Pests of ORNAMENTALS
Reports on control experiments

Circular 203 • May 1958

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION • NEW HAVEN

Control of Slugs, Sowbugs, Centipedes, and Millipedes in the Greenhouse and Garden

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Insect pests are common enemies of plants. Animals other than insects are sometimes as destructive as some of the insects.

Snails, slugs, garden centipedes, garden millipedes, and sowbugs or pillbugs are among the other animals most frequently troublesome.

Seedlings, succulent plant foliage, fleshy roots, bulbs, tubers, and corms provide food for these pests. In addition, ripe fruit and vegetables may be seriously damaged.

Snails and Slugs

Snails and slugs are mollusks, and both have a mantle which covers at least part of the body. The mantle of the snail takes the form of a spirally coiled shell. Slugs have no discernable shell but a rudimentary mantle or smooth area covering about one-third or less of the forward part of the back. Both snails and slugs have a large, flat, creeping foot for locomotion. Individual species vary from less than one-half inch to four or more inches in length.

Many species of snails and slugs occur throughout the United States. In addition to being plant feeders, they may occasionally become a nuisance in damp cellars, and around walls and foundations. Constant attention must be given to their control in mushroom culture. All species leave a telltale slimy trail wherever they go on the ground, walk, wall, or plant.

Occurrence

The most common species of slug found in Connecticut gardens are the small black garden slug, *Deroceras reticulatum*, and the larger tawny garden slug, a yellowish-brown species, *Limax maximus*. Both are more or less mottled or streaked with darker markings.

Snails are mostly grayish in color. Their shells are whitish to brown or black and mottled. Both snails and slugs have two pairs of head appendages or feelers. An upper pair bears the eyes and a lower pair bears the olfactory nerves. These animals eat by rasping plant tissue.

Both species reproduce by means of small, glossy, translucent, pearl-like eggs which are deposited on damp soil under wet litter. They occur singly or in groups without a noticeable pattern of distribution. Overwintering may occur in all stages of larval development and as eggs.

Contents

Photos by B. W. McFarland

Notice

The accompanying publication, printed some years ago, contains descriptions and biological information, and suggestions for control by spraying. It suggests the use of DDT.

Present regulations of the State Board of Pesticide Control restrict use of DDT by custom spray operators for this purpose.

Carbaryl (Sevin®) or lindane may be used to control these pests.

May 1, 1967

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION

Habits

Snails and slugs are secretive in habit, feeding only at night and hiding away during the daytime. On dull, cloudy mornings, particularly as the days grow shorter in late August and early September, slugs may remain on food plants longer than during clear weather and when the sun rises earlier.

Habitually, they occur most abundantly in damp, moist places, especially in shaded areas, among low-growing plants on the north side of a building, and in dense vegetation under trees and shrubs. They may be found under fallen leaves or decayed leaf mold that has accumulated over a number of years. Almost any rotting plant material offers them protection and an ideal place to lay their eggs when essential moisture prevails. Protected by their shell, snails are less particular about hibernating quarters.

After hatching, the young slugs may remain together for some time. As they grow older, they tend to migrate farther and farther afield. Hence, their colonial habit may be lost. Usually, unless disturbed, slugs are extremely methodical in their habits, returning repeatedly to the same plant and hiding place by night and day.

The list of plants attacked by these creatures, especially slugs, is extensive. Serious losses may occur among seedlings of all kinds.

Certain species of plants appear to be especially attractive and desirable for food. Marigolds, especially the low-growing dwarf varieties with their characteristic pungent odor, are often more seriously damaged than Sweet William, for example. Sweet William is also a common food for slugs, but seems to receive less attention when growing with marigolds. In addition, goldenglow, violets, salvia, funkia (plantain-lily), lily-of-the-valley, iris, and many other varieties of flowers may be more or less severely injured by the pests.

Potatoes, tomatoes, cabbage, and celery as well as other vegetables, both while growing and after harvest when stored in damp, cool places, are subject to attack. Slugs and snails also eat ripening strawberries and other small fruits.

The lower leaves of certain shrubs and low-growing trees, for example, azaleas, syringa, flowering fruit trees, and privet hedges, may suffer severely when slugs are abundant.

Investigations on control

Because of their secretive nature, nocturnal habits, and the protection given by their slimy covering, slugs and snails are difficult to control. They have been controlled to some extent with poisoned bait containing metaldehyde and calcium arsenate or sodium fluosilicate. Copper in any form is toxic to slugs. It has been used in dust formulations without injuring plants. Paris green baits have also proven helpful in eliminating the pests.

In 1955, to learn more about control measures, studies were made in a garden with a large population of the larger tawny garden slug. They had been feeding extensively on foliage of goldenglow, plantain, lily-of-the-valley, chrysanthemums, and violets. Dieldrin granules (5 per cent) failed to control them. A 15 per cent dieldrin emulsion diluted 1 to 400 was applied, and the application repeated because of a heavy rain. About 75 per cent of the slugs were killed by these treatments.

Calcium arsenate and a 7 per cent copper dust were used in 1957 to control slugs on four varieties of garden plants: funkia, violet, goldenglow and marigold, in clumps of 7, 2, 18, and 12 respectively. Most of the leaves on these plants had been seriously damaged by the small black garden slug and the larger tawny garden slug.

The number of slugs hiding during the daylight hours in stake holes, under small pieces of wood, leaves, and other decaying organic matter associated with each variety of plant were determined by actual counts, soon after sunrise on August 27 (Table 1). The large tawny slug was the only species feeding on the first three varieties of plants, the small black garden slug was also found feeding on the marigolds. Most of the slugs appeared to be fully grown.

Foliage injury before treatment was determined somewhat differently from the method used in 1955. Instead of counting all of the holes eaten in the damaged leaves (which disregarded size of holes and so gave an erroneous picture of the injury) the percentage of consumed leaf area was estimated. Obviously, this would give a more accurate measure of injury. With the exception of the marigolds, an average of 40 leaves taken from each variety of plant were examined. The results indicated that 54.3 per cent of the goldenglow, 12.3 per cent of the violet, and 35 per cent of the funkia leaf surface had been consumed by the slugs. Because of the formation, size, and character of the marigold leaves, area estimates of injury were impractical. About 200 leaves on each plant were damaged.

All of the injured leaves were removed from the plants before treatments were made. The number of uninjured leaves remaining on the plants was goldenglow 40, violet 18, funkia 40, and marigold about 500.

On August 27 the funkia, violet, and goldenglow plants were dusted at 7 p.m. with calcium arsenate. The plants were moist with early evening dew at the time. The marigolds were treated in the evening of August 30 with 7 per cent copper dust.

The results of these treatments are given in Table 1. All of the litter under each plant was carefully examined for slugs. Some were also found in stake holes and under small pieces of wood.

Table 1 indicates good control of slugs with calcium arsenate applied to the first three plants listed and 7 per cent copper dust applied to the marigolds. Many new leaves grew during the 2 weeks subsequent to treatment. Almost none of these were damaged by slugs.

Figure 1. Foliage of marigold, ageratum, salvia, and iris, showing damage from feeding by garden slugs.

Observations made later in the evening after treatments were made indicated that the slugs climbed into the plants treated with calcium arsenate and commenced feeding. They were repelled by the 7 per cent copper dust and avoided the plants to which it had been applied.

Examinations made on September 22, 4 weeks after the treatments, indicated that the 2.24 inches of rainfall had removed all noticeable calcium arsenate residue from the goldenglow, funkia, and violet foliage. Two live slugs were found and there were signs of recent feeding.

On that date 7 per cent copper dust was applied to these plants. Before treatment, 20 slugs were released; 12 were already under the goldenglow. One week later three dead and three dying slugs were found. No additional feeding was evident on new or old

Table 1. Control of slugs dusted August 27 and 30

Plant	No. of slugs before treatments	No. of slugs found during 10 days after treatment		Feeding injury
		Dead	*Alive*	
Goldenglow	40	13	19	None
Violet & Funkia	36	4	2	None
Marigold	13	1	0	Less than 1 per cent

foliage. Examinations made on October 28 (5 weeks after treatment) showed less than 1 per cent slug injury to the new leaves. No live or dead slugs were found in the litter under these copper-dust treated plants.

Phytotoxicity from calcium arsenate appeared as marginal injury where feeding holes occurred in the plant foliage. It was most noticeable in the funkia leaves, some in violets, and almost non-existent in the goldenglow foliage. Copper dust seemed not to cause similar injury.

Sowbugs or Pillbugs

The name pillbug has been given to sowbugs because some forms, when disturbed, roll into the shape of a ball or pill. One of the most common species, *Oniscus asellus*, is known as the dooryard sowbug. It is about a half inch long, dark gray to deep slate in color, and occasionally speckled with some small white spots and marbled along the side edges.

Sowbugs appear to dislike direct light and become very lively when exposed to it. They live in damp, moist places, under decaying wood, bark, logs, leaves, flowerpots, and stones in gardens and cellars, and under rotting manure. In fact, they may be found in any favorable location where it is dark and decomposition is in process. They feed principally on decaying vegetable matter but often attack plants in gardens and greenhouses, doing damage to the roots and tender growing parts of many species, especially carnation and sweet pea.

Control of sowbugs

Sliced potatoes treated with paris green, poisoned-bran mash, and other dry materials containing paris green have given good control when placed where sowbugs could find them. Surface soil sprays of pyrethrum and nicotine sulfate and tobacco dust treatments have been suggested as effective control agencies.

A serious infestation of sowbugs in two large commercial greenhouse benches in October 1954 resulted in extensive injury to the lower part of carnation plants. The plants were in bud and just beginning to blossom.

There were about 162 sowbugs per square yard of bench. A count of the number of plants in a small area of the bench indicated that 13 out of 25 plants were girdled or partly girdled. In addition, many buds growing low on the plants or on branches bent so as to touch the bench or lower part of an adjacent plant were hollowed out by the sowbugs.

Girdled plants were not wilted. Hence, it would appear that the vessels in the woody center of the plants probably took up sufficient water to keep them alive.

The sowbug infestation was controlled by drenching the soil in the benches with DDT used as a 50 per cent wettable powder at the rate of 3 pounds in 100 gallons of water. Each bench received 50 gallons of prepared drench on October 21. An apparently complete kill of sowbugs was obtained within 2 days with this method of treatment.

The Garden Centipede

The garden centipedes (*Scutigerella immaculata*) are tiny, white, many legged (one pair of legs per each body segment) worm-like creatures that live in greenhouse benches, especially the ground type, and garden soils. They eat the fine rootlets and root hairs of many varieties of plants, sometimes resulting in total loss of the crop. Potted plants resting on soil, gravel, or ashes may be seriously damaged when the pests gain access to their roots through the drainage holes in the pots.

A wide variety of plants are attacked, among them carnation, chrysanthemum, poinsettia, cyclamen, tomato, radish, and lettuce.

Out-of-doors during the winter the centipedes may be found near the roots of plants and in cracks in the soil, close to the surface of the ground. At the close of the winter season they work their way down about a foot in the soil through any available opening, such as those made by earthworms or dead roots. During this time they feed on decaying organic matter and deposit their eggs (where dampness prevails)

Figure 2. Sowbugs feeding at base of carnation.

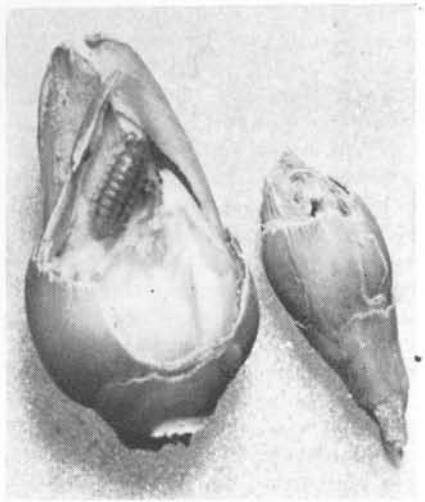

Figure 3. Sowbug injury in flower buds of carnation.

for another season's brood. Essentially the same activity goes on in ground benches in greenhouses when the soil is allowed to dry out at the surface.

Eggs are deposited in clusters of a few to several dozen, and may hatch in less than 2 weeks. Under favorable conditions broods may occur at regular intervals of about 3 months. New crops (watered periodically in ground benches or moistened by rain in the open) will be attacked as rootlets develop.

Control of centipedes

Fumigation or sterilization of soil in greenhouse benches has been used to control this pest.

Tests to control Symphylids were carried on in a commercial greenhouse range during 1954 and 1956. In November 1954, a 200-foot greenhouse in which poinsettias were growing in 6-inch and 8-inch pots became seriously infested with the pest. There were 16 benches in the house, each 100 feet by 4 feet. From several to 12 to 15 Symphylids per pot were disclosed by removing the pots. In addition, a scattered few were seen on the bench between the pots.

The benches were dusted between the pots with a 10 per cent DDT dust at the rate of 1 pound to 100 square feet. All pots were then moved onto adjacent treated surfaces of the bench. Areas from which the pots were removed were not treated.

Observations made at 24-hour intervals for several days indicated that all exposed Symphylids, in addition to those that had emerged through the pot-drainage holes, were dead.

Symphylid infestation in commercial greenhouse benches during the fall of 1956 was brought under control with Lindane. The number of centipedes was estimated to be about 25 per square foot of bench. All potted poinsettias were shifted progressively as the Lindane soil drench was made. The drench was 1 pound of 25 per cent wettable powder in 200 gallons of water applied to 1000 square feet of bench. Control of the infestation was apparently complete.

Millipedes

Millipedes are also called thousand-legged worms. They are usually cylindrical, brown, blackish, or grayish in color, with two pairs of legs on all but the first three and last segments.

Often times they are a nuisance around homes in damp, wooded areas with undergrowth and stone walls. When abundant they may wander in large numbers and enter the cellar and house where they are a harmless nuisance. They hide beneath stones, logs, boards, moss, and almost any humus and debris such as leaves, and in loose soil during the day, coming out at night to feed. They crawl slowly unless interfered with, curl up when disturbed, and are not poisonous to touch. Reproduction takes place in the ground where they lay their eggs, 50 to 100 or more, in small cells which they construct for the purpose.

Their food consists mostly of vegetable matter though some may feed on dead animal matter. Sometimes they eat planted seeds, and quite often they are found boring into the fleshy stems of plants or feeding on bulbs, tubers, and heavier root stock.

Millipedes have been controlled through the use of baits poisoned with phosphorous paste or paris green. Sugar mixed with paris green and sprinkled on the surface of the soil has proven helpful in destroying the pest. A ground drench of dichlorethyl ester or a strong pyrethrum solution has been effective. Removal of all stones, boards, leaves, and other debris has discouraged millipedes. They usually leave a damp area or cellar when it is dried out.

Control experiment

Late in 1954 a large greenhouse bench was found to be badly infested with millipedes of the genus *Julus*. The bench had been planted to carnations, snapdragons, and chrysanthemums with about one-half of the area occupied by carnations. All three varieties of flowers had been producing blooms daily. Production, however, began to decline and many of the plants showed signs of deterioration. An examination of the base of the plants near the surface of the soil showed many millipedes feeding on the rootlets, boring into the stems, and girdling the surface stem tissue.

The population of millipedes was determined on November 10 by taking six trowels full of soil to a depth of 2 to 3 inches at random from the bench. The soil was then divided into two equal parts and placed in Berlese funnels for 48 hours to force the millipedes to leave the soil and drop into jars of alcohol fastened to the bottom of the funnels. The sample contained 66 live millipedes.

On November 10, six 8 by 4 foot bench areas were measured off and dusted, one area each, with DDT 10 per cent, heptachlor 2.5 per cent, dieldrin 1.5 per cent, endrin 1.0 per cent, malathion 5 per cent, and parathion 15 per cent wettable powder used as a dust. A small hand duster was used to make the treatments. The treatments were not replicated.

Six trowels full of soil taken at random to a depth of 2 to 3 inches on December 14 from each of the treatments and from an untreated check area were used to determine control. Each of these soils was placed in a Berlese funnel for 48 hours as on November 10. Dead millipedes were not counted. Because of the large numbers of Collembola present in the untreated soil, and lesser numbers in some of the treated areas, counts of these are included in Table 2. Most Collembola live on decaying matter and do not injure plants.

All six insecticides gave good control of millipedes. Several individuals appeared to have survived the endrin, parathion, or DDT treatments after one month. A recheck of the soil (using the above method) in the treated and untreated areas on February 18, 1955, indicated no live millipedes or Collembola in any of the treatments, whereas 27 millipedes and 110 Collembola were taken from the untreated check.

Table 2. Control of millipedes and Collembola

Dust formulations applied Nov. 10	Number of live	
	Millipedes	Collembola
Dieldrin 1.5%	0	0
Heptachlor 2.5%	0	0
Malathion 5%	0	0
Endrin 1%	3	17
Parathion 15%	3	174
DDT 10%	6	470
Untreated check	60±	500±

Summary

Experiments in the control of slugs feeding on goldenglow, plantain-lily (funkia), lily-of-the-valley, hardy chrysanthemums, and violets indicated that a ground treatment of 5 per cent dieldrin granules was much less effective in controlling slugs than a foliage spray of 15 per cent dieldrin emulsion. Because of heavy rain the spray treatment was repeated once.

Best results in controlling slugs, however, were obtained with a 7 per cent copper dust applied to marigolds, and with calcium arsenate used as a dust on funkia, violet, and goldenglow. Slugs fed on the plants dusted with calcium arsenate but appeared to be repelled by the copper dust. Copper dust did not seem to cause any noticeable phytotoxicity whereas calcium arsenate did.

A soil drench of DDT controlled sowbugs in greenhouse benches where they had girdled carnation plants.

The garden centipede was controlled in greenhouse benches where potted poinsettias were growing, with a 10 per cent DDT dust and Lindane 25 per cent wettable powder applied as a soil drench.

Dieldrin, heptachlor, malathion, endrin, parathion, and DDT used as dusts on the surface of the soil of greenhouse benches destroyed millipedes that had caused extensive injury to the roots and base of carnation, snapdragon, and chrysanthemum plants.

This publication is one in a continuing series on research conducted at this Station to control pests on ornamentals. Titles of other publications in this series to date are given below.

B 578 Scale Insects and Their Control

B 588 Aphids and Scale Insects on Ornamentals

B 591 Mite Pests of Ornamentals and Their Control

C 199 Dogwood Borer

C 200 Systemic Insecticides to Control Pests of Ornamentals

C 201 Thrips on Privet and Other Pests on Ornamentals