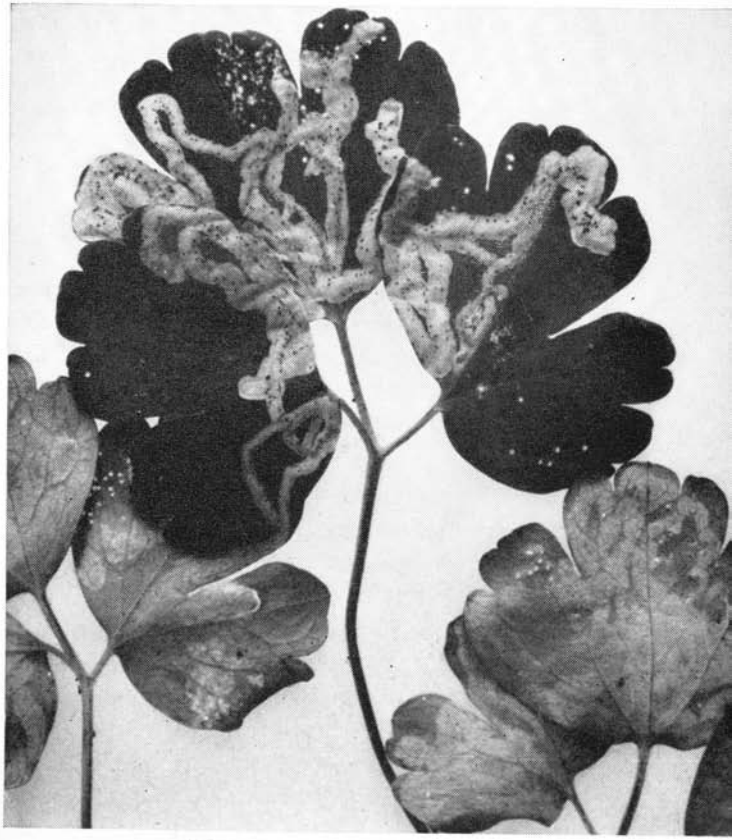
Pests of
ORNAMENTALS
Reports on control experiments

CONTROL OF LEAF MINERS

John C. Schread



Work of the columbine leaf miner.

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Photos by B. W. McFarland

FOREWORD

Infestations of leaf-mining insects have always presented difficult problems of control. Eggs are laid either in the leaf tissue or on the surface of the leaves. Even if the eggs are external, the larvae may enter the leaves without feeding on the surface. Thus, it is difficult to get complete control by application of sprays.

Furthermore, leaf miners are particularly undesirable on ornamental plants. Their feeding between the two surfaces of the leaves may change an ornamental from a pleasing feature of the landscape to an eyesore.

Entomologists at this Station have worked on leaf miner control for years. About 30 years ago Roger B. Friend demonstrated control of the birch leaf miner by use of nicotine sprays to kill the eggs. More recently John C. Schread found that the young miners could be killed by lindane sprays, a procedure less costly and more effective than killing the eggs.

This bulletin presents results of tests on a number of ornamental plants. These results indicate that the damage from leaf miners can be reduced by spraying.

CONTROL OF LEAF MINERS

John C. Schread

BIRCH LEAF MINER

The birch leaf miner (*Fenusa pusilla*), a sawfly, has been a pest of birches since its introduction here in 1923. In the past 10 years it has varied in abundance. Serious infestations in which leaves of most susceptible birches are damaged have been followed by seasons of relatively low abundance.

The species most seriously damaged by this pest are the native gray birch (*Betula populifolia*), white birch (*B. pendula*), cut-leaf varieties of the European white birch (*B. alba*), and the paper birch (*B. papyrifera*). Red or river birch (*B. nigra*) and black birch (*B. lenta*) may show some slight injury occasionally.

In most years the first generation of leaf miners causes the greatest injury. Leaves may be completely mined, resulting in uniform browning, shrivelling, and premature dropping of the foliage (Figure 1). In areas of dense sawfly population all of the leaves on a tree may turn brown and fall. Usually second generation infestation in late June and early July is less noticeable. Sometimes, as in 1959, favorable growing conditions after mid-June result in continued new growth which is heavily infested in July.

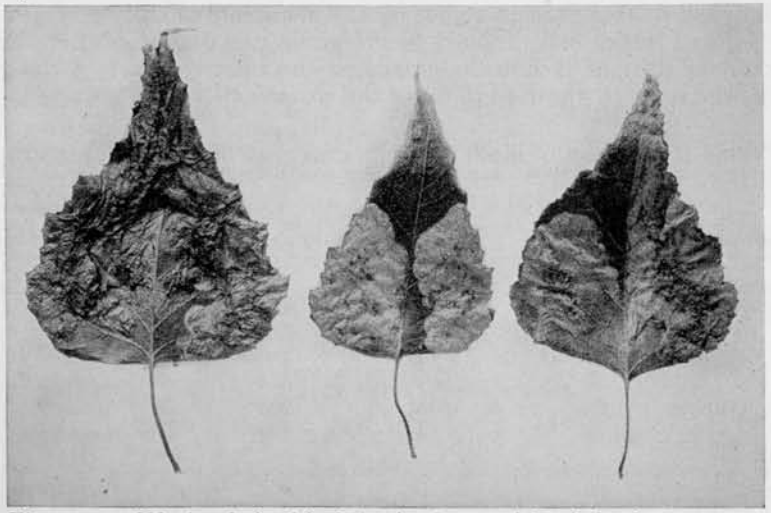

Figure 1. Work of the birch leaf miner. All of the leaves may turn brown and drop early in the season.

The birch leaf miner overwinters as a mature larva in an earthen cell in the soil beneath the trees. Transformation to the adult stage takes place in the spring. The date of initial emergence of the sawflies may vary from year to year. Adults have been observed in southwestern Connecticut as early as April 22 and in the upper and central part of the State a few days to a week later. The date of first emergence commonly falls in or near the second week in May, with some variation apparently related to the weather, when the first leaves of gray birch are about half grown.

The adult sawfly is black and about 1/16 inch long. It deposits eggs only in newly developing leaves. Several days later the young larvae can be seen feeding in translucent blister-like areas in the leaves. When feeding is completed, the larvae emerge from the shrivelled and browning leaves, spin down to the ground, and pupate. There are about four generations a season, each requiring 5 to 6 weeks to complete its cycle. Birch trees completing their annual growth before the last broods appear are not noticeably infested by miners.

The first method used to control birch leaf miners was frequent applications of nicotine sulfate spray to kill the eggs (Friend, 1933). Schread (1952) found that lindane was very effective, and that DDT killed adults but not larvae. Later, malathion was used successfully (Schread, 1954).

Both malathion and lindane have continued to be effective. However, these materials are not satisfactory for controlling other species of leaf miners on ornamental plants. Therefore, several other insecticides have been tested to determine their effectiveness.

Tests Made in 1958

On June 4, 1958, gray birch trees averaging 18 to 20 feet in height were sprayed with emulsions of the insecticides listed in Table 1. At this time the miners were full-grown or nearly so and ranged from 3/16 to ¼ inch in length. From 10 to 20 per cent of them had already emerged from the injured leaves and dropped to the ground to pupate. There was an average of 40 trees each in the untreated and treated areas. A 300-gallon hydraulic sprayer was used to make the treatments.

Table 1. Control of birch leaf miner on gray birch trees, June 1958

Insecticide	Pints per 100 gallons	Control as of June 10: Miners Dead	Miners Alive	Per cent Control
Applied June 4				
25% Diazinon	½	316	0	100
	1	223	0	100
13% Sevin	½	309	0	100
	1	314	0	100
43% Trithion	½	280	1	99.6
	1	466	37	92.6
Untreated	..	...	250	.....

Control data were taken on June 10 by counting the dead and live miners in 50 leaves taken at random from each group of sprayed and unsprayed trees (Table 1).

Table 2. Control of birch leaf miner on gray birch trees, 1959

Insecticide	Pints per 100 gallons	Miners Dead	Miners Alive	Per cent Control
Applied May 20			*Control as of May 27*	
48% Ethion	½	138	6	95.8
	1	227	0	100
Untreated	..	...	109	.....
Applied July 2			*Control as of July 9*	
25% Thiodan	½	6	73	7.4
	1	78	87	47.2
Untreated	..	...	361	.....

Tests Made in 1959

In the 1959 spray treatments ethion emulsion was used on May 20 and Thiodan emulsion on July 2 at a time when many of the miners of the first and second broods were small and some of the eggs were still hatching. There was an average of nine 18- to 30-foot gray birch trees each in the untreated and treated areas. A 12-quart wheelbarrow mist blower was used to apply about 2 quarts of spray per tree.

Control data taken on May 27 for the first brood treatment and on July 9 for the second were obtained by counting the dead and live miners in 25 leaves per tree (Table 2).

Tests Made in 1960

Following the system used in the previous year, the spray treatments made in 1960 were applied to both the first and second broods of birch leaf miners. On May 20, Dimecron, Dibrom, and Guthion were used on 7- to 14-foot gray birch trees. On June 20, chlordane, heptachlor, and

Table 3. Control of birch leaf miner on birch trees, 1960

Insecticide	Pints per 100 gallons	Miners Dead	Miners Alive	Per cent Control
First brood (on gray birch)				
Applied May 20			*Control as of May 31*	
49% Dimecron	½	158	0	100
	1	215	0	100
64% Dibrom	½	169	0	100
	1	170	0	100
18% Guthion	1	137	0	100
	2	187	0	100
Untreated	..	...	186	.....
Second brood (on cut-leaf European white birch)				
Applied June 20			*Control as of June 24*	
72% Chlordane	⅛	11	54	16.9
	¼	41	30	57.7
25% Heptachlor	1/16	62	30	67.3
	⅛	60	5	92.3
18% Guthion	¼	104	0	100
	½	116	0	100
Untreated	..	...	122	.....

Guthion were used on clumps of 6-foot cut-leaf European white birch. The sprays were applied with a 12-quart wheelbarrow mist blower in May and a trombone sprayer in June. In both instances the treatments were replicated once, and 1 to 3 quarts of spray were used per rate of treatment.

Control data taken on May 31 for the first brood of miners and on June 24 for the second brood were obtained from 25 leaves taken at random from the trees in each treated and untreated area (Table 3).

It is obvious that many of the materials tested during the three years provided excellent control of the birch leaf miner. Thiodan, chlordane, and heptachlor were less effective than the other materials.

THE HOLLY LEAF MINER

The holly leaf miner, *Phytomyza ilicis*, is a troublesome pest of American holly. Heavy infestations disfigure the new leaves.

There is only one generation of the holly leaf miner a year. The adult is a small black fly from 1/32 to 1/16 of an inch long. It emerges in the second season after mining the foliage.

Eggs are deposited in slits in the underside of newly developing leaves. The eggs hatch into small yellow-white maggots that mine between the upper and lower surfaces of leaves. At first the mines appear as almost imperceptible tracings not more than 1/32 of an inch long. Later the mines broaden as the larvae grow (Figure 2). There may be as many as 16 miners in a leaf with an average of 2 to 3. The insect lives over winter as a fully mature miner and is then about 1/8 of an inch long. Pupation in 1960 took place principally between April 8, when only one per cent had pupated, and April 27, when 93 per cent had pupated.

Transformation from the pupae to the adult stage requires 3 to 6 weeks. The time of emergence of the adults varies from year to year. In New Haven County in 1960 the initial emergence occurred on May 15, whereas in 1958 it was on May 29. In 1957, 80 per cent of the adults had emerged by May 27. In 1960 most of the adults had emerged, oviposited, and died by June 13.

The female flies feed repeatedly on droplets of plant juice which exude from ovipositor punctures in the upper surface of the new leaves. Numerous punctures cause a characteristic stunting and twisting of the leaves.

Older Control Measures

In addition to removal and burning of infested holly leaves, Felt and Bromley (1938) found that thorough spraying of infested trees with nicotine sulfate controlled the pest. It was suggested that the sprays be applied several times during the period of adult emergence, hatching of eggs, and while small mines were developing in the leaves.

Spraying the foliage with arsenate of lead when the eggs were hatching gave good control (Felt and Bromley, 1938).

More recently lindane and aldrin were shown to be effective in controlling miners in July, but were ineffective in killing the overwintering ones (Schread, 1953).

Control Experiments in 1959

Spray materials used on June 1, 1959, intended to prevent infestation of newly developing holly foliage by killing adults, are in Table 4. A wetting agent, NNO (Atlas Powder Co.), was used with each treatment at the rate of 3 ounces in 100 gallons to assure complete coverage of the glossy holly leaves. There was an average of eight 7- to 15-foot trees in each of the untreated and treated areas. A wheelbarrow mist blower was used to apply 5 to 9 gallons of spray per treatment on each test plot. Control data taken August 6 were obtained by random sampling of 1000 leaves from each of the treated and untreated areas.

Table 4 indicates that ethion and Diazinon provided much better early season protection to holly leaves than did the other insecticides used in the test.

Table 4. Prevention of leaf miner infestation in newly developing holly leaves in June by killing adults, 1959

Insecticide	Pints per 100 gallons	Leaves		Per cent Control
		Infested	Not Infested	
Applied June 1			*Control as of August 6*	
25% Diazinon	1	144	856	85.6
25% DDT	1	469	531	53.1
20% Lindane	1	709	291	29.1
48% Ethion	1	68	932	93.2
25% Thiodan	1	684	316	31.6
Untreated	..	921	79	.....

Experiments in 1960

The 1960 experiments in control of overwintering holly leaf miners was undertaken on April 1. At this time most of the miners were in the larval stage. A very few were prepupae and none had pupated. The insecticides used in the test are given in Table 5. Triton B1956 (a wetting agent) was added to each spray at the rate of 8 ounces per 100 gallons to facilitate better coverage of the holly leaves. The trees averaged 7 feet in height. A wheelbarrow mist blower was used to apply 1 to 3 quarts of spray per tree. Each treatment was replicated once.

It may be seen from Table 5 that Dibrom and Di-Syston gave the best

Table 5. Control of overwintering holly leaf miner, April 1960

Insecticide	Pints per 100 gallons	Miners		Per cent Control
		Dead	Alive	
Applied April 1			*Control as of April 26*	
49% Dimecron	1	32	29	52.5
	2	39	12	76.5
64.5% Dibrom	1	48	7	87.5
	2	55	2	96.5
26% Di-Syston	1	20	19	51.3
	2	46	5	90.2
18% Guthion	1	4	31	11.4
	2	7	16	30.4
Untreated	..	...	46	.....

control of overwintering holly leaf miner larvae. Dimecron was less efficient and Guthion failed almost completely.

The foregoing tests have shown that some of the newer insecticides such as Dibrom and Di-Syston will give excellent control of mature, overwintering miners in early April. In addition, results with ethion and Diazinon applied at the time the adult leaf miners were emerging in late May and early June indicated that miner infestation could be prevented in newly developing foliage by killing adults.

Figure 2. The light-colored areas in these holly leaves show results of feeding by leaf miners.

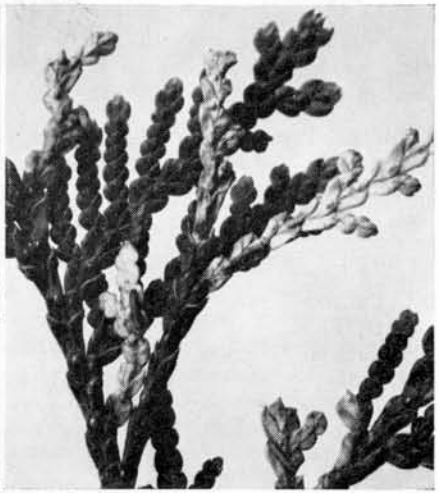

Figure 3. Leaf miners caused the off-color (brown) areas in these scale-like leaves of arborvitae.

ARBORVITAE LEAF MINER

Arborvitae, which are often used in hedges, are sometimes attacked by the arborvitae leaf miner, *Argyresthia thuiella*. Serious infestation may result in discoloration and yellowing of the tips of the twigs, causing a general off-color and brownish appearance of the plants (Figure 3). This results from larvae feeding in the interior of the needles. The larvae may be seen in the mines in late summer or early spring by holding a twig in front of a light and probing the brownish areas to make the caterpillars wiggle. Injury by the insect appears to be greatest where arborvitae are growing in partial shade.

Life History and Habits

There is only one generation of leaf miners a year. The insects overwinter as partly grown larvae in mines excavated during the previous season. A study made during the spring of 1957 indicated on April 8 the presence of larvae only. On May 9, 25 per cent of the miners were still feeding, whereas 75 per cent were in the prepupal stage. By May 20, 60 per cent had pupated, 25 per cent were prepupal and 15 per cent were feeding. A 33 per cent emergence of adults had occurred by June 3, 64 per cent by June 10, and about 98 per cent by June 23. Most of the moths had oviposited and died by July 1.

The light gray moths, averaging 3/8 of an inch in wingspread, deposit their roughened and beaded-like greenish eggs by wedging them between the tip of one leaf scale and the base of an adjoining one. On hatching, a larva enters a leaf scale directly from the inserted end of the egg. The opposite and protruding end may be seen with a hand lens. An examination of 20 two-inch twigs on July 2, 1957, showed that there was an average of 1.5 eggs per twig, 33.7 per cent of which had hatched. Moth emergence and egg deposition was about 12 days later in 1958. As a result only 19 per cent of the eggs had hatched by July 16 in that year.

Control of Arborvitae Leaf Miner

Control experiments on Aug. 13, 1957, and Aug. 26, 1959, indicated the effectiveness of the materials listed in Table 6. The trees were 7 to 9 feet in height. Each treatment was repeated four times. A 3-gallon wheelbarrow mist blower was used to apply 1 gallon of spray for each test. Wetting agent NNO was added to the treatments at the rate of ¼ teaspoon per gallon of spray. Control data were taken on Sept. 23 and Oct. 1. The first two insecticides listed in the table were used in 1957, the remaining ones in 1959.

Ethion gave complete control of arborvitae leaf miner. With the exception of Sevin, which gave only 41 per cent control, the insecticides gave from 87 to 93 per cent control at the stronger dilutions.

Table 6. Control of arborvitae leaf miner, 1957 and 1959

Insecticide	Pints per 100 gallons	Miners Dead	Miners Alive	Per cent Control
Applied August 13, 1957		*Control as of Sept. 23, 1957*		
20% Lindane	1	23	3	88.5
	2	8	1	88.9
55% Malathion	1	13	4	76.4
	2	13	1	92.8
Applied August 26, 1959		*Control as of Oct. 1, 1959*		
25% Diazinon	1	29	4	87.8
	2	31	3	91.2
48% Ethion	1	32	0	100
	2	30	0	100
13% Sevin	1	0	22	0
	2	11	16	40.7
44% Trithion	1	16	17	48.5
	2	27	4	87.1
Untreated	..	...	24	.....

BOXWOOD LEAF MINER

The boxwood leaf miner (*Monarthropalpus buxi* Lab.) is the most destructive pest of this ornamental. There is one generation of boxwood leaf miner each season.

On April 25, 1958, all of the miners in the leaves on 20 small twigs taken at random from boxwood hedges in New Haven contained only mature miners. A second examination made on May 9 showed that more than 90 per cent of the miners had pupated. The balance of the population was in the prepupal stage. In two localities in Fairfield County adult emergence commenced on May 21 and May 22 respectively. Emergence in the central part of the State was about one week later.

Life History and Habits

The adult is a tiny yellow or brilliant orange-red fly or midge about 1/8 of an inch long. It emerges from the lower surface of the previous year's leaves when the new twigs have several leaves. On emergence, adults are whitish or translucent in color. The yellow-orange larvae or maggots, which are about 1/8 of an inch long when mature, feed inside the leaves. They require a year for development from the egg to the adult stage.

Infested boxwood leaves have a yellowish-green mottling on the upper surface. The under surface displays blister-like oval swellings or blotches with a light, water-soaked appearance and central clear area produced by the mature larvae before pupation and through which the adult emerges. Figure 4 shows pupae within the leaf.

Preparatory to emergence the pupae push themselves partly out of the leaf through the central clear area. The adults wriggle free from their whitish pupal cases which then protrude from the under surface of the leaves (Figure 5).

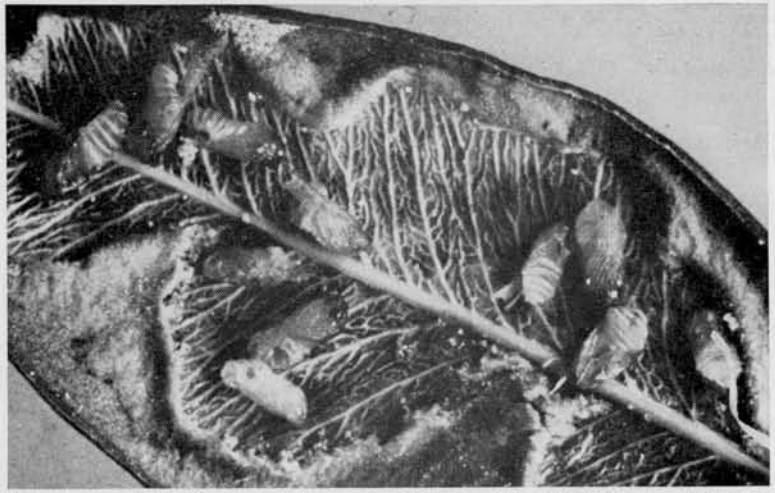

Figure 4. The lower surface of a boxwood leaf has been stripped away to show pupae of the leaf miner.

Emergence continues for several weeks. The males die soon after mating. The females are most active during the early part of the day. Individual egg laying is usually completed in less than a week. There may be as many as 17 or more miners in a single leaf, but the usual number is 5 to 7. Badly injured foliage may drop from a plant in late winter or early spring.

Figure 5. Pupal cases protrude from boxwood leaves which show injury typical in leaf miner infestation.

Control of Boxwood Leaf Miner

Earlier control measures were intended to destroy the adults as they emerged and before they could infest the new foliage. Frequent treatments were needed to assure good results. Later, new insecticides such as DDT, chlordane, aldrin, and dieldrin, applied to infested plants before or at the time the first adults appeared, gave good control with one treatment (Schread, 1953). Malathion and lindane were used to destroy the miners in the leaves (Schread, 1955).

Control Experiment

More recent experiments carried on to control boxwood leaf miners with foliar treatments provided information concerning the effectiveness of some of the newer insecticides.

The emulsifiable insecticides and the rates of treatment used on July 22, 1959, to kill the young miners in new boxwood foliage are given in Table 7. Wetting agent NNO was added to all treatments at the rate of 4 ounces to each 100 gallons of spray.

With the exception of Sevin, ethion, and Trithion at their lowest dilution, all of the insecticides listed in Table 7 gave complete control of boxwood leaf miner.

Table 7. Control of boxwood leaf miner, July 1959

Insecticide	Pints per 100 gallons	Miners Dead	Miners Alive	Per cent Control
Applied July 22			*Control as of July 29*	
48% Ethion	1	130	20	86.7
	2	92	0	100
25% Diazinon	1	68	0	100
	2	44	0	100
44% Trithion	1	45	29	60.8
	2	91	0	100
13% Sevin	1	32	53	37.6
	2	45	70	39.1
Untreated	..	...	60	.....

AZALEA LEAF MINER

The azalea leaf miner (*Gracilaria azaleella*) seems to be increasing in abundance and amount of injury. Injured azalea leaves turn yellow and brown, and drop prematurely. Seriously infested plants may be reduced in vigor, resulting in poor annual growth and sparse flowering in the following year. Greenhouse azaleas are often as badly injured by leaf miner as the hardier outdoor varieties.

Life History and Habits

The azalea leaf miner is a small yellowish larva ranging in length from 3/8 to ½ inch when mature. The young larvae mine a leaf until they are almost completely grown. They then emerge from the mines and fold under the tips or edges of the leaf (Figure 6). Within the folds they continue to feed as skeletonizers until mature. Pupation takes place in the folds from whence emerge the small moths mottled with yellow, brown, and purple. They average 3/8 of an inch in wingspread. Eggs are laid on the new leaves. There are three or more generations a year with the last one overwintering in the larval stage (rarely as pupae) in the folds of the leaves.

Emergence of the first moths in the spring varies with weather conditions. In 1956 the first generation miners were found on June 10, whereas in 1959 they appeared during the third week of May.

An examination made on November 1, 1956, of 112 leaves taken from three varieties of azaleas indicated the presence of 124 miners, ranging from 1 to 4 per leaf. More than 60 per cent of these were fully grown larvae. No pupae were found.

Control of Azalea Leaf Miner

Spraying or dusting infested plants with DDT or lindane is helpful in killing the adult moths and miners. In an experiment undertaken on June 11, 1959, the emulsifiable insecticides listed in Table 8 were used. Twenty-one plants, ranging in height from 18 to 42 inches, of the following varieties were used in the tests: *Azalea obtusum amaenum*, *A. indica*, *A. poukhanense*, *A. hinodegiri*, and *A. kaempferi*. Wetting agent NNO

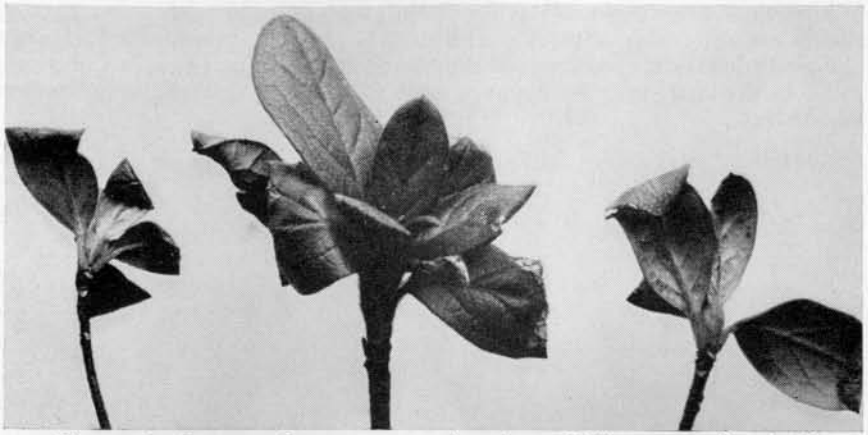

Figure 6. Leaves of evergreen azalea show folding caused by leaf miner feeding.

was used with each dilution at the rate of 4 ounces in 100 gallons of water. A 3-gallon hand pressure sprayer was used to apply 1 to 2 quarts of spray per plant.

Diazinon gave complete control of the azalea leaf miner. Although malathion was somewhat less effective and Trithion even less so, these two insecticides may be expected to prevent a rise in leaf miner population if used several times during the growing season.

Table 8. Control of azalea leaf miner, June 1959

Insecticide	Pints per 100 gallons	Miners Dead	Miners Alive	Per cent Control
Applied June 11			*Control as of June 15*	
50% Malathion	½	75	6	92.6
	1	17	1	94.4
25% Diazinon	½	42	0	100
	1	44	0	100
44% Trithion	½	42	6	87.5
	1	16	2	88.9
Untreated	..	4	70	.....

OAK LEAF MINERS

There are two species of oak leaf miners. One commonly called the blotch oak leaf miner (*Cameraria hamadryadella*) is a solitary form; i.e., only one miner occurs in a single mine. The second and less often seen species (*Cameraria cincinnatiella*) is gregarious—several miners occur together in one large mine. The solitary species attacks red, white, and black oak, whereas the gregarious one occurs mainly on white oak but may also attack red and black oaks. Pin oaks seem not to be affected.

Outbreaks of oak leaf miner occur at long and irregular intervals and then for only one to three consecutive years. A noticeable increase in the population occurred in 1958. In the following year, outbreaks were widespread and serious. For the most part there was no infestation in 1960.

White oaks were the most seriously infested in 1959 with other species much less noticeably affected. The solitary species predominated whereas the gregarious one was observed only once in the central part of Connecticut. In the latter case a maximum of 29 miners were counted in two mines in one leaf.

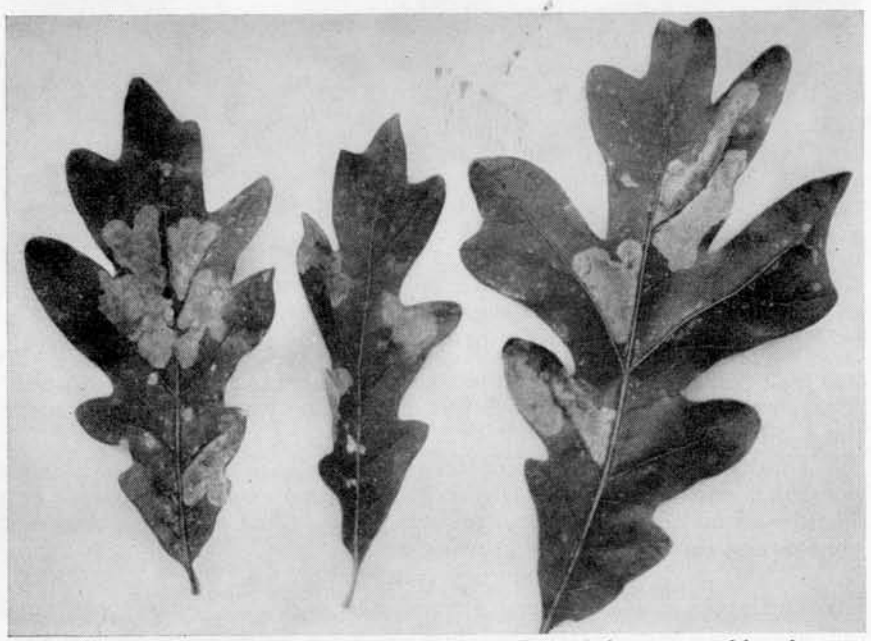

Figure 7. The light-colored blotches indicate injury caused by the solitary oak leaf miner.

Life History and Habits

There are two or three generations of the leaf miners a year. The solitary species overwinters as fully developed larvae and the gregarious one as pupae. The tiny moths varying in length from 3/16 to ¼ of an inch emerge in May. They have lanceolate wings which are banded or otherwise marked with glistening shades of silver gold. The reddish-brown or chestnut colored larvae are very flat throughout their entire length. They feed between the upper and lower surfaces of the leaves, causing whitish blotches or mines most noticeable on the upper surface (Figure 7).

First generation feeding occurs during late May and in June. The second generation mines during July and early August and the third during August and September. An examination of the second generation of solitary miners in 50 white oak leaves on July 29, 1958, indicated 46 per cent larvae, 6.3 per cent prepupae, 43.6 per cent pupae, 3.1 per cent emergence, and 0.7 per cent parasitism. On the same date in 1959 there were 77.2 per cent larvae, 7.5 pupae, and 15.1 per cent parasitism.

The status of the third generation as observed on September 2, 1959, was as follows: 78.8 per cent larvae, no pupae, and 21.2 per cent parasitism. On September 25, 95.9 per cent larvae was indicated with no pupae, and

4 per cent parasitism. The number of solitary miners per leaf may vary in an area of extensive and heavy infestation from 1 to 47 with an average of 21.3.

Control of Oak Leaf Miners

The insecticides tested to control the oak leaf miner are given in Table 9. On July 24, 1958, three 5-foot white oak trees were sprayed with 2 quarts of spray at each dilution. A 3-gallon hand pressure sprayer was used to apply the treatments. On July 31 control data were taken from 10 leaves per treatment.

Dimecron and Trithion gave the best control of oak leaf miner. The remaining three insecticides were somewhat less effective.

Table 9. Control of oak leaf miners on white oak, 1958

Insecticide	Pints per 100 gallons	Miners Dead	Miners Alive	Per cent Control
Applied July 24			*Control as of July 31*	
13% Sevin	½	23	15	60.5
	1	41	11	78.8
25% Diazinon	½	25	11	69.4
	1	21		75.0
44% Trithion	½	41	5	89.1
	1	71	4	94.7
20% Lindane	½	22	63	25.8
	1	261	54	82.8
49% Dimecron	½	46	1	97.9
	1	67	0	100
Untreated	..	...	426	.....

COLUMBINE LEAF MINER

The columbine leaf miner (*Phytomyza minuscula*) is a perennial pest of all varieties of columbine and also attacks aster. It is most destructive in shaded or semi-shaded areas. Infestation commences early in the season on the lower leaves of a plant and may include most of the foliage as the season advances.

The small black two-winged flies lay their eggs on the underside of the leaf. The whitish maggots feed between the upper and lower surfaces, causing serpentine mines which are most noticeable on the upper surface (cover photo).

Columbine plants examined in Fairfield County on May 5, 1958, were uninfested. However, on May 14 both eggs and miners were present, averaging 7 per leaf. Pupae appeared in less than 24 hours on the underside of some of the leaves.

A study of the leaf miner in 1957 indicated five generations. The status of the first one obtained from 30 leaves examined on June 7 was as follows: 10 miners, 1 pupa, 10 parasites, and 40 empty pupal cases. Twenty-one per cent of the second generation was in the pupal stage on June 28, 22 per cent of the third generation on July 24, and 26 per cent of the fourth generation on August 28.

An examination of 85 leaves on September 18 indicated 174 miners, 9 pupae, and that 29 had emerged. These were not on the underside of the leaves as were the pupae of the preceding generations. They (and all that followed) had dropped to the ground where they would remain until the spring of the following year.

Control Experiment

One group of columbine plants was sprayed on July 27 with 45 per cent malathion and another with 20 per cent lindane. There was an average of 6 plants per treatment. A 3-gallon hand pressure sprayer was used to apply 1 pint of spray per dilution.

Control data taken July 30 from an average of 15 leaves per treatment showed that the insecticides had destroyed both the miners and prepupae.

SUMMARY

These tests show that a number of insecticides are effective in controlling some species of leaf miner. The insecticide used in most of the tests was Diazinon, which was generally very effective. Both ethion and Trithion were very effective in all tests in which they were included. If it is expedient to select a single material for control of leaf miners, one of these three might well be considered.

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