

Controlling SUCKING INSECTS on Conifers

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CONTROL OF SUCKING INSECTS ON CONIFERS

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FOREWORD

Hundreds of people seek to learn how to control sucking insects infesting conifers each year from this office. Perhaps the greatest reason for this condition is that such knowledge is widely scattered and often inaccessible. This bulletin undertakes to bring this information together.

The inclusion of scientific names collates the publication with others upon the subject and should aid materially anyone seeking further information upon the control of the insects in question.

RAY HUTSON,
ENTOMOLOGIST.

Control of Sucking Insects on Conifers

E. I. McDANIEL

Of the sucking insects attacking Michigan conifers, aphids and scale insects are the most important. Mites occasionally become a problem and now and then an infestation of spittle insects appears.

APHIDS

The most destructive aphids infesting conifers belong to the subfamily Adelginae. The life history of aphids belonging to this group is complex. Spruce serves as the primary or definitive host, while larch (Larch) fir (Pseudotsuga), arborvitae (Tsuga), pine (Pinus) or balsam fir (Abies) are the intermediate hosts, depending on the species involved.

On the primary or definitive host the aphid not only lives as a naked insect or secretes a white, wax-like covering, but it is capable of causing characteristic gall-like growths; on the intermediate host it either exists as a naked plant louse or secretes a characteristic white wax-like coating typical of the species. Aphids belonging to this group are no longer restricted to any one locality or section of the country, and eventually, in all probability, will be restricted only by the limitations of their host plants. Much information remains to be learned concerning detailed life history and habits for all of the aphids of this group.

THE SPRUCE GALL APHID, *Adelges abietis* Linn.

The spruce gall aphid causes cone-like galls to form at the bases of the new growth on Norway, white, red, black, blue, and Engelmann spruce. There are two generations a year and no intermediate hosts are required. The galls open in mid-August.

Life History—The spruce gall aphid passes the winter as a tiny, naked, greenish, immature aphid in crevices about the bud scales. Early in the spring, about the time the sap begins to move and before the growth starts, these tiny, overwintering forms move out on the twigs and complete their growth. They secrete a covering of white, cotton-like material which not only envelops the eggs but the parent as well. In a week or 10 days these eggs hatch, and the young settle down around the base of the new growth. Their attack causes the individual bases of the leaves to become enlarged, each one forming a bulb-like hollow. There may be as many as 50 cells in a group, each of which contains as many as a dozen young aphids. The fully developed gall resembles a tiny pineapple, varying in size from one-half inch to an inch or more in length. Occasionally a gall may completely

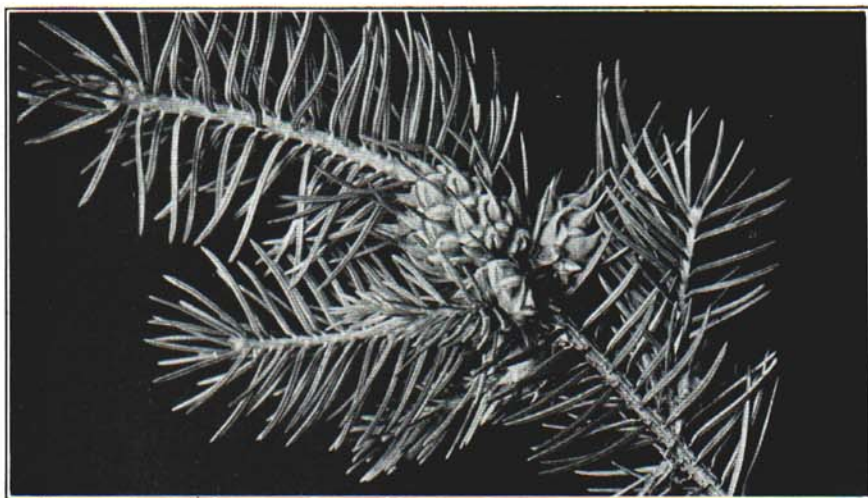


Fig. 1. Basal galls of the spruce gall aphid, (*Adelges abietis*) on Norway spruce.

check the growth of a twig but this is unusual. As a rule, the healthy part of the twig protrudes several inches beyond the gall; where but a few leaves are deformed, the twig may not be completely encircled.

The new galls are pale green with the closed mouth of each cell conspicuously marked by an inverted V-shaped line of brick red or vivid purple, depending on the age of the gall. The galls open in mid-August and from them emerge young with well-developed wingpads. These settle on the terminal growth and develop into the winged adults that deposit the eggs from which are to hatch individuals of the overwintering generation. The females, while winged, apparently do not migrate, since they seldom move from the location where molting has taken place.

Later in the season their dead bodies, each placed protectingly over an empty mass of egg shells, may be found clinging to the needles. Each female



Fig. 2. Empty egg sacs of spruce gall aphid, (*Adelges abietis*) and the new growth of spruce. (Note the development of young galls.)



Fig. 3. Young galls of the spruce gail aphid, (*Adelges abietis*) together with the flocculent covering of the empty egg-masses.

deposits a mass of about 50 eggs, which hatch in 5 or 6 days, and the young seek winter quarters in crevices around the buds. Many individuals winter-kill, and many are washed off by heavy rains before they get established in winter quarters.

Injury—The spruce gall aphid shows a curious preference for individual trees. The galls not only retard normal growth but lower the vitality of the tree. After the aphids leave the galls, the latter turn brown and die. Their

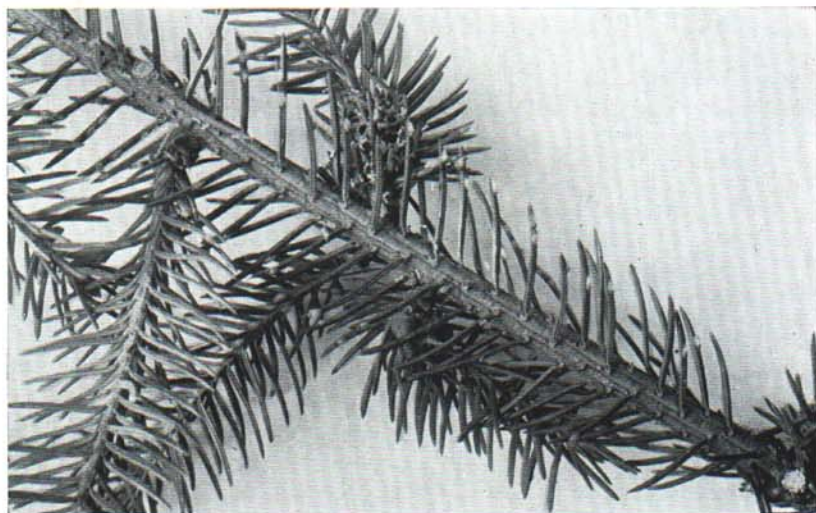


Fig. 4. August generation of the spruce gall aphid, (*Adelges abietis*) depositing their eggs on the foliage of spruce.

presence not only detracts from the beauty of the tree but even where the twigs are not killed the growth is malformed. Mature, vigorous trees are seldom permanently injured, although the new growth may be rendered scraggly and unsightly.

Control—Where the infestation is confined to a few trees on a large planting it is advisable to dispose of such trees before the middle of August. Where only a few small trees on ornamental plantings are infested, hand-picking of the galls is suggested. Spray infested trees in the spring, just before growth starts, with a miscible oil (p. 24) or an oil emulsion (p. 25). Where control measures are necessary against the summer brood a 40-per cent nicotine sulphate spray (p. 25) is recommended.

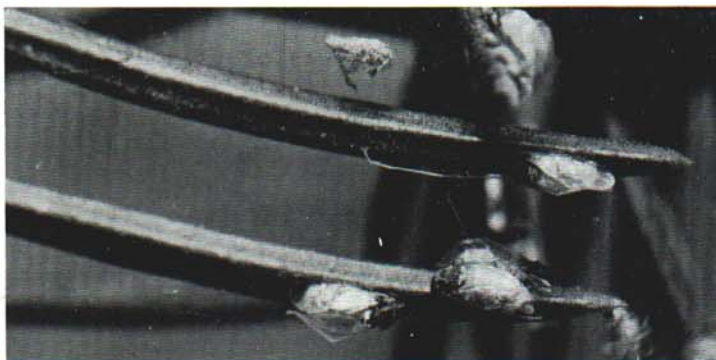


Fig. 5. Egg-masses of the spruce gall aphid, (*Adelges abietis*) protected by the dead bodies of the mother aphids.

BLUE SPRUCE GALL APHID, *Adelges cooleyi* Gill.

The blue spruce gall aphid causes terminal galls to develop on Sitka spruce, Colorado blue spruce, and Engelmann's spruce. The Douglas fir is its intermediate host.

Two years and at least five generations are required to complete a life-cycle. The galls developed by this aphid are among the largest of the aphid galls infesting spruce. They are always terminal, varying in size from one to two inches in length and from one-half to three-fourths inch in diameter. This gall not only is formed by the enlargement and flattening of the needles at their bases but by the thickening of the stem as well. The growing gall varies in color from light green to dark purple. Each gall contains a large number of cells, varying from 75 to 150, and each chamber or cell may contain a dozen or more aphids. The galls open in July.

The blue spruce gall is rare in Michigan.

Life History—Immature individuals pass the winter near the terminal buds. In the spring mature individuals from the overwintering brood settle on the foliage of spruce, envelop themselves in a conspicuous mass of white, cottony material where they lay several hundred eggs, the young from which settle on the new growth and cause the gall to develop. The aphids within the galls are light red, covered with a thin film of wax and thread-like fila-

ments. When mature, the galls open and the clumsy aphids crawl out and settle on the spruce needles where they undergo their final molt, emerge as winged adults, and migrate to fir. Here, they establish themselves on the needles, and egg-laying begins almost immediately. They secrete an unusual amount of wax thus making a secure nest. The eggs are fastened to the needles by slender, silken stalks or filaments of various lengths. As many as 150 eggs may be in a nest. The eggs hatch in a week or 10 days and the young settle on the under surfaces of the leaves, where they pass the winter. These young are dark green in color, fringed with plates of wax. Early in the spring the winter coat is shed and the overwintering aphids develop rapidly. They are soon covered by the waxy secretion and



Fig. 6. Galls of (*Adelges cooleyi*) on Blue spruce.

each aphid lays from 25 to 30 or more eggs, which hatch about the time the new growth develops on fir. The young aphids establish themselves on the new growth, where their feeding may cause some distortion of the leaves. Part of the offspring from the eggs of the overwintering mother aphids fails to develop wings. These wingless individuals, like their parents, lay eggs, and the young hatching from these eggs insert their mouthparts in the leaves of fir, establishing themselves as an overwintering generation. However, certain winged individuals leave the fir and establish themselves on spruce, where they deposit nests of eggs under cottony masses. These eggs hatch into individuals that collect on the twigs near the buds, where they pass the winter. By the time the new growth develops, the overwintering aphids have shed their winter coats, and the mature females establish themselves on the new growth, where they cause the characteristic galls to develop.

Injury—This aphid is capable of causing trouble wherever its host trees predominate or even when they are present in ordinary numbers. On spruce it causes serious injury to both old and young trees. On old trees the galls may be numerous enough to stunt the growth or even to weaken the tree sufficiently to attract other insects which may eventually kill the tree. On young trees where the leaders or terminal growths are attacked the tree may be either deformed or killed outright. On Douglas fir this species is known as *Adelges cooleyi* var. *coveni* Gill. When present in large numbers it causes the infested needles to turn yellow or twist and curl. It also causes an unusual foliage drop.

Control—Do not interplant Sitka, Colorado blue or Engelmann spruce with Douglas fir. Hand-picking is suggested for light infestations since any contact spray affects the coloring of the tree for a time. The contact sprays suggested for *A. abietis* will control *A. cooleyi* on either spruce or Douglas fir.

THE WOOLLY LARCH APHID, *Adelges strobilobius* Kalt.

The Woolly larch aphid causes terminal galls on red and black spruce, and has larch for its intermediate host. The galls open in June.

Life History—The life history is complicated. Two years are required to complete a life-cycle. The immature aphid winter on spruce in the vicinity of the buds. These individuals reach maturity early in the spring and settle down on the developing buds where they set up an irritation causing abnormal pockets to form at the bases of the leaves. Each individual may produce as many as 200 eggs. The eggs hatch and the tiny aphid settle in cells formed by the parent and along in June, when they reach maturity, the galls open and from this blood winged migrants develop which migrate to larch late in June. Each migrant deposits from 30 to 40 eggs on the foliage of larch, these hatch in a short time and establish themselves

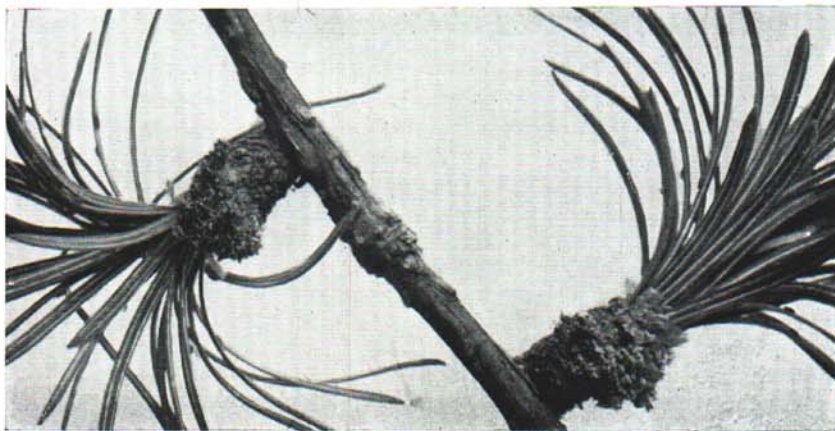


Fig. 7. Immature woolly larch aphids, (*Adelges strobilobius*) collected about the bases of the needles on larch.



Fig. 8. Mature females of the woolly larch aphid, (*Adelges strobilobius*) just as they start secreting their flocculent coating. (Enlarged.)



Fig. 9. Empty egg-masses of the woolly larch aphids, (*Adelges strobilobius*) on larch.

on the under sides of the needles where they remain comparatively inactive until spring. These overwintering individuals lay their eggs at the bases of the leaves of larch and the young establish themselves on the foliage where they secrete a thick mass of white, cotton-like growth. From this generation come certain individuals that remain on larch, as well as winged individuals that migrate back to spruce.



Fig. 10. Galls of the woolly larch aphids, (*Adelges strobilobius*) on Black spruce.



Fig. 11. Gall of *Adelges lariciatus*.

The galls are terminal, small, round, and the needles are usually considerably shortened.

Adelges lariciatus Patch, a closely related species, causes basal galls on white Norway spruce. The galls resemble those of *A. abietis* except that the needles are shorter. Larch is also the intermediate host for this species. These galls open about August 1.

Injury—Neither species has proved to be of economic importance. The woolly aphid stage on larch is conspicuous, but the early migration prevents serious injury.

Control—The control measure recommended for *A. abietis* will be effective against both species, provided the application is made at the time the aphids are active.

THE PINE BARK APHID, *Pineus strobi* Hartig.

So far as known, the pine bark aphid is restricted to pine in America. While white, Scotch, and Austrian pine are infested, it prefers northern white pine. It is gregarious, colonies collecting on the under sides of the large limbs or along the main trunk where the bark is not too thick. Shortly after the colony becomes established and the young commence to feed, a

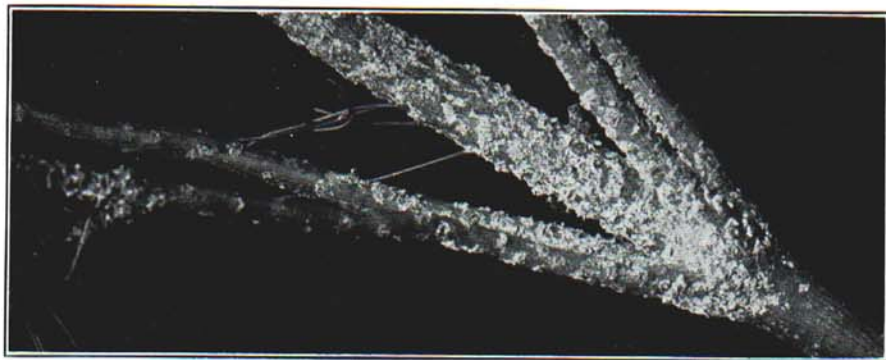


Fig. 12. Pine bark aphid, (*Pineus strobi*) on branches. (Reduced.)

white flocculent growth develops on their bodies, which gives the infested area a "white-washed" appearance as illustrated by the cover picture.

Life History—There are three or four generations each year. Immature individuals winter-over under their white felted secretion or under the bark. Late in April or early May these individuals mature and deposit masses of eggs. From these eggs develop both winged and wingless forms. Most of the winged forms migrate to other pines, while the wingless individuals lay eggs early in July from which develop a brood of adults in August or September, and it is from the offspring of this generation wintering over on the bark, that the spring generation develops.

Injury—The pine bark aphid is seldom a problem on mature trees in natural stands. It is often a problem on trees in ornamental plantings and may kill certain unhealthy trees. It is a serious menace to nursery stock and young transplants.



Fig. 13. Pine bark aphid, (*Pineus strobi*) on trunk. (Enlarged.)

Control—The pine bark aphid is most successfully controlled by a dormant spray applied before growth starts in the spring. The lice are difficult to kill, since their cottony coverings are not easily wet through by sprays. A coarse spray applied with high pressure, 400 to 600 pounds is advised. Either an oil emulsion (p. 25), miscible oil (p. 24), or lime-sulphur (p. 25) is recommended.

These insects can be successfully controlled on mature trees by an application of water applied with sufficient force to wash the aphids off the trees. On young stock this method has not been so successful; here a spray of nicotine sulphate (p. 25) applied with pressure is recommended.

THE PINE LEAF APHID, *Pineus pinifoliae* Fitch.

The pine leaf aphid makes terminal galls on black, red and Engelmann spruce. The galls are compact, having the appearance of true cones. They differ from other galls in that each chamber contains one or at most two aphids. Northern white pine is the intermediate host. The galls open early in July.



Fig. 14. Galls of (*Pineus floccus*) on Red spruce.

The females, when they deposit their eggs on the young needles of pines, arrange themselves six or eight in a row with their heads toward the base of the leaf. Here they anchor themselves and we find the wings and dead bodies of the parents protecting egg masses on the needles.

Pineus floccus Patch, makes terminal galls on black and red spruce and has for its intermediary host eastern white pine. The loose galls are produced by the broadening and thickening of basal portions of the needles. The needles are about normal in length. The galls open late in July. The migrating females settle on the old growth of white pine in a haphazard fashion and secrete a white wax-like coating.



Fig. 15. Terminal galls of (*Pineus similis*).

Pineus similis Gillette, has a life-cycle similar to that of *Adelges abietis*. So far as known no intermediate host is required. It forms loose terminal galls on Norway, white, red, black, Colorado blue, and Engelmann spruce.

Injury—The formation of terminal galls kills the tips of the twigs and causes numerous lateral growths to develop. This gives the trees a bushy appearance. Early in the season the galls die but remain on the trees until the following season. A severe infestation often kills, and mature trees gradually become deformed.

Control—Hand-picking is recommended where practical. A dormant application of oil (p. 24) before growth starts in the spring will kill overwintering individuals. Where summer treatment is required, a nicotine sulphate spray (p. 25) applied shortly after the galls open is advised.

Besides the aphids belonging to the subfamily *Adelginae* there are several species belonging to the genus *Cinara*, formerly known as *Lachnus* which are destructive to conifers; of these the following have been the most destructive to Michigan conifers.

THE RED CEDAR APHID, *Cinara (Lachnus) sabinæ* Gill.

The red cedar aphid attacks only *Juniperus* spp. This reddish-brown aphid is gregarious and collects in large numbers on the new growth of juniper early in the season. These colonies excrete large quantities of honeydew and it is this excess of honeydew on the foliage that often leads to the discovery of an infestation. The aphids usually disappear before the real injury becomes apparent. The weakened trees are particularly susceptible to the cedar bark beetle, *Phloeosinus dentatus* Say, which often follows the red cedar aphid and kills the trees. In this instance the bark beetle gets the credit, while the real culprit was the red cedar aphid. Even where the beetle is not present the aphid is often responsible for individual dead branches.

THE WHITE PINE APHID, *Cinara (Lachnus) strobi* Fitch.

This species is a large browning to black aphid with white or pruinose markings. It winters over in the egg stage, the large smooth black eggs being laid in an even straight line on pine foliage. Sometimes this species causes considerable loss, particularly on young trees.



Fig. 16. Eggs of the White pine aphid, (*Cinara strobi*) on needles of White pine.

Cinara (Lachnus) pini Linn., infests Scotch pine. This large, conspicuous reddish-brown aphid is capable of causing considerable injury, particularly to young trees. The body is reddish-brown flecked with dark specks. The species is generally distributed.

THE ARBORVITAE APHID, *Cinara (Lachnus) tujaefilinus* Delg.

This species is a small, hairy, amber-brown aphid measuring about one-eighth of an inch in length. The upper surface is ornamented with a film of white, powder-like material which not only serves to render the insect inconspicuous but also is a protection in that it prevents the ordinary contact sprays from coming in contact with the insect. The species is gregarious, the young collect in large colonies on the tender bark where they extract quantities of sap. The species is capable of being of considerable economic importance. It is widely distributed and besides Arborvitae it attacks cypress and several varieties of conifers.

Injury—Aphids belonging to this group secrete excessive amounts of honeydew, which is attractive to bees both tame and wild. Since the aphids themselves are often obscure, the presence of bees often leads to the discovery of a colony of aphids at a critical time. Also a black fungous growth invariably appears wherever honeydew collects in quantities. This fungous growth not only detracts from the general appearance of the trees but also tends to lower their vitality.

Control—The aphids belonging to *Cinara* spp. require not only a properly timed contact spray but a thorough application applied with a good pressure machine, giving from 400 to 600 pounds pressure. Since aphids belonging to this group are present on the trees after the dormant period 40-per cent nicotine sulphate (p. 25) is recommended.

SCALE INSECTS

Scale insects are separated into two main groups—the shield scales and the soft scales. The shield scales are those protected by a covering, free from the insect, consisting of molted or cast skins and wax secreted by the insect. Soft scales are those that do not use their molted skins for shields. Shield scales are practically stationary after the first few hours of their existence, while the soft scales are capable of moving throughout all or for a greater part of their existence.

Among the shield scales the male scales can be separated from the female scales readily by the number of molted skins or exuviae; the males have but one cast skin on their shield, while the females have two.

Among the shield scales infesting Michigan conifers are: the hemlock scale, the juniper scale, and the pine leaf scale, while among the soft scales are the Scotch pine scale, the spruce bud scale and *Lecanium corni*.

THE HEMLOCK SCALE, *Aspidiotus abietis* Comst.

The hemlock scale is usually found on the under surfaces of hemlock foliage. Both male and female scales are dark gray or almost black with light edges. Occasionally the shields have a blue, brown, or purplish tinge. The yellowish exuviae is covered by a thin film of transparent wax. It is more or less central in either sex and is always somewhat raised giving the general appearance of being superimposed.

Aspidiotus pini Comst., a species very closely related to *A. abietis* infests pine. The shields are practically identical but certain morphological differences in the insects themselves make it possible to separate the species.

Injury—Besides the accumulation of honeydew which is always produced when either of these scales is present in numbers, pale areas occur on the foliage and there is a tendency for the needles to drop.

THE JUNIPER SCALE, *Diaspis carueli* Targ.-Tozz.

Both the female and the male scales of the juniper scale are glistening white with pale lemon-yellow exuviae or cast skins. The female shields measure about one-twentieth of an inch in diameter. They are convex and circular with the exuviae or cast skin more or less central. The male scales are much smaller, elongated, ornamented with three parallel longitudinal ridges, but the exuviae or cast skins are terminal.

Life History—There is but one annual generation. Winter is passed in the immature stage and by the last of June young are established on the twigs, cones and leaves. The juniper scale is gregarious and it is not unusual for the infestation to be localized to certain individual branches. Several species of juniper as well as incense cedar, cypress and arborvitae are attacked.

Injury—Where the infestation is heavy, the foliage soon turns light gray and the tree does not have a thrifty appearance. Occasionally the scale is present in sufficient numbers to kill isolated limbs or even the entire tree.

Control—The juniper scale can be controlled by an oil spray applied in the spring before growth starts. An oil emulsion made from oil having a viscosity of at least 100 seconds (Saybolt at 100 degrees F.) and 70-per cent unsulfonated residue is preferred. Such an oil emulsion diluted 1 to 30 or 1 to 35 will check the scale without injury to trees, provided these precautions are observed:

1. It is inadvisable to spray a tree or shrub with an oil spray unless there is a definite reason for so doing.
2. Apply all sprays with pressure, taking care to coat the foliage lightly. Spray before growth starts in the spring.
3. Do not spray when there is any danger of the temperatures dropping below 40° F. before the spray dries.

It must be remembered that any oil will change the appearance of the foliage for a time, but that the original color will return in time.

THE PINE LEAF SCALE, *Chionaspis pinifoliae* Fitch.

The pine leaf scale attacks pine, spruce, hemlock, fir, and other conifers. The shields of both the males and the females are white, elongate, and have the cast skin or exuviae terminal. The shields of the males are somewhat smaller than those of the females, and have three parallel ridges lengthwise of the scale; those of the female are smooth.

Life History—The pine leaf scale passes the winter in the egg stage. The eggs hatch over a protracted period and it is difficult to be certain as to the number of generations each year.



Fig. 17. Pine leaf scale *Chionaspis pinifoliae*.

The eggs start hatching in June; the young may remain under the parent shield if the weather conditions are unfavorable; development is slow, and by early August practically all scales have reached maturity. Egg laying continues until late in the fall. The number of eggs per individual varies from 15 to 30.

Injury—Under some conditions the pine leaf scale is capable of killing trees. It is particularly destructive to young trees, to trees recently transplanted, or to trees low in vigor. Occasionally an infestation, severe enough to turn the foliage a sickly yellow, will gradually clear up of its own accord. This is due to the activities of tiny little hymenopterous parasites belonging to the same group as the ants, bees and wasps, or to the activities of some of the lady bird beetles.

Control—The pine leaf scale can be controlled with miscible oil (p. 24) or an oil emulsion (p. 25) or lime-sulphur 1 to 9 (p. 25) applied in the spring before growth starts.

THE SCOTCH PINE LECANIUM, *Toumeyella numismaticum* Pt. and McD.

The Scotch pine lecanium attacks Scotch, Austrian and Jack pine and in all probability will be found on other species of pines.

The mature females are oval decidedly convex, with the surface pitted or irregular. They are reddish-brown in color coated with a thin layer of transparent wax. There is considerable difference in size but they average about one-fourth of an inch in length. The male scales are much smaller than those of the female. They are flat, elongate, and have a transparent glassy appearance. Both sexes occur in the same cluster on the twigs and around the bases of the needles.

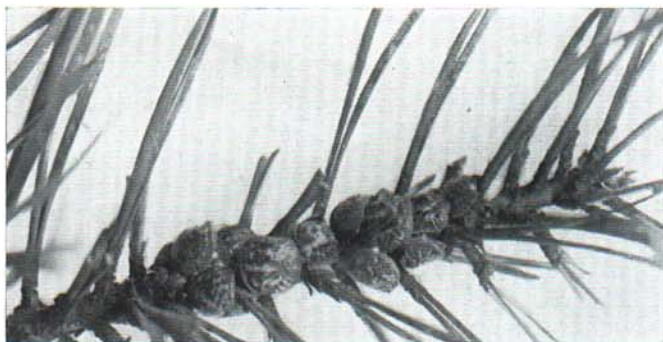


Fig. 18. Mature females of the Scotch pine Lecanium, (*Toumeyella numismaticum*) on Jack pine.

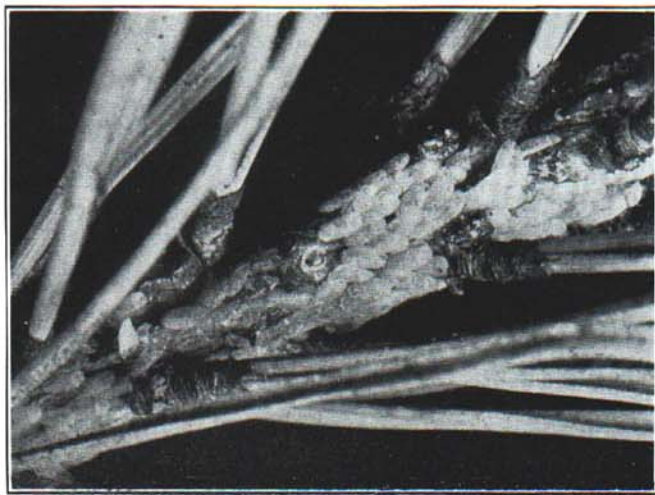


Fig. 19. Male and female scales of the Scotch pine Lecanium, (*Toumeyella numismaticum*) on Scotch pine.

Life History—There is one annual generation. Winter is passed by the obscure immature females on the twigs. The males appear in the fall and die after fertilizing the females, but the empty, glistening, white pupal cases of the males remain attached to the twigs and young branches until the following season. These empty cases give the bark a scurfy appearance and serve to draw attention to the infestation. The females pass the winter as partially grown individuals, wedged in among the empty pupal cases of the males. They adhere close to the rough bark around bud scars or other rough places on the bark and are difficult to detect. The surface of the body is covered with a thin coat of transparent wax. The immature overwintering females measure about one-eighth of an inch in length; as the season progresses they increase in size and take on a dark brown color.

Injury—The injury is confined to the lower branches. Often an infested limb is killed in one season. Where trees are severely infested the foliage drop is unusually heavy, and the needles that do remain on the tree are fore-shortened. The tree takes on an unthrifty appearance and within a few years usually dies. Mature trees are apparently preferred. This scale secretes immense quantities of honeydew.

Control—The Scotch pine lecanium can be controlled with either a miscible oil (p. 24) or an oil emulsion applied just before growth starts in the spring. Either spray to be effective must be applied with at least 500 pounds pressure.

THE EUROPEAN FRUIT LECANIUM, **Lecanium corni* Bouche.

The European fruit lecanium occasionally infests arborvitae. The mature females are large, brown, soft-bodied scales measuring from one-eighth to one-sixteenth inch in length. They are oval in form, more or less elevated, and frequently covered with a powdery or cottony material. The male scales are less conspicuous, smaller, flattened, elongated, practically transparent and ornamented with well developed ridges.



Fig. 20. *Lecanium corni* on arborvitae.

*It is entirely possible this species will prove to be *L. crudum* Green.

Life History—There is one annual generation. The immature forms winter over on the last years growth as small, flat-bodied creatures covered with a thin coat of transparent wax. Development is rapid in the spring and by the middle of June the eggs are laid. Each female produces a large number of eggs, ranging from a few hundred up into the thousands. As the eggs are laid, the soft parts of the mother gradually harden and dry thus forming a shell to protect the eggs. The young appear the last of June and migrate to the tender growth where they feed.

Injury—This insect does not injure arborvitae. It is objectionable largely because it is so conspicuous against the green foliage.

Control—It can be controlled with a miscible oil (p. 24) or an oil emulsion (p. 25) spray applied in the spring before growth starts.

THE SPRUCE BUD SCALE, *Physokermes piceae* Schr.

The spruce bud scale infests several species of conifers, but is especially destructive to Norway spruce. Mature individuals measure about one-eighth inch in diameter. They resemble the new buds of spruce so closely that it is difficult to detect the scales except when they first reach maturity. At this time they give off an excessive amount of honeydew. The adult is globular in form. The round, gall-like reddish-brown body is ornamented with irregular flecks of yellow and the whole subdued with a delicate coating of powdery wax. Usually several individuals collect in clusters of from 3 to 8 about the bases of the new growth. The infestation is terminal and largely restricted to the lower branches.

Life History—There is one annual generation. Winter is passed as immature individuals clustered about terminal buds. Just before the tree comes



Fig. 21. Spruce bud scales, (*Physokermes piceae*) collected about the bases of new growth on Norway spruce.

out of its semi-dormant period in the spring these immature scales complete their development, and eggs are produced in the gall-like bodies of the mother scales. The eggs hatch about June 1 and the young establish themselves on the new growth.

Injury—The spruce bud scale thrives on weak trees. It checks development and tends to lower the vitality of the tree not only by the quantity of sap it extracts from the tree but by the excessive amount of honeydew excreted in the early spring. This drenches the foliage and serves as a culture medium for a black fungus which spoils the appearance of the tree as well as reducing the tree's vigor.

Control—The spruce gall scale can be controlled with a spray of miscible oil (p. 24) or an oil emulsion (p. 25) applied in the spring before growth starts. A summer application of 40-per cent nicotine sulphate and oil (p. 25) applied during mid-summer will be effective.

CERCOPIDAE OR SPITTLE INSECTS

The group Cercopidae are commonly known as spittle insects or frog hoppers. The young have the habit of secreting a quantity of frothy material as a protection between molts and the large bulging eyes of the adult give them a frog-like appearance. The spittle is most pernicious, often adhering to the tree long after the insect has molted and secreted a new mass. There are a number of different kinds of spittle insects, of these the pine spittle insect is the most destructive to conifers.

THE PINE SPITTLE INSECT, *Aphrophora parallela* Say.

The pine spittle insect restricts its host plants to conifers but within this group it is a general feeder. The adults measure from three-eighths to one-half inch in length. The general color is a mottled brown, affording the species a remarkably protective resemblance with the bark on which it rests. The wings slope roof-like down over the sides. The young are wingless when they first appear. Five molts are required to complete development and with each molt the wing pads increase in size until they become adults.

Life History—There is one annual generation and winter is passed in the egg stage. Young appear on the new growth by the last of May or in early June. They feed first near the tip of the twig. The mass of spittle secreted by the young is not particularly conspicuous. With each molt, a new mass of spittle is secreted, and the insect usually gradually works back on the mature growth. The quantity of spittle secreted in the latter development is conspicuous. The adults appear in July and continue to be active into September.

Injury—The injury caused by spittle insects is frequently attributed to other causes since the real culprit usually disappears before the injury becomes apparent. The insect is capable of killing young trees or it may reduce the vigor of the host plant so that the plant succumbs to some other insect or disease. Where the health of the tree is apparently unimpaired the masses of spittle on the foliage are objectionable.

Control—It is possible to dislodge the young even where protected by the spittle, with water applied with 400 to 500 pounds pressure. Contact sprays are also effective but to be successful they must be applied with 400 to 500 pounds pressure. Since the amount required varies with the brand used it will be necessary to follow the directions of the maker. For either pyrethrum or 40-per cent nicotine sulphate use double the amount recommended to kill ordinary aphids.

MITES

Mites have been included along with the sucking insects infesting evergreens since they represent an important group of Arthropods closely related to the insects, and they are controlled by the same applications recommended for the aphids or scale insects.

THE SPRUCE MITE, *Paratetranychus ununguis* Jacobi.

The spruce mite is the predominating species of mite infesting Michigan conifers. Apparently all conifers are subject to attack, but the mite shows a decided preference for spruce, particularly blue spruce. The young mites are pale green in color, growing darker with each successive molt, the adults being either a dark green or nearly black. The dorsal surface of the body is ornamented with plumose spines, and the legs of the mature specimens are salmon pink. The mature mites spin a quantity of webbing which affords an effective protection for themselves and for their eggs.

Life History—The spruce mite passes the winter in the egg stage. Mites in all stages of development are present on conifers from early spring until fall—the generations overlap, making it impossible to separate the broods. About 20 days are required to complete a life-cycle.

Injury—Infested trees have a “rusty”, unthrifty appearance. Where the infestation is long-established the foliage turns greyish-green or bronzed. This typical appearance is due not only to the feeding of the mite but to the accumulation of webbing common to this species. The older needles are attacked first, and the injury is always apparent first on the lower branches. This mite is capable of killing trees. The death of the tree is progressive, and may extend over several years. On young trees or on nursery stock the vitality is lowered and the trees may die the first season or become so stunted that they are worthless.

Control—The spruce mite can be controlled with a spray of a miscible oil (p. 24) or an oil emulsion (p. 25) applied in the spring before growth starts.

Where it becomes imperative to check an infestation during the growing season, either a spray of glue (1½ pounds to 10 gallons of water), or bill-posters' paste (1 pound bill-posters' paste plus spreader to 25 gallons of water) is recommended.

Glue—Dissolve the glue in a small quantity of warm water and dilute to the amount specified. Strain the glue-water into the spray tank and apply with 400-500 pounds pressure. (An application of glue improves the appearance of the tree, leaving the foliage shining as if it had been specially

cleansed.) Occasionally the tips, particularly when the new growth is tender, have a tendency to stick together or to ball up. This can be readily corrected by an application of water. During seasons when mites are particularly troublesome it may be necessary to make a second application during the growing season.

Bill-posters' Paste—An application of bill-posters' paste (1 pound to 25 gallons of water plus a spreader such as skim milk) applied with 400-500 pounds pressure will control mites without detracting appreciably from the appearance of the tree.

CONTROL MEASURES

The sprays which have been most efficient in controlling sucking insects on dormant conifers are listed in the order of their efficiency, miscible oils and oil emulsions, lime-sulphur, and whale-oil soap. Where an outbreak appears in the summer and control measures are required, contact sprays like nicotine sulphate or pyrethrum are advised.

Dormant Applications

Oil Sprays—There are two distinct types of oil sprays—miscible oils and oil emulsions. The miscible oils are largely proprietary and the oil emulsions are now largely homemade. The factors to be taken into consideration before deciding between the two types of oil are largely matters of convenience and cost. Where only a few trees are to be sprayed the amount of money saved by using a homemade preparation will be lost in the inconvenience of preparing the homemade emulsion.

In either case these precautions are suggested.

PRECAUTIONS—Conifers, particularly trees weakened by insects or other causes, are particularly susceptible to oils.

1. Never apply an oil spray at a time when there is a possibility of snow or when there is danger of the temperature's falling below 40° F. before the spray dries.

2. *Be sure that the emulsion is perfect*—that no free oil has separated out and is floating on top before applying the spray.

3. With our present knowledge it is not considered advisable to spray conifers with an oil spray more than once in three years.

4. Where a proprietary preparation is used, follow the directions of the maker.

5. Never use any oil spray on conifers except where it is applied with a spray machine giving 400-500 pounds pressure.

6. A light film of oil on the foliage is all that is required, provided the film is evenly applied. More oil is wasted and injures the tree.

Miscible Oils—Miscible oils are combinations of mineral oils with some material or materials that make them mix with water. The concentrated preparation looks like oil and contains little water. When added to water it forms a milky white emulsion. Since each proprietary brand differs from the other and since all manufacturers are constantly changing their formulæ it is necessary in each instance to follow the directions of the maker.

Bordeaux-Oil Emulsion—Of the homemade oil emulsions used, a 2-per cent bordeaux-oil emulsion has been the most satisfactory on conifers. These proportions in 100 gallons of water will give a 2-per cent emulsion:

Water	4 gallons
Copper sulphate (stock solution)	1 quart
Hydrated lime (stock solution)	1 quart
Oil	2 gallons

Place 4 gallons of water in a clean, empty spray tank. Start the engine and strain the copper sulphate stock solution (4 ounces copper sulphate dissolved in 1 quart of water) into the water; then add the hydrated lime (6 ounces mixed in 1 quart of water), last, add the oil.

Any oil having approximately 100 seconds viscosity (Saybolt at 100 degrees F.) and 60-70-per cent unsulphonated residue should be satisfactory.

Emulsify by pumping the combination at high pressure (at least 250 pounds) through the spray gun or nozzle back into the tank, continue to pump the emulsion until it is a cream and there is no evidence of free oil.

Add water to fill 100-gallon tank and apply. Keep the agitator in operation until the tank is empty and be certain that the concentrated emulsion is out of the hose before applying any spray to foliage.

Lime-Sulphur—Commercial lime-sulphur 32° Baumé, diluted 1 to 8, is sometimes applied to conifers just before growth starts. It is recommended for the control of aphids, especially the pine bark aphid. It is objectionable because it leaves a stain on the foliage.

Whale-Oil Soap—Where whale-oil-soap is diluted, 1 pound to 8 gallons of water and applied to conifers before growth starts in the spring it has been found effective in the control of aphids.

SUMMER APPLICATIONS

During the growing season occasions arise which require summer application of contact insecticides. Both 40-per cent nicotine sulphate and pyrethrum kill aphids and certain species of scales.

Nicotine Sulphate—When an application of 40-per cent nicotine sulphate is applied to infested trees at the time the aphids are on the foliage or on the bark a satisfactory control will be effected. Use 1 pint 40-per cent nicotine sulphate to 100 gallons of water, plus 4 pounds of dissolved laundry soap. Recently a sulphonated higher alcohol commonly sold across grocery counters as a cleansing agent has been substituted for laundry soap and found superior. Use 6 ounces of the dry powder to each 100 gallons. Any nicotine spray should be used immediately after it is mixed.

Pyrethrum—Various brands of pyrethrum are available on the market and since each brand varies to a certain extent it is recommended that the grower follow the directions of the maker. Pyrethrum sprays are particularly useful in protecting valuable ornamental conifers.

Hand Picking—Where only a few small trees are infested hand picking is suggested. When the galls are removed before they open and the aphids establish themselves on the foliage, the infestation will be effectively checked.

CAUTIONS

The spraying of conifers is generally looked upon as an uncertain proposition, and any spray may do a certain amount of injury. However, when the question of allowing the insects to kill or ruin the appearance of the tree is balanced against the possible injury, the grower usually decides in favor of the spray.

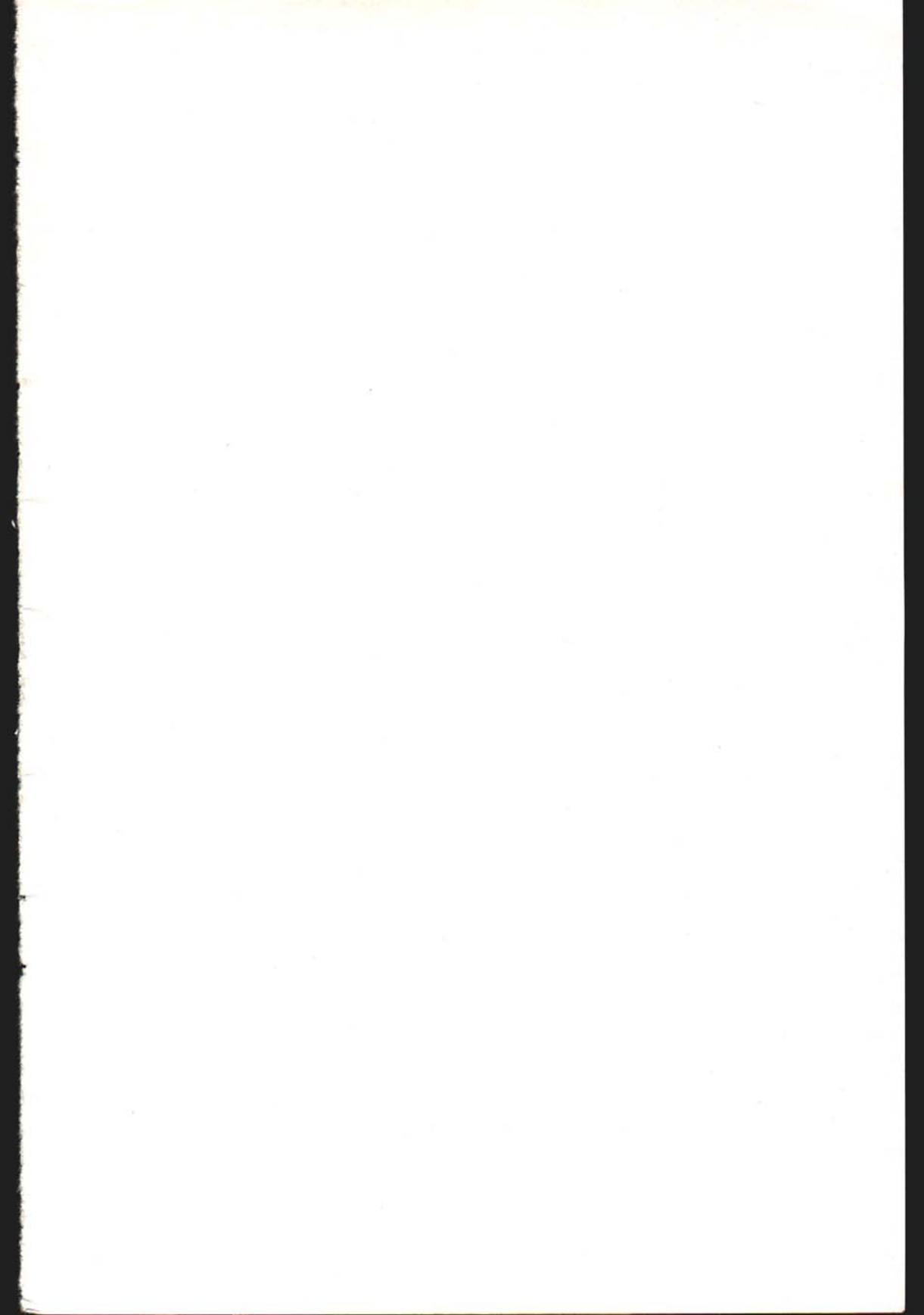
Where oil sprays are applied observe the precautions listed on page 24.

Whatever spray is applied it will kill more insects and cause less damage to the tree if it is applied with 400 to 500 pounds pressure. Remember only a film of oil on the foliage is required.

It is especially important to cover the tip ends of the limbs, especially on the underside since this is where many aphids pass the winter.

Any spray removes the "bloom" from the foliage of conifers, and for a time the tree will be almost a uniform green. The bloom gradually returns.

Be certain in every instance before applying a spray that the spray machine is cleaned thoroughly.



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