple. pink, blister-like growths appear on the under surfaces of the half-grown pear leaves. These blisters are about ⅛ of an inch in diameter at first but may later increase in size and coalesce and result in a blistered surface, which later turns brown or almost black. A section of the leaf through one of these blisters will disclose an irregular cavity in the interior where the mites dwell.

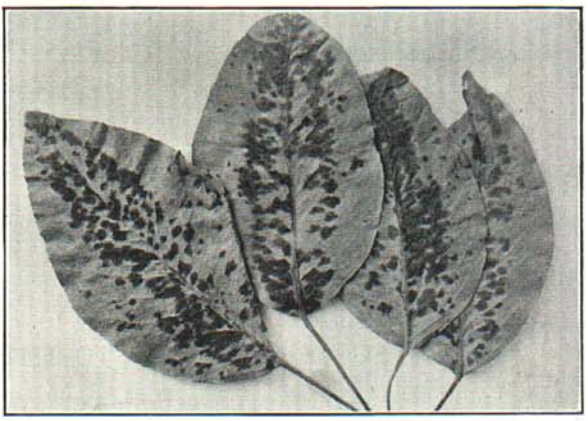


Fig. 13. Pear leaves infested by blister mite.

The mite itself measures less than 1/100 of an inch in length. It passes the winter concealed beneath the outer bud scales, emerges in early spring, and starts to make its blister-like retreat as the leaves develop.

Importance of Injury—At the beginning of the 20th century, the pear leaf blister mite was a major pest of pears in the eastern part of the United States. At present, it has extended its workings to practically all places where pears are grown commercially. The discovery of adequate control measures has, however greatly reduced its importance. The injury done by the blister mite is due to the killing of so great a proportion of the leaf tissue that the leaf is unable to function properly, shrivels, and finally falls to the ground. In severe cases, the skin of the fruit itself becomes involved, the blister-like patches sometimes causing the fruit to crack open. Trees severely attacked may lose the greater part of their foliage, followed by the consequent dwarfing and dropping of the fruit. If the depredations of this pest are allowed to continue for several years in succession, the death of the tree may result.

As has been stated, the pear leaf blister mite is primarily a pest of pear. A lesser degree of injury to apples is brought about in a similar manner except that the young blisters on the leaves and on the fruit are greenish yellow in color rather than pink.

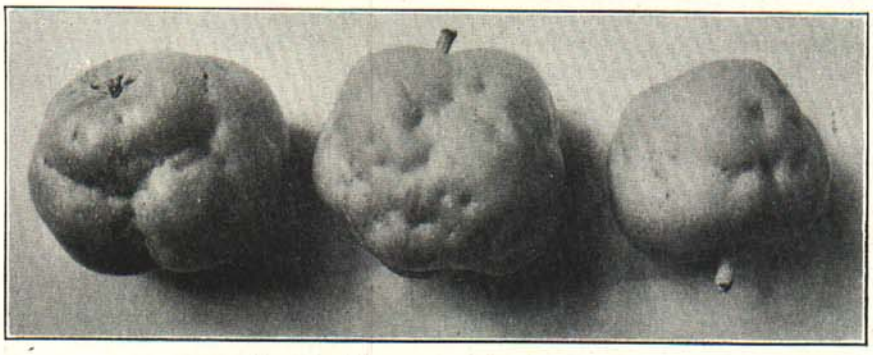


Fig. 14. Blemishes caused by false red-bug.

Control—The dormant spray of strong lime-sulphur ordinarily used to control the San Jose scale is sufficient to effect a very satisfactory control of this mite. In the absence of scale, it is sufficient to apply a spray of strong lime-sulphur, diluted at the rate of 1 part in 10 of water and applied just before the buds swell in the spring.

INSECTS INJURIOUS TO THE FRUIT

Apple Red-bugs

(*Heterocordylus malinus,* dark apple red-bug)
(*Lygidea mendax,* false apple red-bug)

There are two species of inconspicuous, small, flat red bugs, each about ¼ inch long which cause much injury to apples in the northeastern United States. These two bugs, while really distinct species, resemble one another so closely in color and in character of their depredations that they are usually spoken of as red-bugs, without reference to the particular

species under discussion. The red bugs are provided with slender, sharp beaks, with which they puncture the leaves and fruit of apple, sometimes also working on hawthorn, pear, and wild crab. Wherever a puncture is made in the fruit of apple, growth slows up at that point or may even stop completely, so that apples that have been punctured when young, show after development one or more dimples, or pits, on the surface. The appearance of severely injured apples sometimes suggest the work of plant lice, although in the case of the red-bug, the characteristic knobby appearance around the calyx is absent.

Life-History—Of the two species, the dark red-bug, *Heterocordylus malinus,* is somewhat darker, in fact, sometimes almost black, while the false red-bug, *Lygidea mendax,* is more brilliant in color and lacks the greyish hairs on the back, characteristic of the darker species. Both species pass the winter in the egg stage, the eggs being thrust into the bark of the two-year old twigs and branches; in the case of the lighter species, the eggs are usually inserted in the lenticels of the bark. The eggs of the dark red-bug usually commence hatching about the time that the blossom buds first begin to show pink and finish before the time for the calyx application. The eggs of the false species normally hatch a few days later.

Fig. 15. False red-bug greatly enlarged.

Immediately upon hatching, the nymphs attack the small leaves and continue their work on the fruit as the latter sets and afterward until mid-June.

Control—The most effective control for red-bug is a spray of 40 per cent nicotine sulphate applied just after the petals fall. By this time, most of the eggs will have hatched, although few of the insects will be able to fly. If the dark species of red-bug happens to predominate, it may be worth while to put on an additional spray at the late pink stage. This is the case, however, only when the insects are present in abnormal numbers.

Metcalf and Flint recommend that the spraying be done on a warm day, and that two men apply the spray on opposite sides of the tree simultaneously, because of the extremely active nature of the insects.

INSECTS ATTACKING TRUNK, LIMBS, AND BARK

Buffalo Tree-hopper

(*Ceresa bubalis*)

The twigs of apple trees, as well as those of several other trees and shrubs, are often deformed, and sometimes killed, by the deposition of eggs of the buffalo tree-hopper. This insect deposits its eggs in slits cut through the bark into the cambium, the eggs being arranged in two short, curved rows, suggesting a pair of parentheses. In each of these parenthetical slits are deposited five, six or more long, slender eggs, which are thrust into and

embedded in the twig. When these groups of eggs are closely crowded, the twig itself may be seriously injured. Small nursery stock, just set, may suffer the loss of so many of its twigs that the young tree may be killed outright, or, if not killed, the branches lost may result later in a seriously deformed tree which will hardly be worth raising. Older trees seldom suffer permanent injury because the wounds usually heal over, although the resulting scars may prove something of a mystery to the owner of the tree.

The buffalo tree-hopper is a sucking insect, which feeds on the juices of succulent plants. It lays its eggs in the autumn and is attracted to places where succulent growth abounds at that time. It follows that young trees or shrubs planted in the vicinity of succulent plants, such as alfalfa, raspberry, or any other plants that remain fresh, green, and sappy in the autumn, are exposed to attacks of this kind, provided the buffalo tree-hoppers establish themselves in the field.

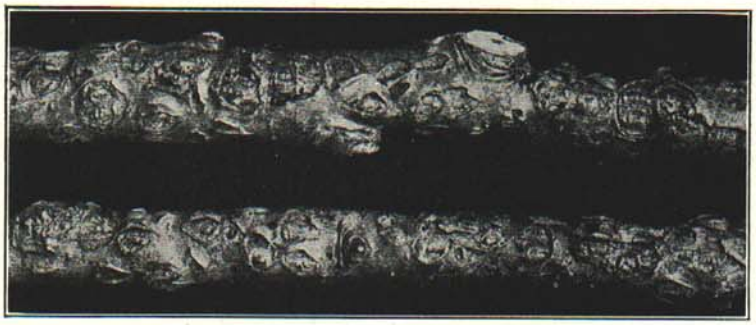


Fig. 16. Scars made by Buffalo tree-hopper.

As already stated, well-established and sizeable trees seldom suffer permanent injury, although the bark of the tree may be scarred considerably. Newly set trees, on the other hand, may either be killed outright, or they may suffer the death of certain branches and twigs, which in the ordinary course of events would be expected to form the scaffold limbs of the future tree. Naturally, the form of the future tree must be determined by the development of such twigs as are left alive after part of the twigs have been killed. No system of spraying is at present known that will protect young trees set out in fields of alfalfa. It is, therefore, suggested that, unless the grower decides to knowingly expose his newly set orchard to the hazard of injury by the buffalo tree-hopper, that he avoid the use of alfalfa in the new orchard until such time as the trees have obtained a fair start and have reached a size where the injury would be slight.

Shield-scales on Apples and Pears

Five species of shield-scales besides the San Jose are to be met from time to time on Michigan apples and pears:

Aspidiotus juglans-regiae, walnut scale,
Aspidiotus ostreaeformis, European fruit scale,
Aspidiotus ancylus, Putnam's scale,
Lepidosaphes ulmi, oyster-shell scale,
Chionaspis furfura, scurfy scale.

Fig. 17. Oyster-shell scale on apple twig. Enlarged about twice.

All of these shield scales live on the bark. The first two live over winter in a partially grown condition, being viviparous, while the last three pass the winter in the egg stage, the eggs being concealed under the scales.

Of these five species, the walnut scale is common on red maple, plum, peach, and at times on apple. The European fruit scale is a serious enemy of plum, currant, walnut, ash, and at times of apple and pear. Putnam's scale is found scattered over apple trees here and there in practically all the orchards in the state. It is normally kept in subjection by parasites and seldom, if ever, becomes a problem to fruit-growers. The oyster-shell scale is well known and is easily recognized by its elongate form and by its resemblance to a minute oyster shell. This insect is at times so plentiful that the bark of apple and pear trees becomes encrusted with a scaly covering to such a degree that the health of the tree is impaired. The scurfy scale is somewhat elongate and, when fresh, is snow-white in color. It is more often found on pear than on apple, but it is only on occasion that it becomes plentiful enough to injure seriously the tree.

Control—All of these insects can be controlled by sprays applied while the tree is dormant, preferably just before growth starts in the spring, since trees are more resistant to spray mixtures at that time. Furthermore,

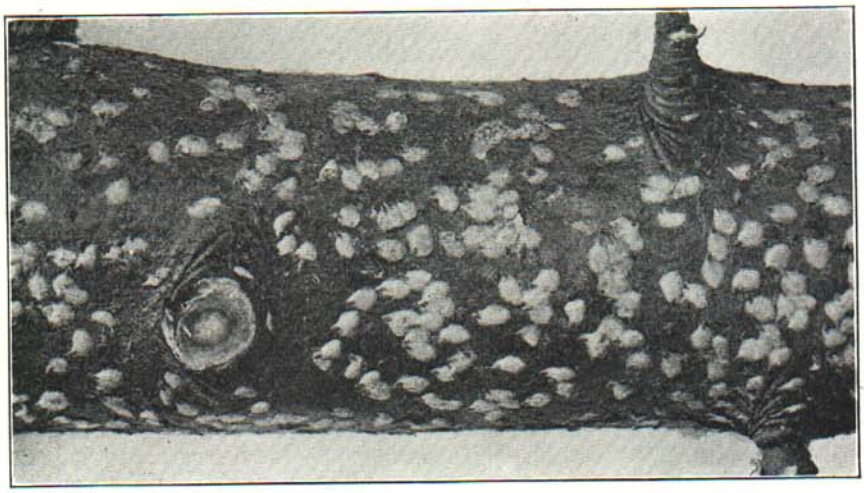


Fig. 18. Scurfy scale on pear. Enlarged about three times.

the insects themselves are more susceptible to treatment at this time than at any other point in the dormant period. Of the five species named, one finds the walnut and the European fruit scale more easily killed by sprays of either strong lime-sulphur or oil emulsions than are the oyster shell, Putnam's, or scurfy scales. Three gallons of actual oil of the diamond-paraffin type to 100 gallons of water, emulsified with calcium caseinate has given good results on apple. A number of the commercial miscible oils have proved very satisfactory in controlling these scales. In case one of the commercial oils is used, dilute according to directions supplied by the maker. A lime-sulphur spray, consisting of 12½ gallons of concentrated liquid lime-sulphur diluted to 100 gallons with water, and applied at the time specified, has also proved effective.

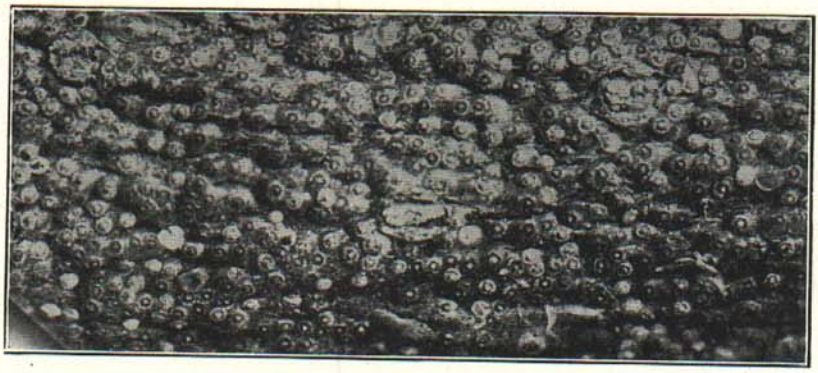


Fig. 19. Overwintering stage of San Jose scale. Greatly enlarged.

San Jose Scale

(*Aspidiotus perniciosus*)

Originally from the interior of China, the San Jose scale was introduced into America by way of San Jose, California, and thence to the eastern seaboard. Finally, the pest spread over the United States and Canada until all the great tree fruit growing districts are now invaded. As is the case with all the shield-scales, the true insect is provided with a papery or waxy covering, entirely distinct from the body of the insect itself. When this pest first invaded that portion of the United States east of the Rocky Mountains in the early '90's, its advent was taken very seriously. In fact, it seemed a the time that the entire industry was threatened. Today the development of adequate control measures, together with the aid rendered by natural enemies, leads one to view this pest in a less unfavorable light, since it has been found that ordinary routine spraying is all that is required to keep the insect within due bounds under ordinary conditions.

The San Jose scale is a serious pest of apple and pear and of most other fruits. It seldom, if ever, is troublesome on sour cherries or on gooseberries, although sweet cherries and currants may be severely attacked. Besides fruit trees, a host of ornamentals and forest trees are occasionally attacked by this pest.

Life-history and Habits—Aside from the fascinating life-history of the San Jose scale, which reads almost like a fairy tale, it is important to note that this pest multiplies at an astonishing rate. It is possible for an overwintering female to produce millions of offspring in a single season under ideal weather conditions. The young are born alive, sometimes as many as 400 in the family. There are four generations each year at the latitude of Washington, and usually three in Michigan. The tiny young are carried from one place to another on the bodies of other insects and on those of birds, besides being disseminated at times by strong winds. Individuals are often produced in such numbers that the bark of a tree may be completely covered and encrusted by the scaly coverings under which the insects live.

The San Jose scale becomes stationary once it settles down after establishing itself. It sucks its food from the bark, foliage, or fruit, as the case may be, apparently injecting into its tissue some irritating principle which acts as a poison to the host plant. The inner bark of the tree is very likely to be stained purple wherever the scales congregate.

As may be inferred from what has been previously stated, the San Jose scale does not pass through an egg stage. It winters as a partially grown insect in hibernation under the scale, and, for this reason, the San Jose scale is easier to control by means of a spray than are some of its relatives that pass the winter in the egg stage. Eggs of insects are notoriously more difficult to kill by means of sprays than are breathing, active insects even when the latter are in a state of partial hibernation.

Control—San Jose scale is best controlled by a spray put on in the dormant period, preferably as late as possible before the buds burst in the spring. Two types of spray are in common use, both being entirely satisfactory when applied painstakingly, one a spray consisting of one of the miscible oils or an oil emulsion, and the other a spray of strong lime-sulphur. In making a choice between these two types of sprays, one should be guided and influenced by several outside considerations. Oil sprays are also effective in destroying the eggs of mites and various other pests. Lime-sulphur exerts a strong influence on fungus diseases of several kinds. Lime-sulphur may be safely put on at a time when the weather is cold and dry. It is believed that oil sprays should not be applied when there is danger of the spray freezing before it is thoroughly dried. Furthermore, one should consider the sprays that are to follow, and avoid using an oil spray if lime-sulphur is to be used soon afterward.

In case lime-sulphur is selected, it is customary to add enough water to 12½ gallons of liquid lime-sulphur to make 100 gallons of spray mixture. If an oil spray is used, then use 3 per cent of actual oil emulsified either by calcium caseinate or bordeaux mixture. In case prepared miscible oils or emulsions are used, follow the directions given by the maker, since there is considerable variation in the characteristics and formulae of the different makes. For full directions for preparing home-made emulsions, consult the latest spraying calendar.