Control of

THE ANDROMEDA LACE BUG

and THE HOLLY LEAF MINER

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ANDROMEDA LACE BUG

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Andromeda (*Pieris* spp.) are valuable broad-leaved evergreen shrubs or small trees. They do best in sheltered positions in peaty, somewhat sandy and moderately acid soils. Several species of *Pieris* are grown for their year-round beauty throughout the cooler parts of North America, including Connecticut.

With the exception of red leaf spot and occasional root rot, Andromeda have until recently been almost completely immune from attack by insects and diseases. However, during the middle 1940's a new lace bug, *Stephanitis globulifera* (Matsumura), probably of Japanese origin, was discovered ruining the introduced species of Andromeda, *Pieris japonica* (Thumb).

Distribution and Abundance

Stephanitis globulifera was first reported in North America from Connecticut in 1946 by Bailey (1). It occurs mostly in the southwestern part of the State, and is especially prevalent in the shore towns bordering Long Island Sound. Localized infestations have been discovered in the vicinity of New Haven and Hartford. Reports of the presence of the pest have come also from Rhode Island, parts of New York State and Long Island.

Transportation of infested nursery stock from one area to another would seem to be the most certain method of spread of the insect. Local distribution may be achieved through flight of the adults. However, their flying ability is poor, and natural dissemination is probably less important than the movement of plant material.

Character of Injury

Several varieties of Andromeda, Azalea and Rhododendron growing together were observed in Bridgeport in 1951 and 1952, but the lace bug occurred only on *Pieris japonica*. It was reported (1), however, that it was found with the Azalea lace bug, *Stephanitis pyrioides* (Scott), on deciduous Azalea in Greenwich, Connecticut, in 1950. In all cases observed by the writer *Stephanitis globulifera* was a major pest of *Pieris japonica*. Other lace bugs apparently do not feed on this species of Andromeda.

Both the adults and nymphs damage infested plants by sucking the sap from the underside of the leaves. This withdrawal of plant juices causes the foliage to become mottled with grayish-yellow blotches which, when abundant, result in complete blanching.

The lower surface of infested leaves is discolored by numerous flattened, black, shiny, molasses-like spots of excrement. Molted skins

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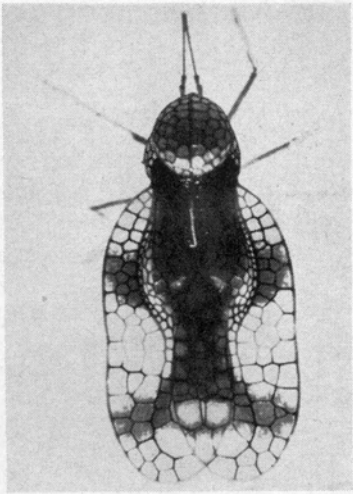

Figure 1.
Adult of the Andromeda lace bug. *Stephanitis globulifera* (Matsumura). Picture is 15 times natural size.

together with dead adults of the last brood (in late fall) may be seen adhering to the underside of the foliage until well into the following year. Badly damaged plants produce a sparse foliage with individual leaves much reduced in size. Inflorescence is poor, and after several seasons of repeated loss of vitality the plants may die.

Description, Life History and Habits

Adult lace bugs vary in length from $\frac{3}{32}$ to $\frac{5}{32}$ of an inch and are about $\frac{1}{16}$ of an inch wide, somewhat larger than a related species on Rhododendron (1). The hood which covers the head of the adult is intensely black and greatly inflated. The wings are broad, more so in fact than in other species. All of the wing veins are abundantly clothed with silky hairs, and are conspicuously marked by an extremely black color pattern which assumes an hour-glass appearance when the wings are at rest.

The Andromeda lace bug overwinters in the egg stage, the eggs being imbedded in the underside of leaves, mostly on the lower part of an infested plant. The winter eggs are scattered with no apparent system of distribution. The presence of an overwintering egg is indicated by a small, raised, water-soaked blister about $\frac{1}{3}$ mm. in diameter. The summer egg masses are sufficiently conspicuous to be seen without trouble, and are usually deposited in masses on either side of the midrib of new foliage.

In 1952 the overwintering eggs began to hatch on May 15. Five molts occurred before the adult stage was reached. On June 3 the first adults began to appear and by June 15 all the nymphs had reached

maturity. After that time overlapping of broods took place. However, a close check on the development of the lace bug indicated four to five generations from mid-spring to late autumn.

An examination of leaves taken at random from a badly infested plant in mid-summer showed the first and second stage nymphs to vary in abundance from 7 to 57 per leaf. There is almost no scattering of newly hatched nymphs until one or two molts have occurred. Then they crawl to nearby foliage, disseminating more completely with the onset of maturity.

Overwintering eggs are deposited late in the fall. On December 18, 1952, 17 live adults were counted on an untreated plant in the vicinity of Bridgeport. Most of them were on foliage close to the ground. By January 18, 1953, all adults were dead.

Control Measures

Because the Andromeda lace bug made its first appearance in this country so recently, no control schedule had been worked out. It was reported (1), however, that frequent spraying of badly infested plants (even into the winter) on an estate in Fairfield County controlled the pest. Plants thus treated were said to be beautiful and almost free from infestation the following year.

Experiments in Control

In view of the value of Andromeda for ornamental purposes and the seriousness of the damage resulting from lace bug infestation, experiments were planned to study the habits and control of the pest.

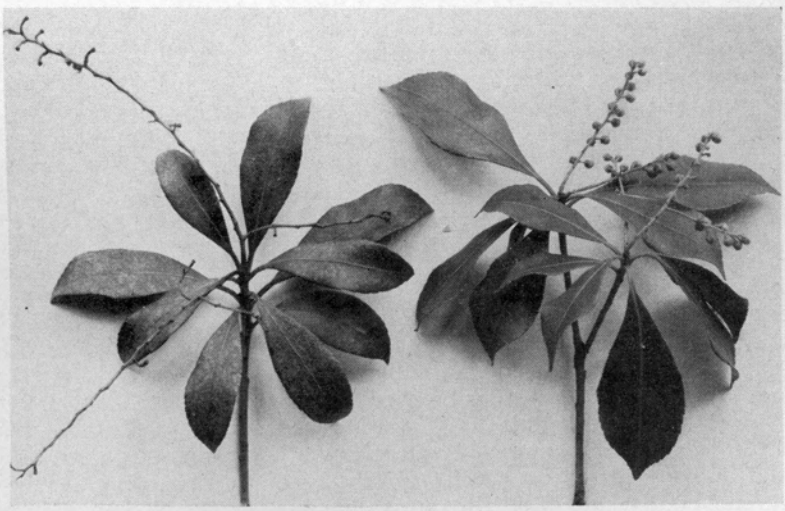

Figure 2.
Injury to Andromeda caused by Andromeda lace bug. Plant on left received no treatment; plant on right was sprayed with chlordane.

Materials and Methods

Because of reported success in control of lace bugs on evergreens and deciduous trees with chlorinated hydrocarbon insecticides, the materials DDT, lindane, heptachlor, endrin, chlordane, aldrin and dieldrin were selected for trial. All were used in emulsion form, DDT and heptachlor as 25 per cent, lindane as 12.9 per cent, endrin as 18.5 per cent, chlordane as 75 per cent, aldrin as 21.85 per cent and dieldrin as 15 per cent formulations. Each emulsion was used in a dosage series; chlordane, aldrin and dieldrin at the rate of 1 to 200, 400, and 800 in the 1951 experiments and DDT, lindane, heptachlor and endrin in dosage series of 1 to 400 and 800 in the 1952 tests. A portable mist blower was employed to apply the treatments. The apparatus provided thorough coverage of both the upper and lower surfaces of the foliage.

The *Pieris japonica* plants used in the 1951 experiments varied in size from 5 to 7 feet in height and those in the 1952 tests from 2½ to 5½ feet. The largest plants were 8 to 12 feet in circumference. Plants sprayed in 1951 were not used in the 1952 experiments. Sprays were applied at the rate of 3 quarts per large plant and 1 to 2 quarts per small one. All treatments were made on clear days with a temperature range of 85° to 90° F.

The 1951 sprays were intended to control both young and adult lace bugs. The 1952 experiments were planned to determine, in addition, the effect of the sprays on the eggs. This was the reason for the 10-day delay in the initial spray treatments in 1952. Three spray treatments were made in 1951 and two in 1952.

Evaluation of Results

To find out how effective the treatments were, 1,200 leaves were selected at random on each treated plant, and the insects on each leaf were counted. The number of leaves per terminal twig (usually 2 to 15 terminal twigs per outer branch) varied from 4 to 22. Infestations on the untreated plants ran high, and examination of 150 to 200 leaves appeared ample for comparable data.

Results

Examination of data indicates satisfactory control of Andromeda lace bug with the seven insecticides at all concentrations. Treated plants were examined six times during the season of 1951. However, the amount of data presented in Table 1 has been reduced to a minimum because of the uniformly good control obtained. For example, on July 3 only one adult was found on the treated plants, whereas 150 adults and an average of approximately six nymphs per leaf occurred on the untreated plant. On July 24, eight days after the second treatment made to check the apparent rise in population indicated July 9, all treated plants were free from infestation. On the other hand, 76 adults and 165 nymphs were counted on the untreated plant.

TABLE 1. ANDROMEDA LACE BUG CONTROL, 1951. 1200 LEAVES EXAMINED PER TREATMENT, 150 PER CHECK.

Treatments June 15 July 16 July 31		Distance of treated from untreated plant (feet)	Examined			
			July 9		July 31	
			Adults	Young	Adults	Young
Chlordane	1-200	240	0	0	0	0
	1-400	12	5	25	44	0
	1-800	1424	0	0	0	0
Aldrin	1-200	120	3	0	0	0
	1-400	105	3	0	5	0
	1-800	102	4	0	9	0
Dieldrin	1-200	18	0	0	75	0
	1-400	15	0	9	167	0
None			5	249[1]	171	11

[1] On 12 leaves.

Owing to an increase in lace bug population on most of the experimental plants, all were given a final treatment on July 31. An examination made August 25 showed all treated plants to be uninfested whereas 38 adults and no nymphs occurred on the untreated one. Treated plants were still free of the pest on October 15, while the untreated plant had 11 adults and 26 nymphs.

Obviously the distance of the treated plants from the untreated ones had a marked influence on the rapidity and degree of reinfestation of the former (Table 1). The plants farthest away from the untreated Andromeda remained uninfested or only mildly so after treatment. By contrast, plants within a few feet of the untreated one became seriously reinfested. This continued until the source of infestation was removed by spraying the check plant with dieldrin at 1-800 on July 31. From that time on all plants in the experiment, including the original check plant, were free from lace bug infestation for the balance of the season (with the exception of an isolated plant added to the experiment as a check on July 31). Close watch was kept on these experimental plants throughout 1952. With the exception of the check plant added to the experiment on July 31, 1951, all of the treated ones were free from lace bug infestation.

In 1952, the first treatment was made on June 25, when many egg masses were present. Hatching did not occur until July 8 or 9. On July 21, there were 128 nymphs per 168 leaves on treated plants, showing that the treatments did not kill the eggs. Respraying all plants July 21 prevented reinfestation for the remainder of the season. Check plants were far enough (300 feet or more) from the treated ones to constitute no serious threat of reinfestation. Untreated plants examined four times between July 21 and August 28 showed adults and nymphs present per 200 leaves as follows: 11-63, 63-48, 50-0, and 43-0.

None of the insecticides used to control lace bug caused detectable injury to Andromeda foliage.

Summary

The insecticides DDT, chlordane, lindane, heptachlor, aldrin, dieldrin and endrin gave excellent control of Andromeda lace bug at all concentrations used. Serious reinfestation of treated plants occurred when untreated ones remained nearby. A distance of several hundred feet or more between treated and untreated plants prevented reinfestation. Treatments did not injure foliage.

Suggested Control Measures

Any one of the seven residual insecticides discussed in the foregoing pages may be employed to control Andromeda lace bug. It should be used at the rate of 1 pint of emulsifiable concentrate per 100 gallons of water (1 teaspoon per gallon). Wettable powders may be substituted for emulsions at the rate of 1 to 2 pounds per 100 gallons of water (2 to 4 teaspoons). Low concentrate dusts should prove effective. Wetting agents may be added to the spray if necessary.

One well-timed spray may be expected to control the lace bug for the season. Treatment between May 25 and not later than June 1 (after overwintering eggs have hatched) will destroy lace bugs before they transform to adults. When treatment is delayed until adults are present and eggs have been deposited, additional sprays may be necessary to assure complete control. It is important that all plants are sprayed and that the underside as well as the upper surface of the foliage is thoroughly coated with insecticide. A small three-gallon hand pressure sprayer is convenient for the purpose.

THE HOLLY LEAF MINER

Although the American holly occurs more often in the South, its range extends as far north as southern Massachusetts. In Connecticut, holly is frequently seen in ornamental plantings in the central and southwestern areas of the State, where the plants do well in most years. Occasionally during severe winters some browning of the foliage may occur, especially where the plants are not protected.

All species of holly are remarkably free from insect and disease troubles (1). However, the American or Christmas holly (*Ilex opaca* Ait.) is attacked by the holly leaf miner (*Phytomyza ilicis* Curt.).

Description of Injury

Injury from holly leaf miner is easily recognized by the yellowish or yellowish-brown serpentine mines in the thick, green leaves. When the infestation is severe, there may be several miners per leaf, causing almost complete browning of the foliage.

Life History and Habits

The holly leaf miner has only one generation a year. The adults are small black flies, varying from $\frac{1}{32}$ to $\frac{1}{16}$ of an inch in length. They begin to emerge after the middle of May and continue to do so into June.

The female flies make slits in the undersides of newly developing holly leaves where they deposit their eggs. The larvae which hatch from the eggs vary from $\frac{1}{7}$ to $\frac{1}{6}$ of an inch in length and are pale yellow to whitish in color. At first their mines appear as almost imperceptible tracings not more than $\frac{1}{32}$ of an inch long. As the larvae grow, the mines become more conspicuous, broadening out towards the anterior end into irregular blotches. By the end of the summer the larvae have completed their feeding and are ready for overwintering. Although it has been reported (1) that this insect overwinters as larvae and pupae in some sections of its range, the pupae stage did not appear in Connecticut until spring.

Control Measures

In addition to removal and burning of infested holly leaves, the earliest control measures called for thorough spraying of infested trees with nicotine sulfate, 1 pint to 100 gallons of water, to which 4 to 5 pounds of powdered soap was added as a spreader. It was recommended that the sprays be applied several times during the period of adult emergence, and that the treatment be repeated at the time the eggs were hatching and small mines were developing in the foliage (2, 3).

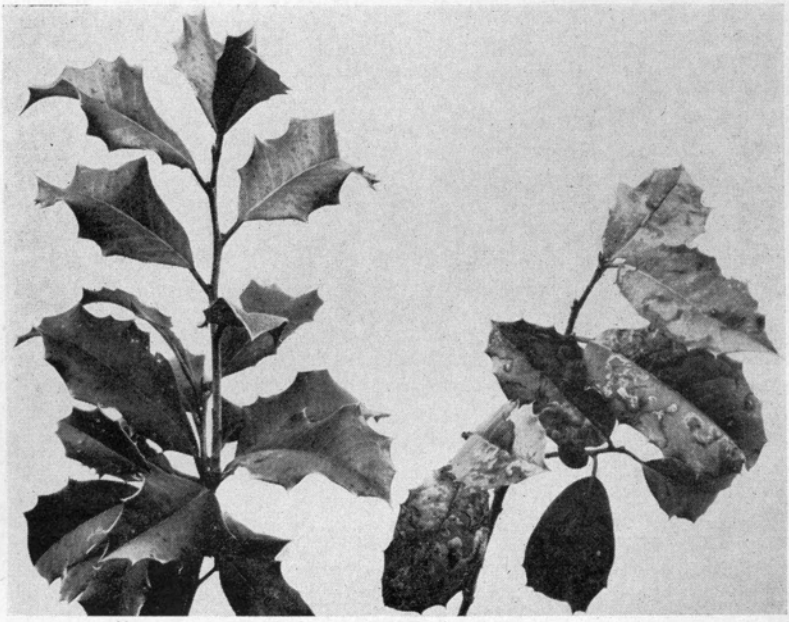

Figure 3.
The holly leaf miner caused the damage to plant at right. Healthy plant shown on the left.

More recently sprays of nicotine sulfate at 1 pint per 100 gallons of water, combined with a 2 per cent white summer oil were used. This treatment was applied to infested foliage in mid-May when the puparia were present, but control was not very satisfactory (4). Spraying the new foliage with arsenate of lead at a time when the flies were abundant and eggs were hatching gave a good kill. The rate used was 5 pounds of lead arsenate to 100 gallons of water plus a suitable spreader and sticker.

Experiments in Control

Because of the seriousness of leaf miner troubles on other species of plants in recent years, and the success achieved in their control by use of new insecticides, experiments were designed to study the possibility of protecting holly foliage from invasion by the holly leaf miner.

Materials and Methods

An acre block of 4 to 8-foot holly trees was selected for the experiment. Three rows of more than 40 trees each in the center of the block were tagged for treatment. There was an average of 5.7 mines per leaf.

The experiment was planned in three phases. The first phase was designed to destroy the overwintering miners before the adults emerged. The second phase was intended to prevent infestation of the current season's foliage by killing the adults. The third phase anticipated the destruction of young miners as they hatched from the eggs or were actually in the process of forming mines.

All plots were randomized and most of them were replicated once. Sprays were applied by a portable mist blower, which provided a thorough coverage of the leaf surfaces.

Results

In the first test, aldrin, heptachlor and lindane emulsions were applied on May 7. Leaves were taken from treated and untreated trees, and held in rearing cages until the adults emerged. The results have been summarized in Table 2. None of the materials gave satisfactory control of the pest.

In the second test, DDT and dieldrin were sprayed on May 27. An additional treatment was made on two-thirds of the trees on June 9, and a third treatment on one-third of the trees on June 23. Results obtained by opening the mines on January 14, 1953, are given in Table 3. Dieldrin was somewhat more effective than DDT. Control with two or three treatments was very satisfactory. Infestation probably followed the single treatment after residues had disappeared.

TABLE 2. OVERWINTERING HOLLY LEAF MINER MORTALITY. TREATMENTS MADE MAY 7, EXAMINED MAY 16.

Treatment		No. leaves in sample	Total no. miners	No. killed	Per cent killed
Lindane	1-800	10	25	4	16.0
	1-1600	12	17	3	17.6
	1-3200	32	76	0	0.0
Aldrin	1-800	11	15	2	14.4
	1-1600	28	54	14	25.9
	1-3200	13	24	3	12.5
Heptachlor	1-800	20	30	10	33.3
	1-1600	20	35	5	14.3
	1-3200	13	10	2	20.0
None		7	33	0	0.0

TABLE 3. RESULTS OF TREATMENTS TO PREVENT HOLLY LEAF MINER INFESTATION. RESULTS REPRESENT 25 LEAVES PER TREATMENT, EXAMINED ON JANUARY 14, 1953.

Treatment		Date sprayed					
		May 27		May 27, June 9		May 27, June 9, 23	
		Dead	Alive	Dead	Alive	Dead	Alive
DDT	1-400	6	3	0	0	0	0
	1-800	6	4	7	3	0	0
	1-1600	1	4	0	0	0	0
	1-3200	2	11	0	5	2	2
Dieldrin	1-400	0	0	0	0	0	0
	1-800	0	0	0	0	0	0
	1-1600	1	0	0	0	0	0
	1-3200	4	6	1	1	2	0
None		10	193	10	193	10	193

TABLE 4. RESULTS OF TREATMENTS APPLIED TO HOLLY FOLIAGE JULY 28 TO CONTROL EARLY STAGE OF NEW BROOD OF MINERS. RESULTS REPRESENT 10 LEAVES PER TREATMENT TAKEN AT RANDOM ON AUGUST 13.

Treatment		Miners		Per cent killed
		Dead	Alive	
Lindane	1-400	40	2	95.2
	1-800	62	17	78.6
	1-1600	21	47	30.8
	1-3200	1	60	1.6
Aldrin	1-400	79	0	100.0
	1-800	139	4	97.2
	1-1600	20	58	25.6
	1-3200	7	44	13.7
None		0	77	

Summary

The residual insecticides, lindane, aldrin and heptachlor, effective in controlling several species of leaf miners, gave very poor results when applied to holly foliage in early May to control overwintering miners. DDT and dieldrin applied to newly developing holly foliage one, two and three times between late May and late June to prevent infestation by leaf miners gave good control. DDT gave best results when applied two or three times, rather than as a single spray. In contrast, dieldrin

provided good protection for holly foliage when applied once. Lindane and aldrin applied to current season's foliage infested with holly leaf miner gave a high degree of control, especially at the strongest dosages. This appeared to be more consistent with aldrin than with lindane.

Suggestions for Control

Spraying newly developing holly foliage with dieldrin once or twice at two-week intervals between May 21 and June 5 should prevent infestation under most conditions. When DDT is used, two sprays and perhaps a third about June 23 will be required for comparable control. A pint to a quart of 25 per cent DDT emulsion or 15 per cent dieldrin emulsion per 100 gallons of water or 1 to 2 teaspoons per gallon should be used.

When spray treatments are delayed until early summer, aldrin or lindane 25 per cent emulsions applied to miner-infested holly foliage about July 25 at the rate of 2 quarts per 100 gallons of water or 4 teaspoons per gallon will kill the miners. A more complete kill may be expected from aldrin.

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