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CHRISTMAS TREE INSECT MANAGEMENT



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Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U. S. Department of Agriculture, G. S. McIntyre, Director, Cooperative Extension Service, Michigan State University, East Lansing, Mich.

CHRISTMAS TREE INSECT MANAGEMENT

By WILLIAM E. WALLNER¹ and JAMES W. BUTCHER^{2,3}

Christmas tree production is an important Michigan enterprise. In addition to planting, shearing and harvesting trees, insect and mite control may be a major consideration. It is a rare tree-planting which is not subject to attack by one or more pests sometime during the period from planting to harvest. Pests hinder normal growth and damage tree quality, reducing the percentage of marketable trees. They can cause different types of damage and vary in intensity between plantations and state location. Routine inspection with the aid of this bulletin will allow you to detect early infestation before problems become acute. Early detection will minimize tree losses and control procedures over the long term.

Presently, chemicals offer the most practical, quick, remedial treatment for protecting trees from losses by insects and mites. However, because Christmas trees do not command a high-acre value per year, application of routine protective sprays year after year in the absence of a major pest problem reduces profits. Routine chemical sprays, particularly those with persistent activity, may reduce beneficial insects and lead to increased pest species activity. Many insects found on plantation trees have parasites, predators or diseases which tend to keep them at low numbers. While the impact of these natural controls is not completely known, judicious use of short-lived chemicals, applied at the proper time, will encourage their integration into your management program.

Complete eradication of an insect is seldom possible. However, it is possible to reduce insects to tolerable levels which do not detract from harvest profits. An insect population can be managed by watching its increase closely and applying controls when it increases to an economic level. Each grower

must establish the economic or control level for his different plantings since it will vary with tree age, time until harvest, extent of infestation, and the pest involved.

Numerous insects damage Christmas trees; all parts of the plant (roots, trunk, branches, twigs, and needles) can be affected at one time or another. When considering their control, remember that: (1) Insects usually damage trees in different ways; and (2) insects can be present at different times of the year. These two conditions complicate Christmas tree insect control.

This bulletin has four sections. The first outlines some ideas about the use of chemicals. The second describes insects and mites and lists control methods. The third gives dosage rates and warnings about the insecticides and miticides you may be using. The fourth describes the equipment needed.

To identify insects properly, learn the important parts of their bodies. The labeled photographs on page 4 show a sawfly larva (caterpillar-like worm), June beetle adult, two types of scales and the two kinds of mites found on pines. Refer to these drawings when insects or mites are described.

NOTE: When insects have wings, they are attached to the thorax.

To properly identify a tree's damaged parts, learn the important names of its structure. The two photographs on page 5 show a Norway spruce and a cross section of a white pine trunk. The important parts of the spruce and the white pine cross-section are labeled. Refer to these draw-

ings when damaged parts of a tree are described. **NOTE:** The numbers in parentheses following each insecticide or miticide in Section II refer to the same numbers in Section III that describe the insecticides or miticides. In some cases, dosages are given in Section II without referring to Section III.

Plant Christmas Trees For Better Insect Control

Christmas tree insect control depends largely on how well you can apply treatments. Hard to control insects, such as European pine shoot moth, white pine weevil, scales, mites, and others, require thorough application of insecticides. With heavy ground equipment, leave roadways every 40 feet. These roadways will allow you to spray your trees effectively from two sides.

The abundance of various insects will vary over the years. New pests may become dominant and once critical problems may decline. For example, European pine shoot moth, the most severe pest attacking plantation trees 10 years ago, is presently of minor importance. The reasons for its scarcity are unknown, but natural and chemical controls as well as mid-summer shearing, which destroy eggs, are believed to have caused its decline. On the other hand, insects such as aphids that cause needle cast, pine shoot borer, thrips, and a newly discovered needle and bud miner have recently become dominant problems. It is not possible to predict the impact of trees resistant to insect attack or natural or silvicultural controls but such practices should be encouraged where possible.

WARNINGS

All insecticides, fungicides and nematocides are poisonous in varying degrees. Some are very dangerous to use. Handle these materials cautiously so that they will not poison livestock,

children, or the user. Read the label on the package carefully for instructions on how to use all insecticides, fungicides, and nematocides. State and federal literature also contains valuable

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³The authors thank Professor Lester Bell, Extension Specialist in Forestry, for his help in preparing this bulletin.

information on the proper use of these chemicals.

NOTE: DO NOT ALLOW INSECTICIDES OR MITICIDES TO DRIFT ONTO PASTURES, HAY FIELDS, FOOD CROPS, LAKES, STREAMS, PONDS OR WOODED AREAS OTHER THAN YOUR OWN CHRISTMAS TREE PLANTATION.

When used on animal or human food crops, certain restrictions are placed on the chemicals listed in this bulletin. When applied to water, many of the materials listed herein can kill fish.

To determine the dangers of drift, read the label on the package. Follow the same restrictions for insecticide and miticide drift as for direct application of the same materials to food crops. For dangers of fish poisoning from insecticides applied to water and for their effect generally upon wild life, get information from your county agricultural agent.

Insecticides vary in their poisonous effects on birds and other wildlife. Generally chemicals such as BHC, lindane and chlordane are more persistent than malathion, dimethoate, and meth-

oxychlor. If at anytime there is a question about the use of the more dangerous materials, MALATHION can be used advantageously on sawflies, jack-pine budworm, and other foliage feeders.

POISON CONTROL CENTERS:

Your doctor can get help for insecticide, fungicide, and nematocide poison cases. Have him telephone or write one of the poison control centers listed on page 29.

IDENTIFICATION KEY FOR THE INSECTS*

Place of injury	Description of damage, insect, or mite	Name of insect or mite
Damage to roots	Small roots eaten; bark of larger roots stripped; larger root tips missing. Large (up to 1½ inches long), white curved grubs with brown heads and thoracic legs.	White grubs (June beetles)
	Small rootlets eaten; bark often removed. Small, (up to ½ inch long) white curved grubs with brown heads; no thoracic or abdominal legs.	Strawberry root weevil
Damage to trunk	Bark damaged at ground level; blackened pitch present. Small, (up to ½ inch long) white curved grubs with brown heads; no thoracic or abdominal legs.	Pine root collar weevil
	Small, pinkish worms with black spots occur inside wilted terminals. Top of tree dies because of tunneling around terminal and lateral growth of first whorl or elsewhere on the main trunk. Growth may enlarge above girdled stem.	Zimmerman pine moth
Damage to bark of trunk, stems and twigs	Gum may ooze from damaged bark turning into a white scale-like material. A STICKY, HONEYDEW IS PRESENT. White speckled, brown, or yellowish-green sucking insects that feed in colonies or move about slowly.	Aphids
	Gum oozes from damaged bark turning into a white scale-like material. Injured needles are brown, notched on one side, and often bent over. Buff or dark-tan beetles, ½ inch long.	Anomala beetle (pine chafer)
	In the spring, gum oozes in droplets from leader bark. Injured needles and leader bark turn brown and die in July. Small holes occur in the bark.	White-pine weevil
Damage to twigs or branches	Ball of gray or brownish pitch located in branch crotches. A reddish worm with brown head occurs inside the ball.	Pitch-blister moth
	Small, green or brown-pineapple, or cone-like galls or swellings located at the base of new twig growth on Norway, white, black, and red spruce.	Eastern spruce gall aphid

* Not all of the insects given in this bulletin are listed in this Identification Key. Consult the index for others.

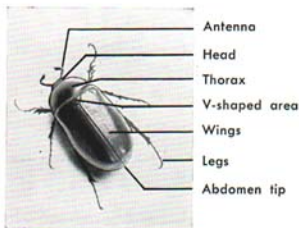
IDENTIFICATION KEY FOR THE INSECTS

Place of injury	Description of damage, insect, or mite	Name of insect or mite
Damage to twigs or branches/Cont.	Green or brown (often slightly curved) galls located on new growth tips of oriental, Colorado blue, Sitka, and Engelmann spruce; similar to eastern spruce gall, but longer and less compact.	Cooley spruce gall aphid
	Irregular areas chewed in bark of twigs 2-3 years old, causing twigs to die. Damage primarily associated with cutover plantings.	Pales weevil
Damage to shoots	Shoot stunted, yellow or brown. In the spring and fall, the tunnel inside the damaged shoot or bud can contain a brown worm.	European pine shoot moth
	Terminal and lateral shoots wilt, break off at right angles, then turn brown during July and August. One or more larvae completely tunnel out center of shoot.	Pine shoot borer
	Shoots stunted or killed preventing elongation. New growth killed back causing stunting and goose-necking.	Pine needle miner
Damage to needles	Needles often entirely eaten. When mature (¾ inch long), these worms are dirty gray-green with black heads and striped bodies. They feed in large groups. Present from early May to early June.	European pine sawfly
	Needles often entirely eaten. When mature, (1 inch long) these worms are red-headed and yellow-bodied with six rows of black spots down the back. They feed in large groups. Present from early July to mid-August.	Red-headed pine sawfly
	Needles chewed off at base and webbed together when new growth is 1 to 1½ inches long. Reddish brown worms with yellowish sides and a shiny black or brown head are often found inside the web.	Jack-pine budworm
	Needles notched just above the sheath; the needles often turn brown and break over at the notch. Heavy beetle feeding completely destroys needles. Damage caused by buff or dark-tan beetles, ½ inch long.	Anomala beetle (pine chafer)
	Pine foliage yellows in September, turns brown in spring. Brown flecks present beneath bark of needle bearing parts of plant. Spittle masses on sweet fern, blackberry, and other plants, but not on pines; the adults feed on pines.	Saratoga spittlebug
	Needles brown; twigs die from tip to trunk. Spittle masses present on pine twigs and branches, mid-May to July.	Pine spittlebug
	Needles yellowish with a gray-speckled appearance. Black specks present especially on the underside of the needles.	Mites
	Needles 2-3 years old turn yellow, then drop during late summer and early fall. Trees become thin with few internal needles.	Aphids

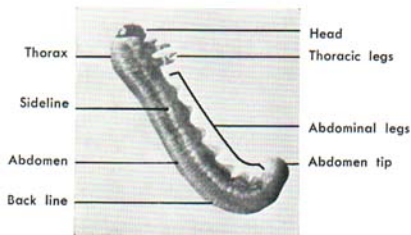
IDENTIFICATION KEY FOR THE INSECTS

Place of injury	Description of damage, insect, or mite	Name of insect or mite
Damage to needles/Cont.	Elongated white or yellowish-white shield-like scales on the needles. Length of these scales is not more than $\frac{1}{5}$ inch. Off-colored foliage; growth is stunted.	Pine needle scale
	Oval, chestnut-brown insects about $\frac{1}{4}$ inch long on branches nearest tips. Tree growth stunted; branches or trees killed; foliage covered with black sooty accumulations.	Pine tortoise scale
	Growth of Norway and other spruces, particularly of lower branches, is retarded. Branches may be killed and blackened due to honeydew liberated by scales when feeding.	Spruce bud scale
	Needles stunted and brown, dropping prematurely. Black or lemon yellow insects $\frac{1}{16}$ inch long feed on buds and needles of new growth, causing brown patches.	Thrips
	Needles stunted, tips become distorted, and turn brown. Mites $\frac{1}{25}$ inch long feed in the needle sheath and along inside blade of needle.	Eriophyid mites
	Needles mined out and webbed together along axis of twig. Trees rarely defoliated but appearance is ruined due to webbing of older needles.	Spruce leaf tier
	Other troubles	Name of trouble
	Needles yellowish with brown tips or grayish-green with yellow tips.	Drought and wind burn
In early spring, young spruce shoots turn white or yellowish-white. The needles on these shoots are crisp and dry.	Frost damage	

Insect Identification Parts

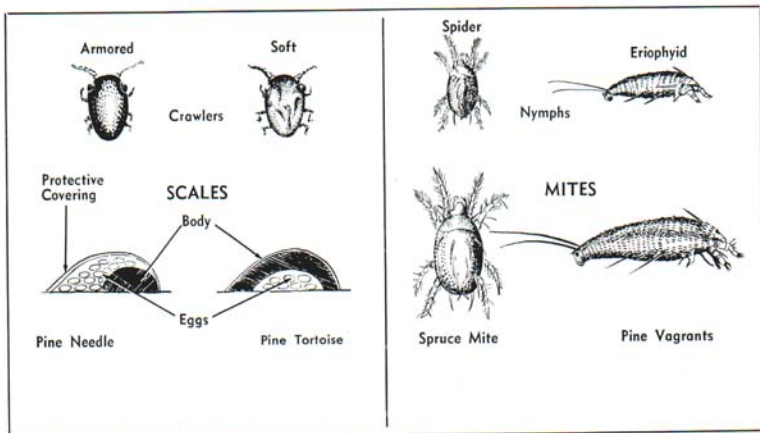


June beetle adult

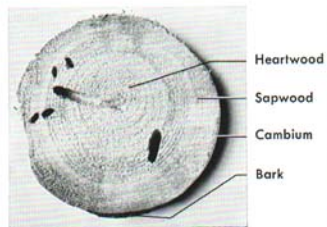


Sawfly worm. Note the eight pairs of legs on the abdomen. By contrast, moth caterpillars have only five pairs of abdominal legs.

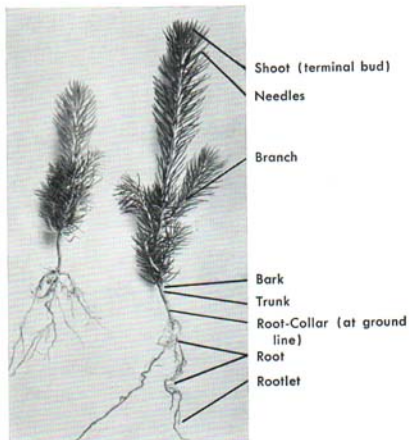
Scales and Mites Affecting Christmas Trees



Structure of a tree



Cross-section of white pine trunk.



Seedlings

SECTION I

INSECT CONTROL

Since insect problems are seldom identical for different plantings, it is impossible to prescribe a standard, all-purpose, spray program. Specific treatment for each insect gives the most satisfactory results. However, should two or more insects occur on the trees at the same time, you may be able to apply one insecticide to control all of them. If a single insecticide is not available, combine two materials that will do the job.* To make the proper selection, carefully read the control section for each insect.

Not all pests damage trees rapidly

*When mixing two different insecticides in the spray tank, be sure they will combine safely. Help for the compatibility of insecticides is in American Fruit Grower's Farm Chemicals, "Spray Compatibility Chart," or Michigan State University Extension Bulletin, E-312 (1969 Farm Science Series) or E-164 (1976 Farm Science Series).

nor do they produce the same symptoms. Periodic inspection of plantings is essential for early detection of the insect or mite and the damage it causes. Insects such as Zimmerman pine moth, pine root collar weevil, pales weevil and pine shoot borer usually will not damage a large part of a planting in 1 or 2 years. Early symptoms indicate their presence so that their increase can be observed, and controls can be applied when needed. Other pests such as aphids, mites, scales, anomala beetles and sawflies can damage plantings extensively in one year. They require quick detection and control. Use this bulletin, particularly the damage identification section on pages 2-3, to recognize early symptoms.

In Section II, the life cycle of each insect and control procedures are discussed. In most cases, a treatment con-

trols a certain stage of the insect. However, since insect activity is directly influenced by weather conditions, you must be capable of recognizing the insect's state of development. The critical time for applying controls will depend upon the location of the planting within the state. Consult your county extension agricultural agent for seasonal and area Christmas tree insect activity.

Correct diagnosis and timing of controls are important, but, in the final analysis, proper selection and dosage of the chemical and adequate spray coverage are paramount. One, thorough, well-timed application may be all that is necessary to suppress a pest. Poor application practices may necessitate repeat treatment. Refer to Section IV for equipment suited for applying chemicals to Christmas trees.

SECTION II

ANOMALA BEETLE (Pine chafer)

Trees Damaged: The adult insect prefers jack and Scotch pines but also feeds on red and white pines.

How to Identify: The adult anomala beetle occurs in two colors. The female is tawny or buff; the male is dark-tan with a greenish-bronze head. The female is $\frac{5}{16}$ inch long while the male is $\frac{3}{16}$ inch. Note: this pest belongs to the same family as the white grubs.

Life History: Anomala beetle eggs are laid in grassy soil often near the trees upon which the adult feeds. The grub feeds on grass rootlets and other materials; it passes the winter in the soil. Grub feeding continues again in the spring. Pupation occurs in early June and the adult comes from the soil about June 15 to July 5, depending on the location.



Adult anomala beetles. The dark colored ones are males; the light ones are females. About $\frac{1}{2}$ inch long.

Type of Injury: The adult is the only form that damages the foliage of evergreens. It notches the needle just above the sheath causing it to bend downward and turn brown. However, large numbers of beetles tend to devour both needles and sheaths. Also the bark is damaged causing pitch to form on its surface. This pitch eventually dries into a hard, gray-white, scaly material. Thus, areas of branches

are stripped of needles and bark is damaged, reducing tree value.

Control: Apply treatments directly to adult beetles on the foliage. Spray with Carbaryl (Sevin), (3a or 3b or 3c), or lead arsenate or methoxychlor (12a or 12b).

APHIDS

Trees Damaged: Aphids damage all pine and spruce trees.

How to Identify: Winged and wingless aphids occur on needles, twigs, or branches. Their color varies from yellowish-green or brown to black. While most aphids affecting evergreens are quite small, the white pine aphid is nearly $\frac{1}{8}$ inch long. Aphids have two tubes (cornicles) projecting upwards and backwards from near the abdomen tip. Aphid honeydew is usually present on infested trees.

Life History: Pine and spruce aphids overwinter either as nymphs or black eggs on needles and twigs. The eggs hatch into nymphs that in time give birth to living young. Several generations occur each year. Most aphids present during the summer months are females. These also give birth to living young. It is only in the fall or during adverse summer weather that males appear and eggs are laid.



Typical winged adult aphid. Enlarged about 6 times. The two outside tubes projecting from the abdomen tip are typical of aphids.

Type of Injury: Aphids suck juices from branches, twigs, and needles of Christmas trees. This feeding causes galls, swelling of woody parts, leaf injury, premature needle cast, or leaf curl. Gum often oozes from aphid feeding wounds. This gum hardens in time, in many cases reducing the trees' sale value.

Note: Sooty mold fungus often grows on the honeydew of aphids and the secretion of scale insects. Best control of it is the prevention or elimination of aphids and scale insects.



Aphid feeding damage. Aphid injury is the gray damage to the new growth needles.

On valuable trees, sooty mold can be removed as follows: Use 4 ounces of detergent to 100 gallons of water. Best results follow where the spray is applied with pressure. Rinse trees with water to remove the material within 24 hours after application. Dilute any accumulation of the detergent on grass to prevent burning.

Control for aphids: Spray as soon as aphids are seen, usually during late May or early June. Use diazinon (5a, or 5b), or endosulfan (Thiodan) (7a, or 7b), or Meta-Systox-R (11), or dimethoate (Cygon) (6), or malathion (10a, or 10b). **Note:** for mist-blower application, use at least 50 gallons of dilute spray per acre.

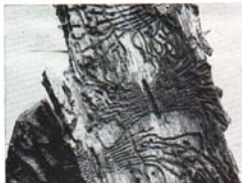
BARK BEETLES

Trees Damaged: Many kinds of bark beetles attack pines and spruce grown for Christmas trees.

How to Identify: The area just beneath the bark is grooved (engraved) by numerous designs. From a larger central groove (tunnel) smaller tunnels run at right angles through the inner bark. Both adult beetles and grubs (worms) can be present at the same time in the tunnels or in the outer bark. Full grown grubs are $\frac{1}{2}$ to $\frac{3}{4}$ inch long, curve-bodied, legless, and whitish with a reddish-brown or black head. The adults are about $\frac{1}{16}$ to $\frac{1}{8}$ inch long, and range in color from reddish-brown to black. Small round holes are usually present in the outer bark of infested trees.

Life History: Life activities vary a great deal among the many kinds of bark beetles that damage pines and spruce. Generally, however, these insects overwinter as grubs in the inner bark. During June and July they come out of the bark as adults. At egg-laying time, the females tunnel egg galleries along the inner bark next to the sapwood part of the tree. Their eggs are laid in the sides of these galleries. The eggs hatch into grubs that make tunnels through the inner bark. One or more broods occur each year, depending on the kind of bark beetle.

Type of Injury: Bark beetles injure and sometimes destroy the food-and-



Bark beetles or engraver-beetles form egg and brood galleries (tunnels) in the inner bark or sapwood, or in both. Each kind of beetle makes its own design.

water-carrying areas of the tree, often killing it in a year or two. Their feeding may also loosen the bark.

Control: If possible, maintain tree vigor by fertilizing and watering. Bark all cut logs or felled trees within the vicinity of Christmas tree plantings. Keep slash (cut limbs, tops, etc.) in the open and turn it often to kill the beetles with the sun's heat. Spray trunks and branches of growing trees June 1 and again August 1 with lindane (9a, or 9b) or methoxychlor (12a, or 12b).

COOLEY SPRUCE GALL APHID

Trees Damaged: This aphid produces galls on Colorado blue, Sitka, and Englemann spruce. It also feeds on Douglas fir, but does not form galls on this tree.



Cooley spruce gall aphid; the gall shown is about 1/3 actual size.

How to Identify: Elongated pine-apple- or cone-like curved galls or

swellings, 1 to 2 inches long, are located at the tip of new twigs. When the galls open in July, you can see the aphids inside of them.

Life History: The life history of Cooley spruce gall aphid is extremely complicated. However, the following information will give you a good idea of how this insect lives: It overwinters as a nymph at the base of spruce or Douglas fir buds. In the spring, the overwintering nymph matures and lays eggs. The eggs hatch and the young feed on the base of new spruce needles, causing them to swell and form galls. In July or August the galls open, and some of the escaping aphids fly to Douglas fir where they lay eggs on needles. The eggs hatch and the nymphs overwinter on this tree. The next summer these aphids either continue to live on Douglas fir or fly back to spruce. Cooley spruce gall aphid can also live continuously on spruce.

Type of Injury: Cooley spruce gall aphid feeds on spruce by sucking juices from the needles. This feeding causes the spruce tree to form galls. Some of the aphid-injured twigs become weakened, deformed, or die.

Control: Spray spruce or Douglas fir trees in late April or early May with endosulfan (Thiodan) (7a, or 7b) or Meta-Systox-R (11) or carbaryl (Sevin) (3a, or 3b) or BHC (2a, or 2b, or 2c), or lindane (9a, or 9b, or 9c). Galls may be removed from spruce before they open in July, making chemical treatment unnecessary. This may be practical only where small numbers of trees or light infestations are involved.

Note: Do not plant Colorado blue, Sitka, or Engelmann spruce in the same planting with Douglas fir. This will help control Cooley spruce gall aphid on spruce.

EASTERN SPRUCE GALL APHID

Trees Damaged: The eastern spruce gall aphid produces galls on Norway, white, black, and red spruce.

How to Identify: Located at the base of new twigs are small pineapple- or cone-like galls or swellings up to 1/4 inch long. When the galls open

in July, you can see the aphids inside of them.

Life History: This aphid overwinters as a tiny bluish-gray nymph, mainly at the base of spruce buds. In the spring, the overwintering nymph matures and lays eggs. The eggs hatch



Eastern spruce gall aphid.

and the young feed on the base of new needles, forming galls. In late July or August, the galls turn brown and open, allowing the enclosed aphids to escape. These soon develop wings and lay eggs from which the overwintering nymphs hatch. **Note:** Eastern gall aphid does not normally live on Douglas fir.

Type of Injury: The eastern spruce gall aphid sucks juices from spruce needles and other tender plant parts. Some of the injured twigs die, or may become weakened or deformed.

Control: Spray in early April before the buds begin to swell or in early fall when the aphids are on the foliage. Use endosulfan (Thiodan) (7a, or 7b) or Meta-Systox-R (11) or lindane (9a, or 9b) or BHC (2a, or 2b). Galls may be removed before they open in July, making chemical treatment unnecessary. This may be practical only where small numbers of trees or light infestations are involved.

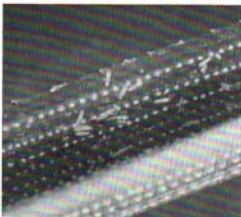
ERIOPHYID MITES

Trees Damaged: Scotch, red Austrian, white and mugho pines.

How to Identify: Extremely small (1/16 inch long) wormlike, creamy-white creatures occur inside the needle sheath or along the inside blade of the needles. The tips of the needles are twisted or hooked, brown in color and if the injury has progressed far enough, dead. Stunting and deforming of new growth is a characteristic symptom.

Life History: It appears that adult hibernating forms overwinter and become active with the first warm weather of April. Eggs are laid in or on the needle sheath. Several overlapping generations occur by late fall.

Type of Injury: Eriophyid mites pierce the needles, liberating juices which they take up through their sucking-type mouth parts. Injury to Christmas trees is twofold: 1) Loss of plant juices and 2) Preventing movement of fluids in the needle due to the lacerations and punctures by the mites. This type of feeding and the damage it produces, turns the needle tips yellow or brown and premature drop of these plant parts occurs.



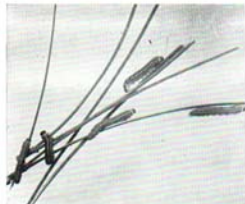
Eriophyid mites on the inside blade of a pine needle (highly magnified).

Control: Two sprays of malathion (10a or 10b), one during early May and another in 10 days, will reduce populations. Spray branches and needles thoroughly.

EUROPEAN PINE SAWFLY

Trees Damaged: The European pine sawfly feeds on jack, red, and Scotch pine plantings 2 to 15 feet tall.

How to Identify: When mature, the European pine sawfly larva (worm) is



European pine sawfly. Note the 7 or 8 pairs of legs on the worm's abdomen; moth caterpillars have no more than 5 pairs of these abdominal legs.

$\frac{1}{2}$ inch long; its head is black and the body dirty gray-green with a lighter green line down the back. On each side of the lighter green line, two whitish lines border a stripe of dark green which sometimes is nearly black. The European pine sawfly feeds in large groups on mature foliage. When disturbed, it immediately raises its head.

Life History: During September and October, eggs are laid in a series of slits cut in the needle's edge of the current season's growth. They overwinter in the needles and hatch in early May. While feeding, the worms move from needle to needle. There is only one brood a year.

Type of Injury: The European pine sawfly feeds only on mature foliage. When numerous, it strips the old needles from the trees; thus, single branches or a whole tree can be killed.

Note: Since the damage is almost entirely to mature foliage, there is a greater chance for the tree to recover than if the injury were to new needles. However, because any amount of foliage damage will reduce tree vigor, control of European pine sawfly should be done before extensive injury occurs.

Control: Apply treatments as soon as complete egg hatch has occurred and larvae begin feeding—usually from early May to early June. Spray with Carbaryl (Sevin) (3a, or 3b, or 3c, or 3d) or azinphosmethyl (Guthion) (1a, or 1b) or Meta-Systox-R (11) or diazinon (5a, or 5b) or malathion (10a, or

10b). Aircraft or mist-blower application of these materials can be effectively employed to control this insect. Ultra low volume malathion applied by aircraft at the rate of 10-16 fluid ounces per acre has given excellent results. **Note:** See Section IV for information about the use of aircraft and mist blower for insect control.

A virus extract (taken from diseased European pine sawfly larvae) gives excellent control of this insect, but is not effective for others. Consult the Entomology Department, Michigan State University or the Michigan Conserva-



Eggs of European pine sawfly laid in slits cut along edge of needle.

tion Department for information on availability. **Note:** Aphids and other insects may affect the trees at the same time the European pine sawfly does. Therefore, it is usually best to select a chemical that will control all pests.

EUROPEAN PINE SHOOT MOTH

Trees Damaged: This insect damages two- and three-needled pines. It prefers red, but also attacks Scotch and mugho pines extensively.

How to Identify: The adult has whitish legs, a rusty orange-red body, and a wing expanse of about $\frac{1}{2}$ inch. When present in plantings, it can be seen flying around the trees in late June and early July.

When first laid, the eggs are small, flat, and yellowish; later they turn reddish brown. The full grown cater-

pillar is about $\frac{1}{8}$ inch long and brownish with black head and thorax, and is found in damaged shoots in the spring.

Life History: Eggs are laid on the surface of needles and shoots. The young caterpillar (hatching from an egg in about 10 days) bores first into a needle base. Later in the summer, it leaves the needle and bores into a bud. This boring causes a flow of pitch which hardens over the bud, covering up the caterpillar's burrow. Winter is passed as a caterpillar in the bud or under the hardened pitch. In the spring, the half-grown caterpillar leaves its overwintering place, and bores into an uninjured shoot. In late May or early June, the caterpillar becomes full grown and pupates inside the damaged shoot. The adult moth comes from the shoot, usually during the last half of June.

Type of Injury: The European pine shoot moth adult does not injure pines. The caterpillar, however, damages needles, buds, and shoots. This often deforms the tree by stunting the twigs and branches. Spring-tunneled shoots turn yellow and then die. The tunnel inside the shoot tells the presence of this insect.

Control: Apply methoxychlor (12c, or 12d) or dimethoate (Cygon) (6) when the larvae begin to move from overwintering places to new shoots, usually April 15 to 30.



European pine shoot moth caterpillar (about twice normal size) and its damage to a pine shoot. Note the hardened pitch as shown by the light laid-open area around the caterpillar.



European pine shoot moth pupal case attached to a damaged shoot. Eggs are laid about 10 days after these cases appear.

Good summer control is possible with a spray applied as soon as all adults have emerged from their pupal cases or when 50% of the eggs have hatched. Either of these two conditions normally occur about July 4 in the lower peninsula. Use azinphos-methyl (Guthion) (1a, or 1b) or carbaryl (Sevin) (3b) or dimethoate (Cygon) (6).

Air-blast sprayers (mist-blowers) will give reasonable control of European pine shoot moth. Use suggested insecticides at 4 times the dilute strength. Deliver at least 35 to 50 gallons of liquid per acre. Note: (See Section IV for information on the use of concentrate sprays in mist-blowers.) This strength mist-blower spray should be sufficient for small trees (2nd- and 3rd-year growth). For older trees (4 feet or taller) you may need to use an



European pine shoot moth damage to pine shoots. Note the stubby growth.

8X concentrate spray. For control of heavy infestations especially in older trees, get special control information.

Pruning will aid European shoot moth control by destroying eggs laid during July. See Michigan State University (Department of Forestry) literature for instructions on how to shear Christmas trees. Burn infested shoots pruned up to July 1, or the moths may emerge to lay eggs for another generation. If shearing is delayed until after all eggs are laid on the shoots (usually about July 10-15) many of them will be destroyed.

GRASSHOPPERS

Trees Damaged: Grasshoppers attack all pines and spruce.

How to Identify: These insects feed on many field and vegetable crops and are well known to everyone; therefore, further description seems unnecessary.



Grasshoppers destroy or damage Christmas trees by devouring the needles. Note: The grasshoppers that usually damage Michigan pines and spruce are about 1 inch long when mature.

Life History: Destructive Michigan grasshoppers lay their eggs in the soil; winter is passed in this stage. Grasshopper eggs, depending on the species, hatch during May, June, or July. Some species, such as the lesser migratory grasshopper, can have two broods a year; most species, however, have only one brood. Grasshoppers are more apt to damage Christmas trees in drought years.

Type of Injury: Grasshoppers are mainly foliage feeders. On pines and spruce, they eat the needles and occasionally scar the bark. Most pine trees cannot replace lost needles. Damaged bark oozes pitch which hardens into an undesirable scale-like material. Seedling pines are suscepti-

ble to extensive damage particularly when planted in heavy grass areas.

Control: Apply sprays directly to grasshoppers feeding on the needles and the vegetation beneath the trees. Use carbaryl (Sevin) (3a, or 3b, or 3c, or 3d) or malathion (10a, or 10b).

Note: Grasshoppers often come from areas outside the plantings. When safe, treat these places before the insects move into the trees.

JACK PINE BUDWORM

Trees Damaged: This insect prefers jack pine, but will, under some conditions, damage Scotch, red, and white pine, and white and Norway spruce.

How to Identify: New needles, 1 to 1½ inches long, are chewed off at the base and webbed together. This damage is done by a dark brown or reddish brown worm with a white collar behind the head. When mature, the worm is 1 inch long and has yellowish sides with a shiny black or brown head.



Spruce budworm: The jack and spruce budworms, are similar in appearance, and do about the same kind of damage. When mature, the spruce budworm and jack-pine budworm are about 1 inch long. Note the pupa between the two caterpillars.

Life History: The jack pine budworm passes the winter on the tree as a small caterpillar (worm) inside a silken gray cover. In the spring, the worm bores into old needles and feeds

on pollen. As it grows, it feeds on both new and old needles. The mature caterpillar pupates on the foliage in early July. The adult lays eggs in late July; there is only one brood a year.



Jack-pine budworm damage to jack pine. It feeds also on Scotch, red, and white pine, and white and Norway spruce.

Type of Injury: Trees can be stripped of needles resulting in permanent loss of foliage; also the webbed needles look unsightly and the weakened tree is subject to attack by other insects.

Control: Apply treatment in early to mid-June when the worms are about $\frac{1}{2}$ inch long. Phosphamidon (14) is the preferred treatment. However, malathion (10a, or 10b) or lead arsenate (7a) will also give control.

MITES

Trees Damaged: Mites affect all pines and spruce. They are more apt to damage trees grown on droughty (sandy) soils. **Note:** Prolonged drought favors mite damage on all Christmas tree growing sites.

How to Identify: The needles of mite damaged plants are yellowish or bronze in color. Close examination of the needles shows whitish or brownish spots on their surface. Also present will be small, dark specks of mite frass often netted with silk thread. Mites, when jarred from twigs or branches

onto white paper, can be seen moving about.

Life History: The different kinds of mites overwinter either as eggs or adults. The eggs are laid usually on the needles. Several broods occur, each taking about 30 days to mature. Very young mites can have six legs as do insects; larger immature and adult mites have eight legs (four pairs).

When first laid, mite eggs are shiny and white; afterwards, they often turn reddish. A hand lens or microscope is usually needed to see mite eggs and most nymphs and adults. Adult mites range in color from yellow, grayish-yellow, grayish-green, to yellowish-red or red. In some cases mite color depends on the kind of food eaten.

Type of Injury: Mites damage pine and spruce trees by piercing the needles and sucking the plant juices. Mites compete with trees for plant foods during periods of hot-dry weather. This condition robs the plant of vigor at a time when it needs all its strength to withstand drought and high summer temperatures.



Adults and eggs of spruce mite. **Note:** Adults are about $\frac{1}{50}$ inch long. When mature, mites have 8 legs; insects have 6 legs.

Control: Spray when first signs of mite damage appear on the plant, usually during July and August. In some cases, mites become active as early as late April. If a planting has been troubled with mites previously, inspect it early and treat if necessary. Use one or a combination of chemicals listed under Miticides (10). Spray needles and branches thoroughly.

PALES WEEVIL

Trees Damaged: Scotch, white and red pines and Douglas fir are most commonly attacked but other conifers are also susceptible.



Adult pales weevil. They are most abundant in cutover plantings where they kill twigs on small trees or entire seedlings by feeding on the tender bark.

How to Identify: Adult weevils are about $\frac{1}{2}$ inch long, reddish-brown in color with gray or yellow markings on the thorax and wing covers. Larvae are legless, with white bodies and brown heads, and about $\frac{1}{2}$ inch long. Adults are most easily found during early spring or fall in litter. Larvae are present from early July until September in the inner bark of recently cut stumps.

Life History: Adults pass the winter in the litter and become active during late April or early May. During May and June, adults feed on the tender bark at the bases of seedling or twigs of saplings. About July 1, pearly white eggs are laid in the inner bark of freshly cut stumps or stumps of trees cut the previous fall. Eggs hatch in about 2 weeks and larvae feed on the inner bark of stumps in an area of 4-5 inches above the root collar to 2-3 inches below it. They mature during August and pupate in the inner bark within cells constructed from shreds of feeding excrement. In September,

adults chew through the bark, emerge and feed at night on the bark of twigs or seedlings.

Type of Injury: Larval damage to stumps is inconsequential. The adult feeding, particularly in the fall, girdles twigs of small trees or entire seedlings, thus killing them. Normally, seedling damage is most serious because replantings may be destroyed. However, adult feeding may ruin the appearance but will not kill small trees.

Control: For this insect, control methods are threefold:

1. When replanting a cutover area, delay until the inner bark of stumps and roots have dried and turned brown. This is a must if damage by the insect is to be avoided. Seedlings may be protected by dipping the tops in 2 percent BHC or Lindane emulsion before planting. Use 1 gallon of an emulsion containing 2 pounds of chemical per gallon to 10 gallons of water. While dipping or planting dipped plants, wear rubber gloves.

2. To prevent development of larvae in stumps cut the previous fall, spray about May 1 with BHC in kerosene. Dilute 1 gallon of BHC (containing 2 pounds of chemical per gallon) with 10 gallons of kerosene. Apply to stumps as a mist, using a compressed air sprayer or other suitable equipment.

3. Remove cut trees from plantations when possible. These provide food and encourage build-up of weevils and other bark feeders.

PINE NEEDLE SCALE

Trees Damaged: This insect infests white, red, Austrian, Scotch, and mugho pines; spruce is also affected.

How to Identify: When numerous, this insect whitens the needles, particularly those on the lower branches. The female scale is elongated, yellowish-white, and about $\frac{1}{8}$ inch long; the male is slender, white, and about $\frac{1}{2}$ inch long.

Life History: Winter is passed as purplish eggs underneath the female scale. One or two broods can occur depending on the locality. The eggs



Pine needle scale. This scale occurs in two colors: white or yellowish-white. They are slender and not more than $\frac{1}{9}$ inch long.

hatch into crawlers; these usually appear in May and again in July.

Type of Injury: This scale sucks needle juices. Infested needles appear yellowish and whitened; eventually they become weakened and often drop from the tree.

Control: Apply a dormant spray (14b, or 14c, or 14d, or 14e) in early spring before buds break. Note: In order to be effective, a dormant spray must be applied to all needle surfaces. If it is not possible to obtain complete coverage, apply a summer spray to control emerging crawlers. Generally, a dormant spray will require twice the volume of a crawler spray.

Best results for pine needle scale control on Christmas trees have been experienced with a crawler spray. Crawlers emerge from eggs beneath the female scales during late May (when lilac is in full bloom) and again in July. Use diazinon (5a, or 5b) or Meta-Systox-R (11) or dimethoate (Cygon) (6) or carbaryl (Sevin) 3a, or 3b, or 3c, or 3d) or malathion (10a, or 10b). At least 2 treatments, 10 days apart, are needed for each brood. Recent MSU research indicates that good control is possible with a helicopter application of either azinphosmethyl (Guthion) or Meta Systox-R applied at the rate of 1 pound of actual chemical per acre in 4 gallons of water.

PINE NEEDLE MINER

Trees Damaged: The pine needle

miner has been found only on Scotch pine in Michigan. However, it has been found elsewhere on red pine and less frequently on Mugho pine.

How to Identify: The adult moth has a wing expanse of about $\frac{3}{4}$ inches, dark brown body with forewings dark golden brown with 3 silvery stripes. Newly hatched larvae are pale yellow brown but turn pinkish-red and are about $\frac{3}{4}$ inch long when mature. Adults are inconspicuous and relatively inactive during the day but will fit from tree to tree if disturbed. Larvae are difficult to find in the needle mining stages but toward maturity (mid-June) can be readily observed in mined-out bud tissue.

Life History: Adults, active during early July, deposit eggs singly on needle sheaths or under bark scales on the twigs. Eggs hatch during late July or early August and larvae move to the tips of the needles where they begin mining out the tissues. Winter is passed as partially mature larvae within the mines. During late April or early May, when tree growth begins in the spring, larvae move to the buds. The larvae burrow within the elongating shoots until mature, then pupate. One generation occurs each year.

Type of Injury: Only the larvae cause injury to the trees. Damage by early



Pine needle miner damage to new growth. Larval feeding in buds and new shoots in the spring retard plant growth giving trees a tufted or goose-necked appearance.

larval mining in the needles is inconsequential. The major damage is done in the spring when larvae burrow into buds and elongating shoots and kill them. This feeding retards new growth, producing a tufted or gooseneck appearance. While this insect will not kill trees after one season, repeated attack results in stunted trees which take the appearance of having been severely sheared. In addition, their color turns brown with a somewhat purple tinge.

Control: At the present time, methods for chemical control of this insect are not known. However, it appears that control can be achieved with a Methoxychlor (12a or 12b) or dimethoate (6) spray during late April when the larvae are moving to the buds or a spray of Carbaryl (Sevin) (3a, or 3b) or dimethoate (6) or Guthion (1a, or 1b) during late July when eggs hatch. Several parasites have been found attacking this insect but it is not known if they will suppress this pest.

PINE ROOT COLLAR WEEVIL

Trees Damaged: This insect prefers Scotch, red, and jack pine, but may also attack Austrian and white pine.

How to Identify: The grub is curve-bodied, footless, and white with a brown head. It is larger ($\frac{1}{2}$ inch long) than the strawberry root weevil grub ($\frac{1}{8}$ inch long). Blackened pitch oozes from an infested tree where the roots and trunk join at the soil's surface.



Pine root collar weevil. Damage is to bark and wood near the soil surface. Blackened pitch oozes from the wound.

Life History: The pine root collar weevil passes the winter as an adult in bark crevices and in ground litter. The winter is also passed as grubs under the bark, or pupae in earthen cells in soil next to the tree trunk. Eggs are laid at the base of the tree in pockets chewed by the female, or in the soil up to 2 inches from the tree. The adult beetle can live 3 or 4 years; the grub lives 1 year. Newly matured grubs appear every year; there is one brood a season.

Type of Injury: The pine root collar weevil feeds on the bark, inner bark, and sapwood. This feeding girdles the bark and prevents the tree from getting proper nourishment. At first, scattered trees exhibit retarded growth and pale green color but eventually turn brown and die. Trees are rarely killed after 1 or 2 years attack. Therefore, large numbers of trees may be attacked before extensive damage is apparent.

Control: Avoid planting pine in areas infested with pine root collar weevil unless they have been clearly cultivated for at least 1 year. For treating infested trees, use lindane (9a, or 9b) or BHC (2a, or 2b) or chlordane (4a, or 4b). These treatments can be applied anytime during the growing season. These should not be applied when the soil is frozen or covered with ice or snow because of the possibility of undesirable movement of the chemical. When convenient during the summer, or when controls for other insects are being applied, spray or pour this treatment next to the trunk at ground level. Apply enough spray to thoroughly wet the tree's root collar, and to soak the soil. **Note:** the rotation of seedbeds in nurseries and clean cultivation of fallow land intended for tree planting for at least 1 year, usually controls this insect.

PINE SHOOT BORER

Trees Damaged: This insect favors Scotch, jack, white pines, but may also injure Austrian, red, and pitch pines as well as white spruce and Douglas fir.

How to Identify: Larvae tunnel out the pith of the new growth of ter-

minals and laterals from a few inches above old growth to the tip. This causes shoots to break off at right angles and die. As many as three larvae may infest a shoot. Injury is most apparent in late July.



Full-grown pine shoot borer larva within Scotch pine shoot.



Exit hole of pine shoot borer made by larva in vacating mined-out shoot. Larva drops to ground beneath the tree, pupates, and overwinters.

Life History: Winter is passed by pupae in the soil and litter beneath the trees. During early May the small, coppery moths with a wing expanse of $\frac{1}{2}$ inch emerge and lay eggs on the new growth. Within two weeks the young larvae hatch from the eggs and bore into the center of the shoot. During June and July the dirty white larvae with brownish-yellow heads

feed by boring out the center of the shoots. Larvae mature during July and early August, reaching a length of about $\frac{1}{8}$ inch and chew a hole out through the shoot and drop to the ground and pupate. There appears to be only one brood each year.

Type of Injury: Adult moths do not cause any feeding injury. Larval tunnelling in laterals ruins the shape of the tree; injury to terminal leaders results in the loss of a year's growth to the tops of the trees. Plants are not killed by this insect but their shape is ruined.



Scotch pine showing injury by pine shoot borer. Note how new shoots bend and break at right angles but remain attached to tree.

Control: This insect is difficult to control due to the extended adult emergence period during May. Normally, unless previous damage has indicated 3 or more mined laterals or terminals per tree, attempts at control are questionable. If control is attempted, apply a methoxychlor (12a, or 12b) or dimethoate (Cygon) (6) spray about May 10. A second spray may be necessary when cool weather causes adults to emerge throughout the month of May. **Note:** if major damage to terminal leaders is occurring, selective shearing of tree tops should be employed. Wait until larval damage is obvious (late July) and selectivity retain a healthy undamaged leader.

PINE TORTOISE SCALE

Trees Damaged: This scale attacks Scotch, Austrian, red and jack pines.



Pine tortoise scale and associated black sooty plant discoloration.

How to Identify: Immobile, oval chestnut brown insects, about $\frac{1}{8}$ inch long, suck plant juices from branches near tips. Large amounts of honeydew, a clear sugary substance excreted by the scales, adhere to the plant. This honeydew serves as a medium for, and is turned black by, a sooty mold fungus.

Life History: The pine tortoise scale has one brood each year. Winter is passed by immature females in protected places on the rough bark of the twigs. Beginning the third week in June each female lays 1,000 or more eggs beneath its body. These hatch in a few hours and the reddish crawlers exit from beneath the mother scale and migrate to the terminal branches. In late August females mature, mate with the winged short-lived males, and continue to feed until cold weather occurs.

Type of Injury: The pine tortoise scale damages pines by retarding vigor and killing branches or entire trees. The black sooty accumulations further disfigure trees.

Control: Apply a dormant spray (14a, or 14b, or 14c, or 14d, or 14e) anytime before plant growth begins in the spring. **Note:** effective scale con-

trol depends upon complete spray coverage of all plant parts. If it is not possible to obtain complete coverage, apply a summer spray to control emerging crawlers. Apply an azinphosmethyl (Guthion) (1a, or 1b) or carbaryl (Sevin) (3a, or 3b, or 3c, or 3d) or malathion (10a, or 10b) or diazinon (5a, or 5b) spray after at least 50% of the eggs beneath the females have hatched (usually between June 20 and July 10). Use a hand lens to observe egg hatch and crawler emergence. **Note:** removal of heavily infested trees will aid in controlling this pest. Do not remove trees when crawlers are active (June 20-July 10) because this may contribute to its spread within the plantation.

PINE TUBE MOTH

Trees Damaged: As far as is known, this insect feeds only on white pine.

How to Identify: An elongated, hollow tube made of white pine needles is typical of this insect's damage. The tube is formed by binding a number of needles together with silk threads.

Life History: The pine tube moth has two broods each year. For the first brood, eggs are laid on the needles in May. The mature worm is $\frac{1}{2}$ inch long and yellowish-green with a greenish-brown head that has a brown patch on each side. Winter is



Pine tube moth. This insect forms the tube by binding several needles together.

passed inside the tube as a greenish-yellow pupa.

Type of Injury: The pine tube moth damages white pine in two ways: First, the silk bound needles are unsightly; second, needle tips are eaten. This insect often leaves old tubes and builds new ones.

Control: Spray in June when the tubes are formed. Use diazinon (5a, or 5b) carbaryl (Sevin) (3a, or 3b, or 3c, or 3d) or methoxychlor (12a, or 12b).

PINE SPITTLEBUG

Trees Damaged: Both adult and nymph (immature form) feed on branch and twig bark of all pines and Norway, white, and black spruce. Scotch, jack, and eastern white pine are, however, preferred by this insect.



Pine spittlebug. Note the masses of spittle (foam) hanging to branches and needles.

How to Identify: Spittle masses occur among the needles of twigs and branches. Feeding damage by this insect causes brown foliage and a drought-like appearance. Unless spittle masses are present, the true nature of adult pine spittlebug damage is hard to tell.

The adult pine spittlebug is boat-shaped, $\frac{3}{8}$ inch long, and light brown with both light and dark spots scattered over the wings, thorax, and head.

Life History: The pine spittlebug passes the winter as an egg in plant tissue at the base of terminal buds. In May, the egg hatches into the nymph that produces the spittle mass. The

nymph, protected inside the spittle mass, sucks the tree's juices. The adult feeds and lays its eggs during July and August.

Control: Control of nymphs is difficult because they are protected by masses of spittle. Adults can be effectively controlled in July and August when they feed on pines and lay their eggs. Use a malathion (10a, or 10b) or carbaryl (Sevin) (3a, or 3b, or 3c, or 3d) spray.

PITCH-BLISTER MOTH

Trees Damaged: The pitch-blister moth attacks jack, lodgepole, and ponderosa pines.

How to Identify: This insect forms a hollow ball of gray or brownish pitch at branch forks. The ball is about the size of a marble. A reddish worm with a brown head may be seen inside the pitch ball until about May 15. The wood underneath the bark is exposed by the worm's feeding.

Life History: The pitch-blister moth passes the winter as a worm inside the pitch ball. The worm changes to an adult moth about June 1. This insect lives about 2 years as a caterpillar.

Type of Injury: Damage by this insect is mainly to the food carrying



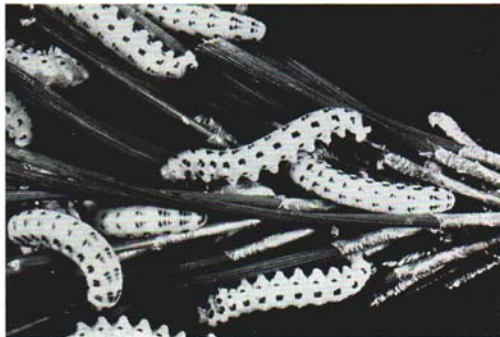
Pitch-blister moth. This insect forms a brownish or grayish hollow pitch ball at branch forks.

tissues of the tree. The worm often girdles the twig killing it above the wound; needle flagging can also result from such feeding. Twigs can be deformed if they are not killed outright.

Control: A good chemical control has not been worked out for this insect. Pruning is suggested when practicable.

RED-HEADED PINE SAWFLY

Trees Damaged: The red-headed pine sawfly feeds on jack, red, Austrian, mugho, and Scotch pine plantings, 1 to 15 feet tall.



Red-headed pine sawfly. Note the 7 or 8 pairs of legs on the worm's abdomen; moth caterpillars have no more than 5 pairs of abdominal legs.

How to Identify: The very young worm is whitish and unspotted with a brown head; the mature worm is 1 inch long; has orange-red head, and 6 rows of black dots running lengthwise of the yellow body. The red-headed pine sawfly feeds in large groups first on the old and then on the new growth. When disturbed, it immediately raises its head. Yellowish-green frass piles are very evident under infested trees.

Life History: This insect has one or two broods a year. Winter is passed in the ground as a mature worm in a brown paper-like cocoon. First brood adults come from the ground some time during the first 2 weeks of June. Eggs are laid in cuts in the needles; first brood worms begin feeding in early July.

Control: Delayed treatment can result in severely damaged trees. Therefore, protective sprays should be applied as soon as larvae are observed, usually in early June. Spray with carbaryl (Sevin) (3a, or 3b, or 3c, or 3d) or azinphosmethyl (Guthion) (1a, or 1b) or Meta-Systox-R (11) or malathion (10a, or 10b). Aircraft or mist-blower application of these materials can be employed to control this insect. Ultra low volume malathion applied by aircraft at the rate of 10-16 fluid ounces per acre has given excellent results. **Note:** See Section IV for information about the use of aircraft and mist blowers for insect control.

SARATOGA SPITTLEBUG

Trees Damaged: The adult spittlebug damages jack, red, and Scotch pines in natural and cultivated stands 2 to 15 feet tall. The spittle mass containing immature spittlebugs (nymphs) occurs on sweet fern, blackberry, and other plants, but not on pines.

How to Identify: The spittle mass occurs on fern and other plants June 15 to July 15. The adult spittlebug feeds on pine trees from July 15 to October. When mature, the nymph inside the spittle mass is light mahogany in color and about 1/2 inch long. The pine-feeding adult is 3/8 inch long, tan to light brown, with a light stripe run-

ning down the back and wavy lines on the wings.

Life History: The insect passes the winter as a purplish, yellow or usually black egg between pine bud-scales. The egg hatches into a nymph as soon as tree growth begins in the spring. It drops to the ground and forms spittle masses on sweet fern and other plants near the ground level. The nymph matures by July 15 and the adult flies to pine.

Type of Injury: The Saratoga spittlebug adult feeds by sucking juices usually from pine tops. This feeding causes the foliage to turn yellow in September and brown in the spring. This condition is known as "flagging." When a spittlebug injured twig is shaved with a knife, brown feeding punctures are present in the sapwood.

Control: Apply treatment during July when most of the spittlebugs have left the spittle masses (usually the second or third week of July). Use carbaryl (Sevin) (3a, or 3b, or 3c, or 3d) or malathion (10a, or 10b).

SPRUCE BUD SCALE

Trees Damaged: Norway, white and blue spruces are preferred but other spruces are susceptible.

How to Identify: Colonies of dusty, red-brown scales cluster at the base of recent twig growth particularly on the lower branches. Mature females are round, globose and about 1/8 inches in diameter. Associated with heavy scale populations is a black sooty mold which darkens and discolors trees.

Life History: Partially mature females pass the winter at the twig bases and begin feeding in the spring when plant growth begins. During May, females mature and lay a hundred eggs or more beneath their bodies. These eggs hatch about mid-June and crawlers emerge from beneath the female scales, settle on the new growth and begin to feed. There is one generation each year.

Type of Injury: The tips of new growth, especially on the lower branches, show reduced growth. Heavy attack may kill individual

branches, but rarely the entire tree. A clear sugary liquid called honeydew is liberated by scales when feeding and accumulates on twigs and needles. This eventually turns black, giving trees an unthrifty appearance.

Control: Apply a dormant spray (14a, or 14b, or 14c, or 14d) in early spring before buds break, or spray during mid-June when the crawlers are emerging, with Guthion (1a, or 1b), Carbaryl (Sevin) (3a, or 3b) or Diazinon (5a, or 5b) or dimethoate (6) or Malathion (10a, or 10b). **Note:** Since egg hatch and crawler emergence are influenced by weather, inspect eggs under female with a 10x hand lens and do not apply sprays until approximately 50 percent of the eggs have hatched.

SPRUCE LEAF TIER

Trees damaged: A variety of spruces are attacked, but Norway, white, Colorado blue and red spruce are preferred.

How to identify: The adult moth has a wing expanse of 3/8 inch and is dark brown in color. Larvae have black heads and reddish-white bodies and are 3/8 inch long when mature. Full grown larvae often hang suspended from the tree by a silken thread.

Life History: Immature larvae pass the winter in mined needles webbed together along the twigs. They resume feeding during April, maturing and pupating about mid-May in the soil at the base of the tree or in the webbed masses of needles. Adults appear during early June and lay eggs on the foliage. These hatch in about two weeks and the larvae mine within and web needles together until late fall. There is one generation each year.

Type of Injury: The insect mines out needles, then webs them together along the twigs. Webbing on small trees may occur over the entire crown while on large trees it is confined chiefly to the lower branches. The nests of severed needles turn reddish-brown giving trees an unhealthy appearance.

Control: Apply a spray when the larvae are actively feeding (late April-

early May or late July). Use azinphos-methyl (Guthion) (1a, or 1b) or malathion (10a or 10b) or methoxychlor (12a or 12b) or carbaryl (Sevin) (3a, or 3b, or 3c, or 3d) or lead arsenate (7a).

STRAWBERRY ROOT WEEVIL

Trees Damaged: This insect feeds on the roots of all pines and spruce.

How to Identify: Strawberry root weevil-damaged trees lack fibrous



Strawberry root weevil grubs. They are about 1/5 inch long. They do not have thoracic or abdominal legs as do moth caterpillars and sawfly worms.



Strawberry root weevil grub damage to pine seedling roots.

roots, and the root bark is often stripped. A small, legless, curved, cream-white grub with a brown head may be found around the roots until about July 1. The mature grub measures 1/5 inch.

Life History: The strawberry root weevil lays eggs in the soil during July and August. Winter is passed mainly as a small grub. Grub feeding occurs during late summer and fall, and again in the spring. There is only one generation a year.

Type of Injury: This insect destroys the tree's fibrous roots; these roots take up soil water. Hence, strawberry root weevil-damaged trees look droughty and stunted.

Control: If strawberry root weevil damage is widespread in nurseries or plantings, treat as follows:

1. When adult weevils are feeding in late June or early July, spray entire trees and the litter beneath them with chlordane (4a, or 4b) or carbaryl (Sevin) (3a, or 3b, or 3c, or 3d).

2. Prior to planting trees, apply chlordane granules (4c) to the soil in a 2 foot wide band where the trees are to be planted. Apply at the rate of 100 pounds of 10% granules per acre within this 2 foot wide row and immediately disc in to a depth of 4 inches.

3. Young seedlings can also be protected by dipping the roots in 0.5% chlordane emulsion prior to planting. When dipping or planting dipped seedlings wear rubber gloves.

THRIPS

Trees Damaged: To date, only Scotch pine has been found infested. However, they may occur on other pines.

How to Identify: The adult is black, about 1/16 inch long, winged and shaped like an alligator. Immature thrips are slightly smaller, lack wings, and are orange-yellow in color. Both adults and nymphs are found on buds or needles of new growth.

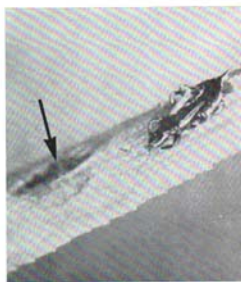
Life History: Thrips activity begins in late April or early May but reaches



Strawberry root weevil adults. They are about 1/4 inch long. Note the rows of small pits on the wing covers.

highest populations during July and August. Many overlapping generations occur by fall. Hot, dry weather contributes to rapid thrips buildup. They overwinter as adults and lay their pale yellow eggs singly on the needle sheaths or in the bud mass area starting in late May.

Type of Injury: Thrips have rasping-sucking mouthparts. They rasp the bud or needle tissues, liberating plant juices which they suck up. This feeding produces brown patches 1/2 to 3/4 inch long on the new growth. Heavily infested trees have distorted, stunted foliage and eventually die.



Adult thrip on Scotch pine needle. Note the area damaged by thrip feeding (arrow).

Control: Spray when thrips adults are first noted (usually during early May) with malathion (10a, or 10b) or diazinon (5a, or 5b) or azinphos-methyl (Guthion) (1a, or 1b) or Meta-Systox-R (11). Early detection (before adults lay eggs during May) and treatment can eliminate repeated sprays later in the summer.

WHITE GRUBS OR JUNE BEETLES

Trees Damaged: All pines and spruce are affected by these insects.

How to Identify: The small tree roots are missing; the bark of larger roots is eaten, or the tips are missing. White, curve-bodied grubs with brown heads may be found around the tree roots. These grubs vary in length from about $\frac{1}{2}$ to 1 $\frac{1}{2}$ inches.

Life History: June beetles overwinter in the soil either as grubs or adults. In May or June, the adults come out of the soil, feed on the leaves of broad-leaf trees (especially oak), and lay their eggs in grass sod. Each egg hatches in 2 or 3 weeks; the grub (depending on its kind) lives from 1 to 5 years in the soil before it comes out as an adult.

Type of Injury: White grub root injury prevents the tree from getting water and nutrients. Damaged trees look droightly and stunted.

Control: If white grub damage is widespread in nurseries or plantings, treat as follows:

1. When adult beetles are feeding in late June or early July, spray entire trees and the litter beneath them with methoxychlor (12a, or 12b) or carbaryl (Sevin) (3a, or 3b, or 3c, or 3d).

2. Prior to planting trees, apply chlordane granules (4c) to the soil in a 2 foot wide band where the trees are to be planted. Apply at the rate of

100 pounds of 10% granules per acre within this 2 foot wide row and immediately disc in to a depth of 4 inches. This treatment can also be applied if white grubs become established after seedlings are set.

3. Young seedlings can also be protected by dipping the roots in 0.5% chlordane emulsion prior to planting. When dipping or planting dipped seedlings, wear rubber gloves.

WHITE-PINE WEEVIL

Trees Damaged: This insect prefers white pine, but also damages jack, red, and Scotch pines, and Norway spruce.



White-pine weevil damage. Note hole at point of knife blade.

How to Identify: The adult is about $\frac{1}{2}$ inch long; it is brownish with white spots scattered over the body. The adult mouth parts are formed into a curved snout about $\frac{1}{8}$ inch long. The grub is curved, white, footless, and when mature, slightly longer than the adult. Both the adult and its grub may be found under the bark of damaged leaders where they feed on the inner bark. As the adults escape from the leader, they may also be found in the bark.

Life History: Pearly-white eggs are laid in small punctures made by the female in leader bark. The young grub (hatching from the egg) feeds on the inner bark. By August, the grub



White-pine weevil grub damage to bark of leader.

is fully grown. It then pupates and the adult leaves the tree about 2 weeks later through a small opening in the bark.

The white-pine weevil overwinters as an adult in ground litter. It becomes active when air temperatures reach about 50°F. for several days, usually sometime during the last 2 weeks of April in Michigan.

Type of Injury: Both the white-pine weevil adult and grub cause damage. Tiny glistening drops of resin occur on the bark of the leader, indicating adult feeding or egg laying. By feeding on the inner bark, the grub girdles the leader; this causes it to curl and die.

Control: When white pine weevil damage is light, infested terminals can be cut and burned before July 15.



White pine leader killed by white-pine weevil grubs.



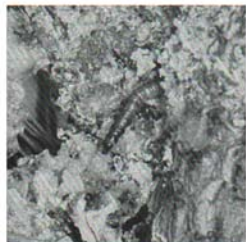
The white grubs of the May or June beetles. When mature, these grubs can be 1 $\frac{1}{2}$ inches long.

By pruning, the top whorl of branches on lateral can be selected to assumed apical dominance and form a new leader. Under heavy white pine weevil infestation, it may be necessary to treat individual leaders. Spray the entire leader to the point of run-off during mid-April. Use lindane (9c) or BHC (2c) or lead arsenate (8b) or methoxychlor (12e).

ZIMMERMAN PINE MOTH

Trees Damaged: Austrian, Scotch, jack, white and red pines are injured.

How to Identify: The adult Zimmerman pine moth may have a front wing span of one and a half inches. These wings are dark gray with narrow, irregular, red lines front to back. The hind wings are light-brown. The eggs are about one-third the width of a Scotch pine needle, oval to round in shape, light brown when laid, reddish brown when fully developed. The larva, (worm-like feeding stage) is about $\frac{1}{8}$ inch when fully grown. The head is dark brown and the body dotted with small, dark spots. The body may be brown, pinkish-brown or greenish-brown. The pupa like the larva is about $\frac{1}{8}$ inch but light to dark brown in color.



Zimmerman pine moth larva amidst mass of pitch.

Life History: The eggs are laid in wounds and bark crevices, normally between August 5 and 25. They hatch in 8 to 10 days and the young larvae overwinter in hibernacula (nests) under bark scales. In the spring they become



Zimmerman pine moth injury. Note hardened pitch at whorl and narrow stem below point of attack. Also larger stem above this point.

active and normally have bored into the inner bark and sapwood by about April 20. Sometime between July 15 and August 20 the larvae become mature and pupate in a feeding tunnel beneath the thin outer bark. The first moths come from the pupa cases about August 7 and continue throughout the rest of the month.

Type of Injury: Damage varies on different species of pines. For example, on forest-grown jack pine, feeding takes place in wounds produced by pine-oak rust. Young red pines may have leaders tunneled by the larvae; larger trees may have "flat tops" due to leader injury. On Christmas trees, mainly Scotch and Austrian pines, damage can occur any place on the main stem or in the terminal shoots.

Control: Between April 5 and 20, spray with enough pressure to wet the bark and main stem, especially where the branches join the main stem. Note: It is not controlled by spraying the foliage.

Use the following materials for Zimmerman pine moth control: trichlorfon (Dylox) (16) or endosulfan (Thiodan) (7c or 7d) or BHC (2a, with the rate increased to 8 pounds, or 2b, with the rate increased to 2 quarts).

OTHER INSECTS

Besides the insects already listed, several others may or may not dam-

age Michigan Christmas trees. These are:

Pine webworm: This caterpillar infests red, white, and jack pine. When mature, it is $\frac{1}{2}$ inch long, and yellowish-brown with two brown stripes down each side of the body. The worm lives in a silken tube. The tube is formed on a twig and encloses pine needles upon which the worm feeds.

Control: No chemical control suggested. Handpick the tubes when first seen and destroy.

Red-pine Sawfly: Up to this time, the red-pine sawfly has damaged only red and jack pine; it relishes old needles. The worm is gray-green, black-headed, and when mature, $\frac{1}{2}$ inch long. The body has a light green backline, and a dull-black line at the base of the legs. Only one brood occurs—from early May to late June.

Control: Spray with malathion (10a, or 10b) or azinphosmethyl (Guthion) (1a, or 1b) or Meta-Systox-R (11) or carbaryl (Sevin) (3a, or 3b, or 3c, or 3d) when egg hatch is complete and larvae are active (in June or July).

Rhynacionia adana (moth): This insect is closely related to the European pine shoot moth. While the two insects resemble each other closely, they nevertheless, have different feeding and life-cycle habits. For differences, compare the following on *R. adana* with the section on European pine shoot moth.

R. adana passes the winter as a pupa attached to the root-collar just beneath the soil surface. The moth emerges about mid-April when the temperature reaches 50 degrees F. Not too long afterward, eggs are laid on the inside of the needle just above the sheath. Hatched larvae enter the inner side of the needles just above where the eggs were laid. In early June they leave the old needles and eat at the base of needles on new shoots.

The mature larva of *R. adana* is about $\frac{1}{8}$ inch long, yellowish-to reddish-brown with the head dark brown to black and the thorax, black.

Control: Apply a methoxychlor (12c, or 12d) or dimethoate (Cygon) (6)

spray in mid-April. It may be necessary to repeat this spray in late May or early June in instances where trees are heavily infested.

Note: No research has been done in Michigan to set the exact time to apply the treatments. These timing suggestions are based on available research information.

Tortricids (moths): Two tortricids have already been discussed—Jack-pine budworm and pine tube moth. Two others are *Tortrix alleniana* and *Tortrix pallorana*.

These latter moths are very similar to each other in habits and appearance. The following life history notes are for *T. pallorana*. It has two broods a year with adults present in late June and again in August. The larvae of the second brood overwinter as partially grown worms in *hibernacula* (nests) on alfalfa and clover.

Mature larvae are about 1 inch long and a uniform light-or-yellowish green. Only the last two instars (an instar is the period between molts) of the first brood feed on conifers, normally during May and June. They tie the shoots of a single branch together and feed in this enclosed area.

Control: Follow the instructions for jack-pine budworm or pine tube moth.

Nantucket Pine Tip Moth: The wing expanse of the moth is about $\frac{3}{16}$ inch. Its body is reddish-brown with silver-gray markings on the wings. Full grown larvae are about $\frac{3}{8}$ inch with yellowish to light brown bodies. The head and thoracic shield are dark brown.

The circular, flattened, and light-yellow eggs are usually laid on shoots, buds, or needles. Upon hatching, the larvae normally feed on new shoots near the base of needles. A protective web is spun over the feeding areas; later these become covered with pitch. As the larvae mature, they bore either into buds or the succulent growth near the tip of the shoots. Here they finish their growth, pupate, and overwinter in this stage.

Control: This moth is presently of minor importance in Michigan. However, should this insect require control, an azinphosmethyl (Guthion) (1a, or 1b) spray applied in late June or early July will give good results.

OTHER TROUBLES

Frost Damage: In early spring, buds and new growth turn white or yellowish-white. The needles on these are crisp and dry.



Frost damage to young buds.

Pine Grosbeak: This bird eats the upper buds, especially of Scotch pine.

Sapsucker: The yellow-bellied Sapsucker feeds on the sap and cambium of Christmas trees. It makes round holes in the bark, penetrating to the cambium layer. The mechanical damage causes the trees to bleed, forming gums on the bark. The damaged bark also permits diseases and insects to enter the tree.

Squirrels: Occasionally twigs and branches are cut from Christmas trees. This may be the work of squirrels. Perhaps the best evidence of this kind of damage is the teeth marks on the dismembered twig or branch.

SECTION III

INSECTICIDES

For good insect and mite control, you must know how to use insecticides and miticides (chemicals) effectively. Most insecticides and miticides are available in several different formulations. Each formulation has its own use for Christmas tree insect and mite control.

This insecticide and miticide information is divided into two parts. The first discusses the forms (formulations) in which you can use the various insecticides and miticides.

The formulations given are the more common ones. Read the label on the container for instructions on how to use formulations not discussed in this bulletin.

The second part of this section discusses the individual insecticides and miticides and lists the formulations usually available for insect and mite control. Also included in this second part are the WARNINGS on the use of each insecticide and miticide.

Formulations

A. Dusts

Dusts are dry powders which normally contain a lower percentage of insecticide than do wettable powders. Dusts are used as bought. **They are not mixed with water.** Use them on those insects against which they are effective. Dusts generally are less effective than either wettable powders or emulsions because they have poorer weathering quali-

ties and do not give the same coverage as sprays. Dust applications are difficult to control and often result in undesirable drift. DUSTS ARE NOT RECOMMENDED FOR CHRISTMAS TREE INSECT CONTROL.

B. Emulsions

These insecticides are liquids. They must be mixed with water, turning it milky. Emulsions are usually more toxic to plants than either wettable powders or dusts. Hence, use them strictly according to directions.

Emulsions in concentrated form are dangerous if spilled on clothing and skin. Wash with soap and water immediately after spilling on the skin. Change clothing.

C. Wettable Powders

These insecticides are similar to dusts. (See paragraph A above.) They contain, however, a higher percentage of chemical than do dusts. For some insect control purposes, wettable powders are used as bought instead of dusts. However, wettable powders are more often mixed with water and applied as sprays. Wettable powders can either

be used in dilute or concentrate sprays although emulsions are more suited for use in concentrate sprays. Avoid breathing or getting wettable powders on the skin. Use masks and protective clothing.

D. Other Formulations

Aerosols, vapors, and oil solutions are not normally used on Christmas trees. Oil solutions which resemble emulsions in the concentrated form generally do not mix with water and if applied alone could injure trees.

WARNINGS

- Avoid heavy application to tender (young) trees, especially when using chlordane.
 - Use only chlordane granules for soil insects.
 - People with sinus trouble may find lindane and BHC especially annoying.
 - Always read the label before using sprays or dusts. Note warnings and cautions each time before opening the container.
 - Keep sprays and dusts out of the reach of children, pets, and irresponsible people. Pesticides should be stored outside the home and away from food and feed.
 - Always store sprays and dusts in original containers and keep them tightly closed. Never keep them in anything but the original container.
 - Never smoke while spraying or dusting.
 - Avoid inhaling sprays or dusts.
- When directed on the label, wear protective clothing and masks.
- Do not spill sprays or dusts on the skin or clothing. If they are spilled, remove contaminated clothing immediately and wash yourself thoroughly.
 - Wash hands and face and change to clean clothing after spraying or dusting. Also wash clothing each day before re-use.
 - Cover food and water containers when treating around livestock or pet areas. Do not contaminate fishponds.
 - Use separate equipment for applying hormone-type herbicides in order to avoid accidental injury to susceptible plants.
 - Always dispose of empty containers so that they cannot harm humans, animals, or valuable plants.
 - Observe label directions and cautions to keep residues off edible plants.

INSECTICIDES AND MITICIDES

Descriptions, formulations and rates of application of insecticides and miticides suggested for various insect and mite control problems follow:

1. Azinphosmethyl (GUTHION):
This is an organo phosphate chemical of moderate to high toxicity with good residual properties. It has broad spectrum activity and is particularly effective against scale crawlers, shoot and tip moths, most aphids and thrips.

No.	Guthion Formulations*	Amount per 100 Gallons of Water	Amount per Gallon of Water
1a	50 percent wettable powder	1 pound	1 tablespoon
1b	22 percent emulsion	1 quart	2 teaspoons
1c	50 percent wettable powder	1½ pounds	1½ teaspoons
1d	22 percent emulsion	2 quarts	4 teaspoons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

2. Benzene hexachloride (BHC):
This material is a chlorinated-hydrocarbon and is closely related to lindane. BHC is not widely used as an insecticide on fruits and vegetables because it may cause an off flavor (chemical taste) in these products. However, this taste problem is absent in Christmas trees. The chemical can be substituted freely for lindane; however the dosage will be different.

You can buy BHC in three forms for use on trees. The following table lists its common formulations:

No.	BHC formulations*	Amounts per 100 gallons of water	Amount per gallon of water
2a	12 percent wettable powder*	4 pounds**	4 tablespoons
2b	Emulsifiable concentrate containing 2 pounds of chemical per gallon	1 quart**	2 teaspoons

*USE ONLY AS SUGGESTED. SEE SECTION II.

**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.

- 3.** (Carbaryl) SEVIN: This insecticide is a carbamate insecticide with good residual properties. It is available in various formulations. The following table lists its common formulations for treating tree foliage:

No.	Sevin Formulations	Amount Per 100 Gallons of Water	Amount Per Gallon of Water
3a	50% Wettable Powder	2 pounds*	2 tablespoons
3b	50% Wettable Powder	3 - 4 pounds*	3 - 4 tablespoons
3c	4 Flowable	1 quart*	2 teaspoons
3d	85% Wettable Powder	1½ pounds*	1½ tablespoons

* This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist blower.

- 4.** Chlordane: This is a chlorinated hydrocarbon used solely for weevil and grub control. It is the only insecticide suggested for soil insect control in Christmas tree plantings.

Chlordane is available in the following forms for treating foliage:

No.	Chlordane formulations*	Amount per 100 gallons of water	Amount per gallon of water
4a	40 percent wettable powder	2½ pounds**	2½ tablespoons
4b	72 percent emulsion	1½ pints**	1½ teaspoons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.

Chlordane formulations for soil treatment:

No.	Chlordane formulations*	Amount per acre
4c	10 percent granules	100 pounds

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

Notes: Immediately after applying chlordane to the soil surface, disc it 4 inches deep.

5. Diazinon: This is an organo phosphate chemical of moderate toxicity with broad spectrum activity against most insects except beetles.

No.	Diazinon formulations*	Amount per 100 Gallons of water	Amount per gallon of water
5a	50 percent wettable powder	1 pound	1 tablespoon
5b	48 percent emulsion	1 pint	1 teaspoon

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

6. Dimethoate (Cygon): This is a systemic organo phosphate chemical of moderate toxicity. It is particularly effective against sucking insects such as scales and aphids.

No.	Cygon formulation*	Amount per 100 gallons of water	Amount per Gallon of water
6	30.5 percent emulsion	3 pints	1 tablespoon

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

7. Endosulfan (Thiodan): This is a chlorinated hydrocarbon of moderate to high toxicity. It has good residual properties and is extremely effective against aphids and certain borers.

No.	Thiodan formulations*	Amount per 100 Gallons of water	Amount per Gallon of water
7a	50 percent wettable powder	1 pound	1 tablespoon
7b	20 percent emulsion	1 quart	2 teaspoons
7c	50 percent wettable powder	1½ pounds	1½ tablespoons
7d	24 percent emulsion	1½ quarts	3 teaspoons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

8. Lead Arsenate: This insecticide is the most commonly used stomach poison for chewing insects because it is effective and causes less injury to plants than other kinds of arsenicals. Lead arsenate is a powder. It is used in water as a suspension spray or mixed with a diluent (filler) for use as a dust.

Lead arsenate may be used alone at the rate of 3 pounds to 100 gallons of water. However, it will be more effective if used according to the suggestions given in 8a in the following table. Formula 8b in this same table is for control of white-pine weevil only. (Spray the leader.)

No.	Ingredients*	Amount per 100 gallons of water	Amount per gallon of water
8a	Lead arsenate (100 percent wettable powder) Summer oil or Milk	3 pounds** 1 quart	3 tablespoons 2 tablespoons ½ cup
8b	Lead arsenate (100 percent wettable powder) Boiled linseed oil Commercial spreader-sticker	¾ pound 4 fluid ounces ½ teaspoon

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.

9. Lindane: This material is a chlorinated hydrocarbon and is especially related to BHC. Lindane is not widely used as an insecticide on fruits and vegetables because it may cause an off-flavor (chemical taste) in those products. However, we do not have this taste problem when using it on Christmas trees.

You can buy lindane in three forms for use on trees. The following table lists its common formulations:

No.	Lindane formulations*	Amount per 100 gallons of water	Amount per gallon of water
9a	25 percent wettable powder	1½ pounds**	1½ tablespoons
9b	20 percent emulsion	1 pint**	1 teaspoon
9c	20 percent emulsion	2½ gallons	3 tablespoons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.
Note: A lindane emulsion spray is especially desirable for control of all kinds of leaf miners on shade, ornamental, and Christmas trees.

10. Malathion: This is a phosphate-type insecticide related to parathion, TEPP and other similar materials. Malathion is different from parathion and TEPP in at least one important respect. It is NOT as DANGEROUS TO USE at THE TIME OF APPLICATION AS PARATHION or TEPP. It must be kept in mind, however, that no matter how safe a material may seem to be, it can be dangerous if used improperly.

Malathion is available in two different formulations, as given in the following table:

No.	Malathion formulations*	Amount per 100 gallons of water	Amount per gallon of water
10a	50 percent emulsion	1½ pints**	1½ teaspoons
10b	25 percent wettable powder	3 pounds**	3 tablespoons

*USE ONLY AS SUGGESTED FOR EACH INSECT OR MITE. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.

Malathion is listed for control of numerous insects in this bulletin. It is especially effective against aphids and mites. Whether you use it in one form or another will depend greatly on the type of spraying or dusting equipment you have. For the most part, however, sprays tend to be better than dusts for treating Christmas trees.

11. Meta Systox-R: This is an organo phosphate insecticide with good systemic properties. It is particularly effective against aphids and other plant-sucking insects.

No.	Meta Systox-R formulation	Amount per 100 Gallons of water	Amount per Gallon of water
11	25 percent emulsion	1½ pints	1½ teaspoons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

12. Methoxychlor: This is a chlorinated hydrocarbon of low toxicity to man and animals. It is similar in action to DDT but does not have the same long residual properties. Methoxychlor, while relatively non-toxic to birds and other wildlife, is extremely toxic to fish.

No.	Methoxychlor formulations*	Amount per 100 Gallons of water	Amount per Gallon of water
12a	50 percent wettable powder	3 pounds	3 tablespoons
12b	25 percent emulsion	3 quarts	6 teaspoons
12c	50 percent wettable powder	4 pounds	4 tablespoons
12d	25 percent emulsion	1 gallon	8 teaspoons
12e	25 percent emulsion	8 gallons	8 tablespoons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

13. Miticides: There are several miticides and ovicides available that will adequately control mites on pines. Miticides control active mites whereas ovicides kill the eggs. For controlling both active mites and eggs choose a material which will control both stages, or use a combination of a miticide (acaricide) and an ovicide. Note: Concentrate (mist blower) application of miticides is not recommended.

Note: Morestan may injure pines if applied in combination with an oil spray, or preceding or following an oil spray.

Ovex may cause skin irritation if it comes in contact with the hands, face, and body.

Avoid getting Aramite in the eyes.

Formulation	Amount Per 100 Gallons of Water	Amount Per 1 Gallon of Water
Aramite* 15 percent wettable powder	2 pounds	2 tablespoons
Aramite* 25 percent emulsion	1 pint	1 teaspoon
Chlorobenzilate† 25 percent wettable powder	1½ pounds	1½ tablespoons
Chlorobenzilate† 25 percent emulsion	1 quart	2 teaspoons
Genite* 50 percent wettable powder	2 pounds	2 tablespoons
Genite* 25 percent emulsion	1½ pints	1½ teaspoons
Kelthane† 18.5 percent wettable powder	2 pounds	2 tablespoons
Kelthane† 18.5 percent emulsion	1 quart	2 teaspoons
Morestan*‡ 25 percent wettable powder	½ - 1 pound	½ - 1 tablespoon
Ovex* 50 percent wettable powder	2 pounds	2 tablespoons
Tedion* 25 percent wettable powder	1 pound	1 tablespoon
Tedion* 10 percent emulsion	1 quart	2 teaspoons

Note: *—ovicide—effective against eggs.
 †—acaricide—effective against active mites.

Where control of both active mites and eggs is desired, a combination of an acaricide and ovicide or a chemical which kills both stages is recommended. Miticides are generally not effective against insects.

14. Oils and Other Dormant Sprays: Apply before buds break in the spring, after danger of freezing nights has passed and when the temperature is above 40°F. Follow all label instructions. Generally, dormant sprays are most effective when applied late in the dormant season.

No.	Formulations	Amount per 100 Gallons of Water	Amount per Gallon of Water
14a	Dormant oil*	2 gallons	5 tablespoons
14b	Dormant oil* containing 2% ethion	2 gallons	5 tablespoons
14c	Lime Sulfur suspension	12 gallons	1 pint
14d	Dinitro's (DN's) slurry	1 gallon	8 teaspoons
14e	Dinitro's (DN's) Powder	4 pounds	4 tablespoons

* Many types of oils are available. However, narrow cut, paraffinic, superior oils of 60- to 70-second viscosity by the Saybolt test are preferred. These are sold under various trade names and are ready for dilution in water. It is not recommended that spreaders or stickers be combined with commercially prepared oils since the addition may reduce their effectiveness. COMPLETE COVERAGE OF ALL PLANT PARTS IS ABSOLUTELY ESSENTIAL FOR EFFECTIVE INSECT OR MITE CONTROL. Therefore, mist blower application of oils is not recommended because it does not give the uniform coverage of a hydraulic spray and may cause plant injury. Do not apply oils to sugar and Japanese maples, birch, beech, walnut, hickory or butternut since plant injury may result. Oil will remove the bloom from blue spruce but will not permanently injure trees.

15. Phosphamidon: This is an organo phosphate chemical of high toxicity which kills by systemic and contact action.

No.	Phosphamidon formulation*	Amount per 100 Gallons of water	Amount per Gallon of water
15	49 percent emulsion	1 pint	1 teaspoon

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

16. Trichlorfon (Dylox): This is an organo phosphate of moderate toxicity. It has specific activity against lepidoptera and diptera but has little effect on aphids and mites.

No.	Dylox formulation*	Amount per 100 Gallons of water	Amount per Gallon of water
16	80 percent wettable powder	1½ pounds	1½ tablespoons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

SECTION IV

EQUIPMENT

Choose equipment well and use it carefully for Christmas tree insect control. With the exception of airplane application, roadways must be present in all plantations where power equipment is used. Types of equipment and their use are given below.

Compressed Air Sprayer:

The water capacity of a compressed air sprayer is usually 3 to 4 gallons. Air is pumped into the tank, thus forcing the spray out when the nozzle is opened. Emulsions and wettable powders can be applied with a compressed air sprayer. Because this sprayer has limited size, it is not practical for large acreage spraying. Agitate the sprayer when you use wettable powder.

Knapsack Sprayer:

The water capacity of a knapsack sprayer is usually 3 to 5 gallons. This sprayer is carried on the back and continuously hand-pumped. Both emulsions and wettable powders can be applied with a knapsack sprayer. Because this sprayer has limited size, it is not practical for large acreage spraying. The knapsack sprayer must have a built-in agitator for successful operation especially when wettable powder insecticide is used.

Power Sprayer:

The power-driven hydraulic sprayer (it uses large amounts of water) is suitable for treating large acreages. Because water weighs 8 pounds a gallon, a loaded sprayer is normally heavier than a loaded duster. This will limit the sprayer's use on rough or sloping soils. A hydraulic sprayer is satisfactory for control of all Christmas tree insects.

Mist-Blower: (Also referred to as air-blast)

The mist-blower (it uses concentrated spray mixture) can treat large tree numbers. This machine uses small quantities of water to apply insecticides. While a hydraulic power sprayer uses 100 or more gallons of water to an acre, mist-blowers can use as little as 30 gallons of water to an acre. A mist-blower has two important drawbacks. 1. Not enough is known about its use against most insects damaging Christmas trees, especially the Zimmerman pine moth; 2. Generally it does not cover satisfactorily a spray-width of more than about 40 feet.

In comparison with a regular dilute spray, a concentrate spray is made by putting 2, 3, 4, or more times the amount of chemical in 100 gallons of water. When twice the amount of chemical is put into 100 gallons of water—that is called a 2X concentrate spray; three times is called 3X, and four times is called 4X, etc. For example: If 3 quarts of 25 percent Methoxychlor emulsion are put into 100 gallons of water to make a regular (dilute) spray, then 1½ gallons (6 quarts) of this same material in 100 gallons of water make a 2X concentrate spray; 2½ gallons (9 quarts) make a 3X spray; and 3 gallons make a 4X spray.

The object of using a mist-blower (concentrate) spray is to apply less water (spray) per acre yet use the required amount of insecticide. This makes it possible to cover more ground per tankful and avoid extra hauling of water and compaction of soil. For example: Suppose 3 quarts of 25 percent Methoxychlor emulsion are used in each 100 gallons of hydraulic (dilute) spray. (This is the standard dosage for hydraulic spray when controlling anomala

beetles, aphids, budworms, and sawflies but not for European pine shoot moth which requires a higher dosage of Methoxychlor.) Then 50 gallons of a 2X concentrate spray would apply the desired 3 quarts of 25 percent Methoxychlor emulsion. A 3X concentrate would take 33 gallons, and a 4X concentrate spray would take 25 gallons for the required 3 quarts of 25 percent Methoxychlor emulsion. Because European pine shoot moth control takes a larger amount (dosage) of Methoxychlor than other Christmas tree insects, concentrate sprays for shoot moth control are figured as follows:

Strength of Mixture	Amount of insecticide per 100 gallons of water
Dilute	1 gal. 25% Methoxychlor emulsion
2X	2 gal. 25% Methoxychlor emulsion
3X	3 gal. 25% Methoxychlor emulsion
4X*	4 gal. 25% Methoxychlor emulsion
5X	5 gal. 25% Methoxychlor emulsion
6X	6 gal. 25% Methoxychlor emulsion
7X	7 gal. 25% Methoxychlor emulsion
8X	8 gal. 25% Methoxychlor emulsion

* A 4X concentrate spray is the least amount you should use for European pine shoot moth control.

Remember that using a mist-blower or air-blast (concentrate) spray does not change the need for careful, thorough, and timely spraying. Effective protection of Christmas trees against insects requires thorough coverage.

Airplanes:

The airplane can treat large tree numbers. Airplane use is limited by such conditions as poor weather, telephone and electrical power lines near the trees, and hard-to-control

insects. Special insecticide formulations must be used with airplanes.

Helicopters:

Helicopters are usually better than airplanes for applying insecticides for control of Christmas tree insects. Their slow hovering motion makes it possible to apply treatments more uniformly and in amounts closer to dosage requirements.

NOTE: Both helicopter and airplane application of insecticides has

proven effective in controlling sawflies, anomala beetle, jack pine budworm, white pine weevil and spittlebugs. Application by aircraft is done with less total chemical in a shorter period of time than with ground equipment. However, not all pests are as easily controlled. Helicopter has given better results than fixed wing aircraft for controlling the crawling stage of scale insects and certain aphids. Such insects require high gallonage applications, (5 to 10 gallons per acre)

applied once along and once across the rows, in order to achieve the desired coverage. Even under such procedures the coverage of internal portions of trees by helicopter cannot compare with a properly applied spray with ground-based equipment. Control of pine root collar weevil, Zimmerman pine moth, mites, pales weevil, European pine shoot moth or pine shoot borer has yet to be demonstrated by either fixed wing aircraft or helicopter application.

MICHIGAN POISON CONTROL CENTERS

In Case of Poisoning

1. *Call your physician.* **NOTE TO PHYSICIAN:** The table below lists Poison Control Centers in Michigan which can furnish specific information including antidotes, for various trade and common named poisons. Services of the Centers are intended mainly for Medical Doctors. However, offices remain open 24 hours a day and can give emergency poison treatment advice over the phone.

2. *For poisons spilled on the skin:* Wash thoroughly with large amounts of soap and warm water. Particles in the eyes may be removed by thorough

flushing with plain water. For phosphate materials absorbed through the skin, give atropine by injection or in tablet form.

3. *For poisons that have been inhaled:* Place the patient in the open air. Give atropine as directed above if a phosphate material is responsible. Administer artificial respiration when necessary.

4. *For poisons that have been swallowed,* induce vomiting as soon as possible. To do this, gently stroke the inside of the throat and/or give an emetic such as warm salt water (1 tablespoon in a glass of water). Repeat until the vomit fluid is clear. After the stomach has been emptied, give

a demulcent such as raw egg white mixed with water.

5. When the physician arrives, he may inject $\frac{1}{30}$ to $\frac{1}{60}$ of a grain of atropine sulfate at hourly intervals for phosphate materials, or phenobarbital for chlorinated hydrocarbon chemicals.

NOTE: A new antidote, specific for phosphate chemicals, is available to doctors for emergency treatment of phosphate poisoning. This antidote, called PAM (protopam chloride or pralidoxime) can be injected intravenously by doctors or prescribed in tablet form. In several instances persons poisoned by phosphate chemicals have responded to PAM when atropine failed to give desired results.

City

ADRIAN

Poison Control Center
Emma L. Bishop Hospital
818 Riverside Avenue 49221
375-6161
Robert Greiner, M.D.

ANN ARBOR

Poison Control Center*
University Hospital
1405 E. Ann St. 48104
764-5102
George H. Lowrey, M.D.

BAD AXE

Poison Control Center
Hubbard Memorial Hospital
423 E. Irwin St. 48413
CO 9-6444
Alice J. Shoemaker, R.Ph., Dir.
Roy Gettel, M.D.

BATTLE CREEK

Poison Control Center
Community Hospital
200 Tomkins St. 49016
Woodward 3-5521
Meta Lou Henderson, R.Ph.
(Chief Pharmacist)

City

BAY CITY

Poison Control Center
Merry Hospital
100 15th St. 48706
TWINbrook 5-8511
Theodore Meyer, Pharmacist
Poison Treatment Center
Bay City Osteopathic Hospital
300 Mulholland St. 48706
TWINbrook 3-9554
(Emergency Room under charge of Floor Supervisor)
Mrs. Virginia Davis, LPN
7:00 a.m. to 3:00 p.m.

BERRIEN CENTER

Poison Control Center
Berrien General Hospital
Dean's Hill Rd. 49102
471-7741
Richard C. Chaulohr, R.Ph.

COLDWATER

Poison Control Center
Community Health Center of Branch County
374 E. Chicago St. 49036
379-9591
John G. Hefelfinger, M.D.
Office 378-2359

City

DETROIT

Poison Control Center
Children's Hospital
5224 St. Antoine St. 48202
835-1000
Paul V. Woolsey, Jr., M.D.;
Regine Arrow, M.D.

Poison Information Center

Registrar's Office
Herman Kiefer Hospital
1151 Taylor Avenue 48202

872-3234
Paul T. Chapman, M.D.
William G. Frederick, Se.D.

Poison Control Center

Mount Carmel Mercy Hospital
6071 W. Outer Drive 48235
864-5499
Forest P. Becker, R.Ph.
John Moses, M.D.
(Medical Advisor)

Poison Treatment Center
Saratoga General Hospital
1599 Gratiot Ave. 48205
Lakeview 4-5199
Wm. B. Hennessey, Chief
Pharmacist

City

ELOISE

Poison Control Center
Wayne County General Hospital
39712 Michigan Avenue 48132
723-2599, Ext. 4239-6231
Fernando J. deCastro, M.D.

FLINT

Poison Control Center
Hurley Hospital
6th Ave. & Beale 48502
Cedar 3-4161
Douglas L. Vivian, R.Ph.

GRAND RAPIDS

Poison Control Center
Budget Memorial Hospital
1849 Wealthy, S.E. 49506
456-9548
John P. Foxworthy, M.D.
Poison Control Center
Batterworth Hospital
100 Michigan, N.E. 49503
451-3591
John R. Wilson, M.D.
Poison Control Center
St. Mary's Hospital
201 Lafayette, S.E. 49503
459-3131
John Rupke, M.D.

City	City	City	City
GRAND RAPIDS/Cont.	Polson Control Center	MONROE	TRAVERSE CITY
Polson Control Center	St. Lawrence Hospital	Polson Treatment Center	Polson Control Center
Grand Rapids Osteopathic Hosp.	1210 W. Saginaw St. 48914	Memorial Hospital of Monroe	Munson Memorial Center
1910 Boston St., S.E. 49506	373-2610	709 Stewart Road 48161	Traverse City 49684
452-5151	Howard Comstock, M.D., Dir.	241-6500	947-6140
Eugene M. Johnson, D.O.	William Mueller, Pharm., Asst.	Donald Wojack, Pharmacist	Philip K. Wiley, M.D., Dir.
Wallace Stolensberg, R.Ph.	William Adrian, Pharm.		A. McCrackin, Pharm., Deputy Dir.
HANCOCK	Polson Treatment Center	PETOSKEY	
Polson Control Center	Lanning General Hospital	Polson Control Center	
St. Joseph's Hospital	2800 Devonshire Ave. 48510	Little Traverse Hospital	
290 Michigan Avenue 49929	373-8220 Ext. 225	416 Connable 49770	
482-1122	John Morgan, R.Ph.	Diamond 7-2551	
Howard E. Otto, M.D.	Polson Treatment Center	James M. Stamm, R.Ph.	
Sr. Mary Sharon Jones, R.Ph.	Ingham Memorial Hospital		
	401 W. Greenlawn 48910		
	485-8141		
JACKSON	Robert C. Combs, M.D.	PONTIAC	
Polson Treatment Center*	LINCOLN PARK	Polson Control Center	
Yoete Memorial Hospital	Polson Control Center	St. Joseph Mercy Hospital	
205 N. East 49201	Outer Drive Hospital	900 Woodward Ave. 48053	
State 5-2771	26400 Outer Drive 48146	338-9111	
Ethan Stone, M.D.	286-6066	Robert J. Mason, M.D.	
	W. S. Wheeler, Admin.		
	Carl A. Gagliardi, M.D.		
	W. S. Wheeler		
KALAMAZOO	MARGUETTE	PORT HURON	
Polson Control Center	Polson Information Center	Polson Control Center	
Bronson Methodist Hospital	St. Luke's Hospital	Mercy Hospital	
252 E. Lovell St. 49006	West College Ave. 49855	2601 Electric Ave. 48009	
342-9821	Canal 6-3511	Yukon 5-9531	
H. Sidney Heersma, M.D.;	Charles King, Pharmacist	Robert Luzz, M.D.	
Kenneth Huckendubler, Dir. of	Norman Matthews, M.D.		
Pharmacy and Central Services			
(Asst. Director)	MIDLAND	SAGINAW	
	Polson Control Center	Polson Control Center	
LANSING	Midland Hospital	Saginaw General Hospital	
Polson Treatment Center	4095 Orchard Drive 48640	1447 N. Harrison Rd. 48602	
Edw. W. Sparrow Hospital	TE 5-6771	755-5411	
1215 E. Michigan Ave. 48912	R. E. Lecliner, M.D.	Wm. G. Mason, M.D., Chair.	
487-6111	K. W. Linsenmann, M.D.		
Spring S. Jacob, M.D.	N. D. Fields, M.D.	Polson Treatment Center	
Office 332-6848	W. E. Thamarus, M.D.	Saginaw Osteopathic Hospital	
		515 N. Michigan 48602	
		PE 5-7751	
		T. D. Webber, D.O., Chair.	
		C. S. Chicky, D.O.	
		W. C. Adams, D.O.	

* Facilities available for determining cholinesterase levels in blood samples.

OTHER REFERENCES

You can get more information on the control of insects affecting Christmas trees than is given in this bulletin.

You can buy bulletins and leaflets on certain problems from the Superintendent of Documents, Washington 25, D.C. Bulletins and mimeographed materials are available at the Bulletin Office, Michigan State University, Box 231, East Lansing, Michigan. Single copies of most of this material are free. Your county agricultural agent also has literature from Michigan State University and the federal government.