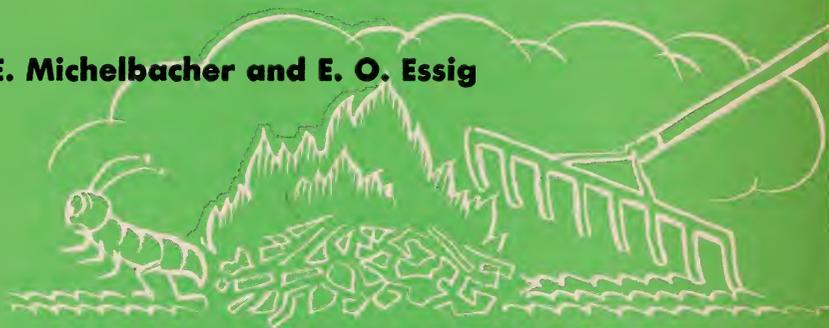


WATCHFULNESS

RIDDING THE GARDEN OF COMMON PESTS

A. E. Michelbacher and E. O. Essig



CLEAN CULTURE



HAND-PICKING

CALIFORNIA AGRICULTURAL
EXTENSION SERVICE ●

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INSECTICIDES

THE HOME GARDENER

grows flowers for fun and vegetables for the family. But each year both the *fun* and the *family* suffer because of the activities of numerous insect pests.

Insects and Related Pests invade the garden from planting of seed to harvesting of crop. Many of them can be controlled quite easily. But to attempt any control the gardener must

- Be able to identify the pests,
- Use common sense in his cultural practices,
- Have a basic knowledge of the insecticides and what they will do.

This circular is planned to help the home gardener in all three phases of his pest control problem.

While Plant Diseases also invade the garden, they are not so easily controlled as are the insects. In fact, for many diseases the control measures are not yet known. The home gardener must control plant diseases largely by prevention and not remedy.

This circular presents a few suggestions for the control of the most common diseases, and encourages the gardener to take a very practical view of the disease problem.

WARNING: The organic phosphates (parathion, hexaethyl tetraphosphate and tetraethyl pyrophosphate) are exceedingly dangerous to human beings in extremely minute amounts when ingested, inhaled or absorbed through the skin. The precautionary statements contained in this publication concerning these materials may not be wholly adequate.

Because of the present uncertainty concerning effective protective methods for applicators and orchard workers when these materials are used as insecticides, the personnel of the University of California has been directed to discontinue work with them until adequate protective measures are available.

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Insect Pests OF THE HOME GARDEN . . .

can be divided into two general groups according to their method of feeding: the chewing pests and the sucking pests

Chewing Pests

are usually larger than those having sucking mouth parts. They eat very noticeable holes in the parts of the plant on which they feed, and in some cases they bore into the part of the plant attacked. This characteristic injury suggests the best method of control—

For the chewing pests, use stomach poisons.

Chewing insects which are commonly found in the home garden, and which will be covered in this circular are: cabbage worms, cutworms or armyworms, corn earworm, tomato pinworm, hornworms, sod webworms or lawn moths, bristly rose slug, cucumber beetles, flea beetles, vegetable weevil, *Brachyrhinus* weevils, pea weevil,



wireworms, root maggots, leaf miners, bulb fly, grasshopper, and European earwig.

Although they are not insects, the following pests have chewing habits and are treated in the same way: sowbugs and pillbugs, snails, slugs, and land planarians.

Sucking Pests

insert their mouth parts into the plant tissue and suck the juice. They may cause stunted or deformed areas. The plant, if heavily infested, gradually

dries up. Some sucking insects excrete quantities of honeydew upon which the sooty mold fungus grows.

Sucking insects are generally controlled by contact insecticides and fumigants.

Sucking insects which cause the home gardener the most trouble, and those which will be discussed in this circular are: aphids, whiteflies, mealybugs, unarmored scales, armored scales, tomato psyllid, thrips, leafhoppers, the harlequin cabbage bug, and squash bug.

Related sucking pests are tomato mite, and red spider.



4 STEPS IN CONTROL



Watchfulness . . .

. . . is the first step in the successful control of garden pests.

The gardener simply cannot plant flowers or vegetables and go away and leave them. A host of pests is waiting for him to turn his back.

The watchful eye of the gardener—frequently scanning the ground around new sets, or checking the underside of leaves, or closely examining the budding fruits and flowers—is the controlling factor for which there is no substitute.



Hand-Picking . . .

. . . and destroying is an old-fashioned method of controlling insects. Nevertheless it still is effective in home gardens against such pests as squash bugs, hornworms, leaf-feeding caterpillars, harlequin cabbage bugs, snails and slugs.

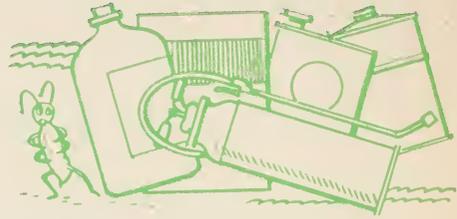


Clean Culture . . .

. . . is a step in pest control which is frequently overlooked.

Remnants of crops should be de-

stroyed as soon as the harvest is complete. Weeds must not remain about a garden since they serve as breeding places for many insects. Rubbish piles and plant refuse should be burned or spaded under.



Insecticides . . .

. . . many times are the only controls you can depend on to hold the insects in check.

Insecticides can be roughly divided into three groups: stomach poisons, contact insecticides, and fumigants. With the advent of many of the new insecticides this classification has lost much of its meaning because a number of the newer organic materials act both as stomach and contact poisons, and in addition some exert a fumigant action.

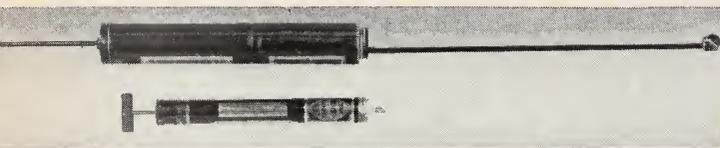
In recent years a number of new insecticides have been developed. Some of these have shown unusual promise as controls for certain insects which had previously been hard to control. Because of the great demand for these insecticides, some of them were put on the market before they were thoroughly tested. They are continually being improved, and recommendations for their use are changing. For this reason it is important to read carefully the directions given on each new container you purchase, and to follow them exactly.



Equipment FOR Spraying AND Dusting

A good sprayer breaks the liquid into a fine mist. Its nozzle can be held at various angles in order to wet the underside of foliage. **Above:** *left*, a good sprayer for the fairly large garden. It is worn on the back of the operator. Up and down movement of handle creates pressure and works agitator; *right*, pressure type also suitable for large gardens. Pressure is built up by pumping. This type is not equipped with agitator, so material must be well mixed before filling, and sprayer well shaken before using as well as in emptying; *center*, small atomizing type good for house plants and window boxes, but too small for general use.

A good duster regulates the dust flow to avoid blobbing of dust. It is not necessary to buy the most expensive duster to get good performance. **Below:** *top*, two small inexpensive dusters very efficient for use in the small garden; *left*, bellows type worn on the back. Suitable for very large gardens or where plants are continuous; *right*, rotary type carried in front of operator. Good for large gardens and continuous plantings.



***Stomach Poisons* AND THEIR APPLICATION**

Cryolite (sodium fluoaluminate), calcium arsenate, and lead arsenate, are strictly stomach poisons. Rotenone is a stomach poison as well as a contact poison. Each of these has peculiarities which make it more, or less, suitable for the job to be done.

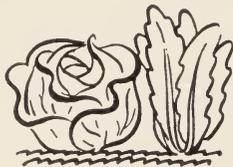
Cryolite (Sodium fluoaluminate) is much less toxic to humans and other warm-blooded animals than either calcium or lead arsenate, and is therefore *the recommended material* for home vegetable gardens.

Calcium arsenate is extremely effective as a stomach poison for garden pests—but unfortunately also for humans. The drift from this insecticide, when used as a dust, has caused poisoning of animals that have eaten the contaminated foliage, and of bees that have visited the flowers.

Lead arsenate should never be applied to any vegetable crop or vegetation if the foliage is intended for human or animal consumption.

Rotenone, an insecticide obtained from a plant, is relatively nonpoisonous, but is effective as a stomach poison against only a limited number of insects.

DUST THE VEGETABLES



For vegetable gardens these stomach poisons are probably most easily and efficiently used as dusts. The following rules will help you do a good job:

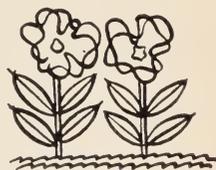
- 1—Regulate dusting apparatus to provide a light, even, thorough coverage.
- 2—Accent on *light coverage*. Overap-

plication or piling the dust into the center of the plants should be avoided. Where the ground is well covered with vegetation and the rows are 18 inches apart, use about ½ ounce of dust to each 20 feet of row.

3—Apply dusts in early morning or evening when there is little or no wind. Drift of insecticides to other plants must be reduced to a minimum.

Never allow poison dusts to drift onto the property of others.

SPRAY THE FLOWERS



Since there is no poison residue problem, flowering plants and ornamentals may be successfully sprayed, and with this process danger from drift is reduced.

Lead arsenate is probably the most effective of the strictly stomach poisons and is well adapted to use as a spray. The standard spray mixture of this insecticide is 1½ pounds of lead arsenate to 50 gallons of water.

The following suggestions apply to the application of any spray material:

- 1—Mix a fresh batch of spray solution for each application. Put in a clean applicator.

- 2—Use a “sticker,” or wetting agent, as recommended by the manufacturer; or use a paste-type oil emulsion.

- 3—Allow spray to dry before watering plants.

- 4—Early morning or late evening is the best time to spray because of a minimum of wind.

HOW TO USE THE *Contact Insecticides*

The contact insecticides include such old stand-bys as **nicotine** and **lime-sulfur**.

Pyrethrum and **rotenone** have become well established over a number of years.

Refined mineral oils are valuable in killing insects, particularly when combined with one of the organic insecticides.

Sabadilla is a newer insecticide which is made from the poisonous plant, Cevadilla, grown in Mexico and Central America.

In addition to these there are a number of new organic insecticides—organic phosphates, organic thiocyanates, and others. Most of these have complicated chemical names which mean a great deal to the men in the laboratory who discover them and make them. Their common names, however, are more familiar to the home gardener.

These organics, using their commonest designations, include:

Parathion

Tetraethyl pyrophosphate

DDT (dichlorodiphenyl trichloroethane)

DDD (dichlorodiphenyl dichloroethane)

Methoxychlor (dianisyl trichloroethane)

Benzene hexachloride (666)

Chlordane

All of these compounds kill by contact, and some of them also act as stomach poisons.

All of the above-listed insecticides are sold as commercial preparations in the form of liquid concentrates, wet-

table powders for spray, or dusts, except the refined mineral oils which come as pastes or liquids. The concentrated spray products can be diluted with water and are then easily applied with ordinary pressure sprayers.



SPECIFIC

USES

Nicotine sulfate (Blackleaf 40) is one of the most common spray materials, and is particularly effective against aphids and thrips. Nicotine is also frequently used in combination with other insecticides.

Pyrethrum and rotenone, when used as sprays, are effective against aphids, leafhoppers, thrips, and many other soft-bodied insects.

Pyrethrum dusts should contain 0.10 to 0.20 per cent pyrethrins. Dusts containing 0.15 to 0.20 per cent pyrethrins and 2 per cent organic thiocyanate, when applied at temperatures below 65° F. give excellent control of leafhoppers, thrips, and cucumber beetles.

Rotenone dusts, containing at least 0.5 per cent rotenone are effective against the pea weevil, pea aphid and cabbage worms.

The highly refined mineral oil emulsions are available alone or in combination with nicotine, pyrethrum or rotenone. They are highly effective in killing a wide range of insects including certain aphids, scales, mealybugs, leafhoppers, thrips, beetles, and caterpillars.

Nicotine, pyrethrum, rotenone, sabbilla, organic thiocyanates, mineral oils, and tetraethyl phosphate are relatively nontoxic to man after they have been applied and then allowed to weather for a day or two. They can be applied safely to vegetables and, of course, to flowering plants and ornamentals at any stage of growth.

The toxicity to humans of DDT, DDD, benzene hexachloride, and methoxychlor has not been fully determined, therefore full precautions—just the same as are followed with the stomach poisons—should be observed when using these.

USE OF FUMIGANTS

Fumigants are not widely used for the control of insect pests in the home garden. They are found practical only for the control of certain underground pests.

Dichloroethyl ether is used for the control of sod webworms, ground mealybugs, and cabbage maggots.

Ethylene dibromide is very effective for controlling wireworms.

Both of these insecticides are for sale in small packages, and the directions for their use are given on the containers.

COMBINATION INSECTICIDES

The home gardener is most interested in controlling a wide range of insects with few applications. Many commercial concerns are now packaging combinations of insecticides with which it is possible to control numerous pests of both the sucking and chewing types.

Some of the combinations include fungicides to aid in the control of plant diseases.* Examples of these combined products are: rotenone, pyrethrum, and

petroleum oil; petroleum oil, nicotine, and DDT.

Numerous combinations are available, and the gardener should compare them, carefully reading labels and directions before buying.

We cannot overestimate the need to *follow directions* on the package. Most of the new products are continually undergoing change as more about them is learned through usage. Recommendations made by the manufacturer may change for the same product over a period of a few months.

Among the many things still not known is the matter of plant tolerance to these materials. It is believed by some that materials such as DDT may collect in the soil and after prolonged use may prove injurious to new plantings.

Another question is that of danger of destroying beneficial insects, particularly bees, ladybird beetles, and other common predators.

It is also possible that while these insecticides will kill certain insect pests, they may actually cause an increase in other pests. In part this is brought about by the destruction of natural enemies. Further, there is believed to be a physical or chemical effect on the environment which is as yet not fully understood.

For example, there is danger of serious increases in the population of red spiders where such materials as DDT and DDD are used. To combat this problem, many manufacturers now are adding sulfur to the other insecticides.

The gardener can help to eliminate the adverse effects of these insecticides by using *just enough and no more* than is necessary for adequate control.

SO, FOLLOW DIRECTIONS ON THE PACKAGE.

* For information on PLANT DISEASES see page 34.



Most of the stomach poisons, and many of the contact insecticides, are extremely injurious, or even fatal, if eaten by human beings, livestock, cats, dogs, chickens, and bees. *They must be used with the greatest caution.*

▶ Cryolite, calcium arsenate, DDT, DDD, and benzene hexachloride leave poison residues which remain on the plant long after application. If any of these have been applied to edible portions of plants (such as tomatoes), carefully wipe, wash, or peel before serving.

On cauliflower, cabbage, lettuce, and similar vegetables, do not use any of these materials after the heads have begun to form. On leafy vegetables that do not head, don't apply these materials after the first month to six weeks.

On beans, peas, squash, cucumbers, and similar vegetables, do not apply after the fruit is set.

▶ Benzene hexachloride has a strong, musty odor which may flavor the product treated. Do not apply benzene hexachloride later than eight weeks before harvest. Now on the market is a product known as lindane (gamma isomer of benzene hexachloride) which is relatively free of odor and less likely to give an off-flavor to vegetables.

▶ In using poison bait, avoid scattering the material on the plants, and keep containers out of reach of children and pets.

▶ DDT and related compounds are poisonous to fish and other cold-blooded animals. Avoid spraying into lily pools, fish ponds, and streams. Where plants might drip into pools, cover the pools before spraying.

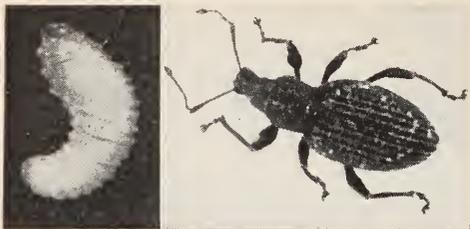
▶ In handling, mixing, and applying poisonous insecticides, take special care not to inhale more than is absolutely necessary. When the job is finished, wash the hands thoroughly, as well as other parts of the body which may have been exposed.

Have a special place for cans and packages of materials. Preferably this should be under lock and key, but at least should be out of reach of children and pets. Be sure all containers are labeled.

A dark storage place is preferred, because any material which oxidizes will do so much more readily in sunlight.

After using any piece of equipment, wash it thoroughly. Wash mixing spoons and containers. Wash out the sprayer with plenty of water.

BRACHYRHINUS WEEVILS



Both larvae and adults of *Brachyrhinus* weevils attack many ornamentals.

There are several species of *Brachyrhinus* weevils that are very destructive to garden plants. The adults, depending upon the species, are shiny brown to nearly black and measure from about $\frac{1}{4}$ to a little more than $\frac{1}{2}$ inch in length. They are true weevils with heads terminating in a blunt snout. The larvae are white, crescent-shaped, legless grubs with brown heads, that are about $\frac{1}{2}$ inch long when mature.

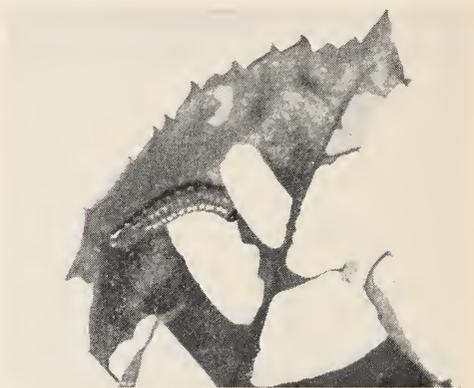
Both the adults and larvae are destructive. The adults feed at night and hide during the day. Their typical way of feeding is to eat out notches along the edge of leaves. The larvae live in the soil and damage plants by feeding on the roots, underground stems, and the bark of the trunk just below the ground level, thus girdling the plants. Plants attacked and often killed include bush berries, strawberries, begonias, cyclamen, privet, many ornamentals such as camellias, rhododendrons, azaleas, primroses, and wistarias.

Control of *Brachyrhinus* weevils is mainly directed against the adults, before they have had an opportunity to lay eggs. The new generation of adults usually makes its appearance in late April or May. At this time many can be killed by scattering a poison bait. The most effective bait is a proprietary one consisting of a poison in a dried-apple-

pulp bait. The bait should be scattered at the rate of from 50 to 75 pounds to the acre or $\frac{3}{4}$ pound for the ordinary garden. Although not as effective, a substitute bran bait that contains sugar, and poisoned with calcium arsenate, or sodium fluosilicate can be used.

DDT is effective against the adult weevils, and infested plants can be sprayed or dusted with this insecticide. However, if DDT is used there is danger of other pests increasing in destructiveness; therefore apply DDT only where needed and as sparingly as possible. Also, use care not to contaminate vegetation meant for human or animal consumption.

BRISTLY ROSE SLUG



The pale green bristly rose slug is a pest of almost every rose garden.

The adult of the bristly rose slug is a small, black sawfly, which is related to bees and wasps. It is about $\frac{1}{4}$ inch in length, and lays its eggs in grooves in the midribs of the leaves. The caterpillar-like larva is pale green, and when full-grown measures about $\frac{1}{2}$ inch in length. All injury is done by the larvae. They are found on the underside of the leaves which they first skeletonize, and later eat holes into or entirely devour. There are at least two

generations a year and the adults first appear in April and May. If not controlled, the pest may defoliate roses.

Control of the bristly rose slug should start as soon as injury is noted. It can be controlled easily with a spray or dust of any of the stomach poisons. It is also controlled with DDT or DDD, or lindane, but in order to avoid a serious increase in red spiders these insecticides should be used in combination with sulfur. Most of the contact insecticides are effective in killing the rose slug if the pest is contacted with the material.

BULB FLY



Careful selection of firm bulbs is the best protection from the bulb fly maggot.

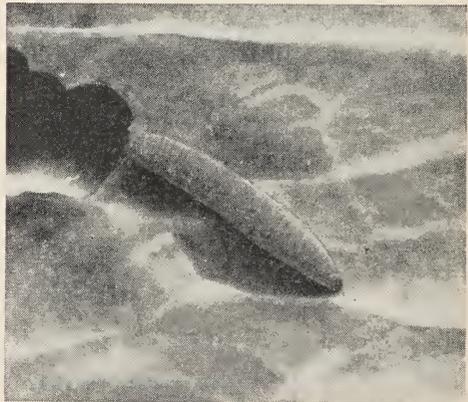
The bulb fly is a large, hairy black fly, marked with gray, yellow, or orange, and is about $\frac{3}{8}$ to $\frac{1}{2}$ inch long. It greatly resembles and acts like a small bumblebee. The eggs are small, oval, white, and are laid near the surface of the soil close to the crown of the host plant. The maggots when mature are robust, measure $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in length, and are white, yellowish, or brown in color.

The young maggots bore into the bulb and feed upon the tissue by means of their strong, hooked mouthparts. This usually results in hollowing out the center of the bulb, or reducing it to a thick brown excrementaceous mass. Usually but a single maggot is found in a bulb. Narcissus bulbs are preferred, but amaryllis, hyacinth, eurycles, galtonia, habranthus, hippeastrum, lilies, tulips, and vallota are attacked. Infested bulbs can be detected by pressing to determine their solidity.

Control of the bulb fly is a difficult problem for the home gardener. Every attempt should be made to select and plant bulbs that are firm and free from maggots or injury. Commercial control is obtained by treating harvested bulbs in hot water for 2 hours at 110° F. The temperature must be accurately controlled because a temperature rise of a degree or two even for a short period is likely to seriously injure the bulbs. Field control has not proved satisfactory.

CABBAGE WORMS

Cabbage worms include three kinds that seriously injure cabbage and related plants. (1) The cabbage worm is



Cabbage worms must be controlled during early stages of plant growth.

the immature form of a white butterfly with dark markings; it is a uniform velvety green and, when full grown, is about 1 inch long. (2) The cabbage looper, the caterpillar stage of a moth, is light green, with several longitudinal fine white stripes running the length of the body. It grows to a length of about 1 inch. In crawling it loops its body—hence the name. (3) The caterpillar of the diamond-back moth is light green. It is the smallest worm attacking cabbage; when full grown it measures about $\frac{1}{2}$ inch.

All three species eat irregular holes in the leaves of cabbage and related plants; and in heavy infestations they make the plant worthless.

Control: During early stages of plant growth, dust with cryolite, calcium arsenate, DDT or DDD. Do not use these poisons after cabbage heads have started to form; instead, apply thoroughly a dust containing at least 0.50 per cent rotenone, or a rotenone dust combined with pyrethrum, nicotine, or organic thiocyanate. For satisfactory results any of these materials should be applied before the worms are large. Destroy cabbage and related plants as soon as harvest of that crop is complete. The worms attacking this group of plants are most serious in summer and fall.

CORN EARWORM

The corn earworm is about $1\frac{1}{2}$ inches long when fully grown. It ranges from green to almost black and may be marked with longitudinal stripes of various colors. It is principally a pest of fruiting bodies, into which it bores. It is the common worm found eating its way down through the kernels of the ears of corn. Also serious pest of tomatoes, it usually enters at the stem end



The corn earworm not only likes corn, but will invade the tomato patch.

and consumes the inside of the fruit. It also attacks beans and many other crops and weeds.

There are no less than three generations in a year. The adult moths become active at about dusk at which time females may be seen flitting here and there, laying eggs on their host plants. The eggs are laid mainly on the silk of sweet corn, while on other crops, such as tomatoes and beans, the eggs are laid on the outer portion of the plant. The eggs are laid singly and are pearly white when first laid but become darker in color as they approach the time of hatching of the young caterpillars.

Control: On corn, the corn earworm may be controlled by injecting directly into the silk channel 1 cubic centimeter (about $\frac{1}{4}$ teaspoonful) of a highly refined mineral oil, which contains 0.2 per cent of pyrethrins, or 2 per cent dichloroethyl ether. You can purchase these from dealers handling insecticides. Oil interferes with fertilization and, therefore, should be applied after

the silk has begun to wilt and turn brown. Use a plunger type of oil can. A setscrew attachment can be fitted to the plunger to regulate the amount of oil ejected with each stroke. Insert the nozzle of the oil can not more than $\frac{1}{4}$ inch into the silk channel. For small plantings an ordinary medicine dropper can be used. Control can also be obtained by clipping off the tips of the ears to remove the entering worms. This should not be done until pollination is complete. Destroy clipped tips.

On tomatoes, lightly but thoroughly dust the plants as necessary with cryolite, calcium arsenate, DDT, or DDD. However, do not use DDT on tomatoes grown under glass. If treatment is required during the harvest season, wash or carefully wipe the fruit to remove any poison residue. See tomato mite.

CUCUMBER BEETLES

The western spotted cucumber beetle (or *Diabrotica*) is small and green, with twelve black spots on the wing covers. It is widespread throughout California and attacks most vegetables and many flowering plants, but particularly cucumbers, squash, melons, beans, corn, and similar crops. The whitish, worm-like larvae feed on the roots; the adults on the leaves, stems, and floral parts.

A close relative, the striped cucumber beetle, is somewhat smaller, and is grayish brown, with three black lines down its back. It seriously attacks cucurbits (squash, melons, and the like).

Control: When there is no residue problem, cucumber beetles can best be controlled by thoroughly dusting the plants with cryolite or benzene hexachloride. DDT is extremely effective against these pests but should not be used on squash since some varieties are

injured through DDT applications. When seedlings are being attacked, apply the dust in generous amounts. When a residue problem is involved, use a contact insecticide such as a dust containing pyrethrum and organic thiocyanate, dusting the infested plants in the cool hours of early morning.

The use of DDT is likely to result in a serious increase of red spiders. The addition of $\frac{1}{4}$ to $\frac{1}{2}$ by volume of sulfur to the commercial dust will help control red spiders. (Do not use sulfur on melons or strawberries.)



This small green beetle with its black spots is to be found in most gardens.



This cutworm is typical of the group that feed at night and hide during the day.

CUTWORMS or ARMYWORMS

Cutworms or armyworms are the caterpillars of moths. When full-grown they are $1\frac{1}{2}$ to 2 inches long. Most species are somber in color, although



The yellow-striped armyworm is one of the cutworms which feed during the day.

some, such as the yellow-striped armyworm, are rather showy. Cutworms attacking vegetables may be divided into two groups: (1) those that feed at night and hide during the day in the soil and debris, and (2) those that spend their entire larval life on the plant and may be found feeding in the daytime.

Cutworms cause injury by cutting off seedlings or newly transplanted plants below or above the ground, or by eating large irregular holes in the leaves or fruiting bodies of older plants.

Control: Cutworms belonging to group 1 are best controlled with commercially prepared poison baits. Scatter the bait over the infested area just before dusk. To control cutworms belonging to group 2, dust the plants thoroughly with cryolite, calcium arsenate, DDT, or DDD. Where seedling stands are being injured by worms of either group, dust with cryolite, lindane, DDD, or DDT. Do not use DDT on very young tomato plants. The use of DDT or DDD is likely to result in a serious increase of red spider. The addition of $\frac{1}{4}$ to $\frac{1}{2}$ by volume of sulfur to the commercial dust will help

control this pest. *Note precautions given for poison residues.*

EUROPEAN EARWIG

The European earwig is a dark chestnut-brown insect about $\frac{5}{8}$ inch long, with a pair of forceps on the rear end of the body. Although provided with short wings, it usually runs. It feeds at night, and hides by day under boards, rocks, rubbish, and in crevices. It attacks many different vegetables and flowering garden plants, eating holes in the leaves and flowers. It is an introduced species, not yet spread throughout the state, and is likely to be destructive only in the cooler coastal regions. Eggs are laid from December through February, and the pest is most destructive from April through July.



Great numbers of earwigs may be found under boards or rubbish, and should be baited, or the infested area dusted.

Control: To control the European earwig, use a poison bait containing bran, sodium fluosilicate, and fish oil. Commercial prepared baits are available. Baits are most effective when used during April to July inclusive and should be applied in the evening. The bait should be scattered over areas fre-

quented by the pest but it should be kept off the plants. Since it is poisonous, it should be kept away from animals.

A dust containing 5 to 10 per cent of DDT, chlordane, or one containing benzene hexachloride or lindane is effective. Apply dusts around the hiding places of this pest, particularly along fences and foundations of the house. Avoid dusting the shrubbery with DDT; it kills beneficial insects that help to control red spiders and other pests.

FLEA BEETLES

Flea beetles are small and black, brown, greenish, or yellowish. Most of them are only about $\frac{1}{16}$ inch long. They jump like fleas and eat small holes in leaves. Many species attack vegetables. Where infestations are heavy, plants may be nearly defoliated. Seedlings or newly transplanted plants are liable to



Tiny flea beetles eat small holes in leaves and can defoliate a plant.

be most seriously injured. The minute wormlike grubs feed upon roots and tubers of cultivated and wild plants.

Control: To control flea beetles, dust the infested plants evenly and thoroughly with cryolite, calcium arsenate, DDT, benzene hexachloride, or lindane. Where a residue problem is involved, use 0.75 per cent rotenone dust.

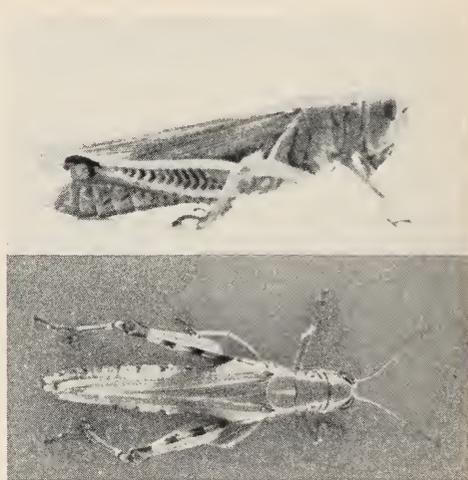
Note precautions on page 9.

GRASSHOPPERS

The grasshopper is a familiar garden pest in the warmer interior areas of California. The young are much like the adults except that they do not have fully developed wings. In growing they cast their skin a number of times. With each cast they gain in size and the wings become more apparent. The fully developed adult appears after the final molt. Eggs are laid in the soil but do not hatch until the following spring.

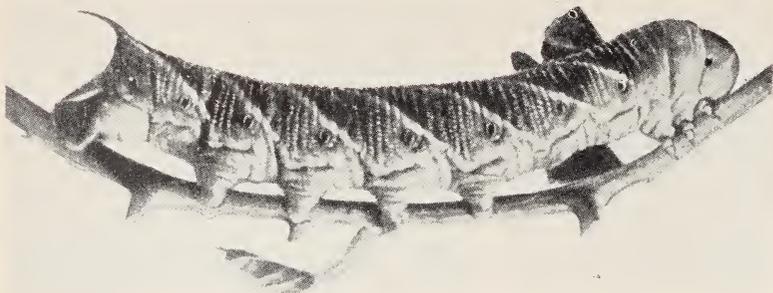
Both young and adults attack plants. Young plants may be eaten off. When infestations are severe, large plants are defoliated and even the tender bark may be eaten from trees and ornamentals.

Control: Grasshoppers are controlled by scattering commercially prepared poison bait lightly over the infested area in early morning. Repeat the operation at intervals of a few days to a week until the pest has been eliminated. DDT, benzene hexachloride, lindane and chlordane dusts are all effective. Organic phosphate sprays will kill all the grasshoppers that are contacted by the spray.



Grasshoppers feed on vegetables as well as the leaves and tender bark of many plants.

HORNWORMS



This big green fellow enjoys vegetables. He can be found most easily in early morning on tomato, pepper plants, eggplant.

Hornworms (tomato and tobacco) are caterpillars of the large "sphinx" or "hummingbird" moths. When fully grown they are nearly 4 inches long. They are predominantly green, with white diagonal stripes, and with a characteristic spine (horn) at the rear end. They are serious pests of tomato and feed upon the vine, blossoms and fruit. Hornworms are most destructive in the warmer interior valleys. If left unchecked, they may completely defoliate plants. They attack potatoes, eggplants, and peppers. A favorite wild host is the Jimson weed.

Control: You can best control by hand-picking and destroying them as soon as they are noticed. You can find them easily in early morning, when feeding is confined largely to the outside of the vine.

Calcium arsenate, and DDD dusts are effective. Dusting should be light but thorough. If the application is made during the harvest period, wash or carefully wipe the tomatoes, eggplants, or peppers to remove any poisonous residue. On tomatoes, if the tomato mite is present, use a dust containing 25 per cent sulfur.

LEAF MINERS



The colorless area in the leaf at left is caused by leaf miners which feed between the two leaf surfaces. At right the mining operations are exposed.

There are many kinds of leaf miners that attack vegetables, flowering plants, and ornamentals. The leaf miner is the larva of a fly. When hatched from eggs

which have been laid on the surface of the plants, these miners, or small maggots, enter the leaf tissues and feed between the two surfaces. They cause

large, colorless blotches or mines. Where numerous they may destroy the entire leaf. On holding infested leaves to the light, you can easily see the maggots in the mines.

The beet or spinach leaf miner is whitish and when full-grown is nearly $\frac{3}{8}$ inch long. Spinach, beets, and chard are among the plants seriously injured. There are other leaf miners in the garden, many of which make a serpentine type of mine in the leaves.

Control: Late summer, fall, and winter-grown crops usually escape injury from the spinach leaf miner. Spring and summer crops are sometimes seriously attacked. There are no satisfactory control measures. Some good, however, will result if the infested leaves are picked and destroyed before the maggots leave the mines. A nicotine spray containing 1 teaspoonful of nicotine sulfate and 2 tablespoonfuls of soap to 1 gallon of water, if applied frequently, is partially effective.

Insecticides containing chlordane, benzene hexachloride, or lindane have been reported as being effective against leaf miners.

PEA WEEVIL

The pea weevil is a short, chunky beetle about $\frac{1}{5}$ inch long. The base color is brownish, flecked with white, black, and gray patches. There is a distinct spot of white scales just back of the head, and another on the exposed tip of the abdomen. The adults leave their hibernating quarters in the spring and fly to peas when they come into bloom. They are attracted to the flowers, and must feed on pollen before they are able to lay eggs. The tiny, long yellow- or orange-colored eggs are laid on the developing pea pods. The larvae

or grubs upon hatching bore directly through the egg shells and pod and enter the developing peas. Except for the first stage, the larvae are legless, grub-like, white with a brown head.

The entrance made by the larva into the peas is very small and difficult to detect. The larvae complete their development inside the pea in from 30 to 50 days. After constructing a tunnel to the seed coat so that the adults can more readily emerge, the larvae pupate. After 10 to 15 days the pupae transform to the



These insects entered the peas as larvae and now emerge as full-grown weevils.

adult beetles, which escape from the peas by cutting out a circular hole in the seed coat. There is but a single generation a year, and unlike the several species of bean weevils, the pest does not breed in storage or in dry peas.

Control: The pea weevil can best be controlled by thoroughly dusting the pea vines with a dust containing 0.75 per cent rotenone. Apply the treatment at weekly intervals from shortly after the beginning until the end of the blooming period. A 5 per cent DDT dust is also very effective and not more than two applications are necessary. The first should be applied shortly after

the start, and the second at the height, of the blooming period. Where DDT is applied, avoid feeding the treated pea vines to livestock. As a sanitary measure, destroy the pea vines as soon as harvest is completed.

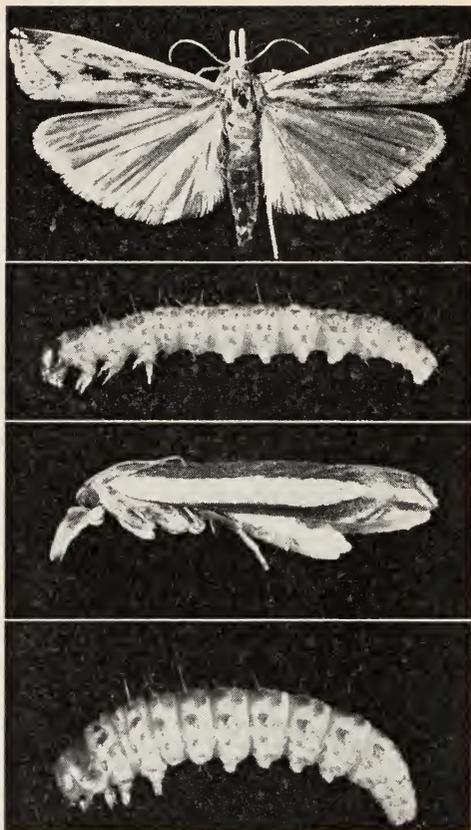
ROOT MAGGOTS

Root maggots include several species that seriously attack the roots of growing plants. The maggots are the larvae of flies and are legless, without distinct heads, and nearly white. They bore into the germinating seeds and roots, and often make it difficult to grow certain vegetables. There are three important species: (1) The cabbage maggot attacks cabbage and related crops. It is serious in summer. (2) The seed-corn maggot attacks germinating seeds and roots of corn, beans, peas, tomatoes, and other crops. It is particularly serious where the soil is moist and cold; and it is usually most active early in the season. (3) The onion maggot attacks onions, garlic, shallots, and related crops.

Control: To control the cabbage maggot, place disks of tarred paper about the plants at the ground level and in close contact with the soil at the time of transplanting. The disks should be about 3 inches in diameter, with a hole in the center and a slit to facilitate placing them about the plants. Dichloroethyl ether has proved effective. It is available in commercial ready-mixed preparations, which may be added to water at the rate of 1 to 400, or 2 teaspoonfuls to the gallon, and applied with sprinkling can to the soil around the plant at the rate of 1 cupful to a plant or 1 cupful to 8 inches of row.

To avoid injury from the seed-corn maggot, particularly to beans and corn, delay planting until the soil warms up.

To avoid injury from the onion maggot, spray the soil about the plants with 2 parts of a highly refined oil emulsion to 100 parts of water. Destroy cull onions as soon as harvest is complete. Chlordane preparations are effective against root maggots. Follow manufacturer's recommendations.



From top to bottom, the adult and the larva of the fawn-colored lawn moth; the adult of the silver-barred lawn moth with the bar showing conspicuously in this profile view; the larva of the silver-barred species.

SOD WEBWORMS or LAWN MOTHS

The two chief lawn-infesting insects are the fawn-colored lawn moth and the silver-barred lawn moth. The adults are small. The forewings of the fawn-colored lawn moth are brown, varie-

gated with buff, white, and black; those of the silver-barred lawn moth are golden with a longitudinal silver stripe. These pests breed continuously throughout the late spring, summer, and early fall. The adults fly slowly over lawns at dusk, while scattering eggs in the grass. All damage is done by the caterpillars which hatch from the eggs. The caterpillars when full-grown are grayish with black spots, and about $\frac{2}{3}$ of an inch in length.

Serious damage is done to bent and bluegrass and other grass lawns during the summer and early fall. The crowns and new buds are attacked which causes irregular brown spots in the lawn. Damage by these insects might be confused with the lawn diseases causing brown patch and dollar-spot, but the insect damage can be distinguished by unevenness of grass height and irregularity in the shape of dead spots.

Accurate determination of infestation can be obtained by wetting the sod about the dead areas with a pyrethrum solution. Use a commercial pyrethrum preparation that contains 2 per cent pyrethrins, diluted with water at the rate of 1 part to 400 (two teaspoonfuls to the gallon), and apply to the grass by means of a sprinkling can at the rate of 1 gallon to the square yard. Any webworms present will come wriggling to the lawn surface. A serious infestation is indicated if at least 100 individuals come up within 10 minutes.

Control: A number of insecticides are effective in controlling sod webworms. Pyrethrum products and dichloroethyl ether at proper dosages result in a good kill of the caterpillar present, but have no residual action, and the lawns are subject to reinfestation right after treatment. If these ma-

terials are used, the directions as given on the container should be followed.

The most satisfactory treatment, and one which prevents reinfestation, is to treat the lawn with a standard lead arsenate spray. The standard lead arsenate is used at the rate of 5 pounds to 50 gallons of water. This amount is enough to treat 1,000 square feet. The mixture is best applied with a sprinkling can, and the spray should be allowed to dry before rewatering. Lead arsenate is very poisonous and every effort should be made to keep it off of vegetation which is intended for human or animal food. Sprays containing DDT wettable powder are also effective.

TOMATO PINWORM

The tomato pinworm, the caterpillar of a tiny moth, is about $\frac{1}{4}$ inch long when fully grown. The young worms are light pink, but the older ones appear grayish purple. They attack all portions of the vine, but are most destructive to the fruit. They may enter it at any point, but usually they enter at the stem end and burrow into the core and the fleshy portions that radiate from it. The pest also attacks potato, eggplant, and nightshade. The area where the pinworm is apt to be a problem is limited to southern California and the central and southern San Joaquin Valley.

Control: Tomato pinworm can best be controlled by applying a cryolite dust evenly and thoroughly to the vines. In seasons when pinworms are serious, dust the vines first when the fruits are about the size of marbles. Apply two other dustings at 2-week intervals, and a fourth after harvest has started. Any dust on the fruit should

be carefully washed or wiped away. If the tomato mite is also believed present, use a cryolite dust containing 25 to 50 per cent sulfur. DDT dust is also effective against the pinworm, and dusting sulfur should be used in combination with it to control the tomato mite.

VEGETABLE WEEVIL

The vegetable weevil is a brown or buff-colored snout beetle that measures about $\frac{3}{8}$ inch in length. The larvae are legless, light green grubs that measure about $\frac{1}{2}$ inch long when full-grown. Both the adults and larvae feed on the foliage of a number of winter and spring vegetables; the larvae also feed on the roots, particularly of carrots and turnips. The vegetable weevil, which has spread to many parts of California, is particularly serious as a pest in the cooler coastal areas. It has not been reported as being a serious pest of flowering plants and ornamentals.

Control: As soon as the first larvae are seen, treat infested plants thor-



The fat grubs of the vegetable weevil destroy root vegetables like turnips.

oughly with a cryolite dust. Use this same treatment for control of the adults. If a poison residue problem is involved, use a dust containing rotenone. Poison baits can be effectively used against the adults but are not effective against the larvae.



Wireworms live in the soil, and attack roots and germinating seeds.

WIREWORMS

Wireworms, the immature stages of "click beetles," have smooth, round bodies and tough skin. They are shiny, and vary in color from pale yellow to dark brown. They live in the soil. Most of the destructive species are not more than 1 inch long and prefer the lighter soil types. Usually one to three years are necessary for wireworms to complete their development. Wireworms injure plants by cutting off roots, by boring into tubers and fleshy roots, or by penetrating into the root and up into the stems of plants. They may also seriously attack germinating seeds.

Control: Wireworms are difficult to control because they live in the soil. They can be attracted to baits, such as carrots, which are placed in the moist surface soil and spaced $2\frac{1}{2}$ to 3 feet apart each way. If the tops are left on, the carrots can easily be pulled out

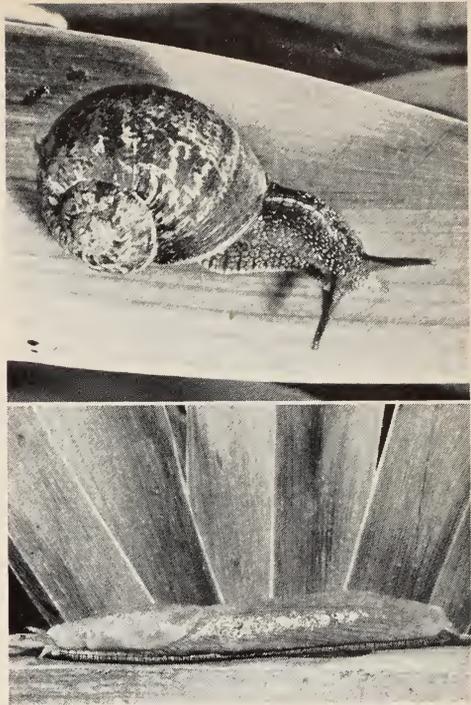
every few days, the wireworms removed, and the baits put back into the soil. Benzene hexachloride applied and incorporated into the soil is effective in the control of wireworms. The commercial dusts usually contain from 1 to 6 per cent gamma isomer, the active ingredient of benzene hexachloride. The amount to apply will vary with the concentration. Two ounces of dust containing 1 per cent gamma isomer, if evenly applied on one hundred square feet is sufficient for satisfactory control. Where vegetables are to be grown, use lindane and follow directions given for benzene hexachloride.

The fumigant ethylene dibromide is very effective in controlling wireworms. This insecticide is available in small containers for home gardens. It should be applied prior to planting, and the directions as given on the container should be carefully followed.

SNAILS and SLUGS

Snails and slugs are so well known to nearly everyone that detailed descriptions are not necessary. The former have shells, and the latter do not. Both have chewing mouth parts and feed chiefly at night. They attack many kinds of plants and often leave slime tracks upon the plant on which they have fed.

Control: Snails and slugs are best controlled with poison baits that contain both calcium arsenate and metaldehyde. Such baits are available as commercial products and are obtainable from almost any dealer selling insecticides. Best results are obtained by scattering the bait in the evening on wet ground. Many of the pests can be destroyed by hand-picking. You can dust plants with cryolite or calcium arsenate.

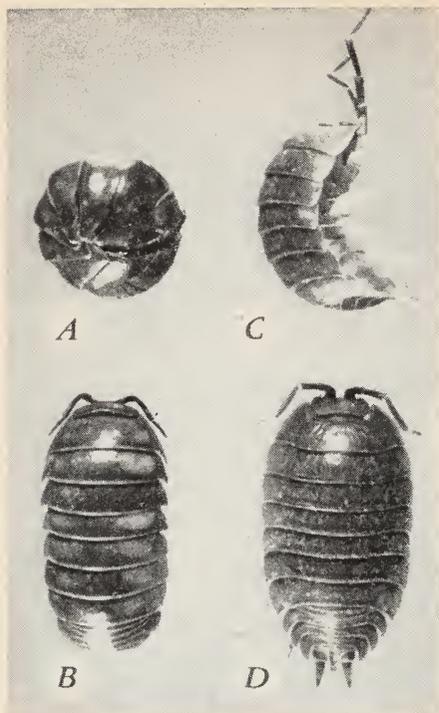


All gardeners know the damage done by these two pests. They feed chiefly at night, and frequently cut off young plants. Poison bait is the best control.

SOWBUGS and PILLBUGS

Sowbugs and pillbugs are dark gray or slate colored, with chewing mouth parts. They are somewhat flattened, have seven pairs of legs, and move rather slowly. They breathe by means of gills and therefore must live in moist, damp places. Unless present in large numbers, they are seldom destructive. They are, however, particularly injurious to seedlings. Pillbugs can be distinguished from sowbugs in that they curl up into a round ball when disturbed.

Control: Sowbugs and pillbugs can be controlled by dusting the infested ground with a calcium arsenate flour mixture. Thoroughly mix 2½ pounds of calcium arsenate with 1 pound of



A and B, the common pillbug; C and D, the dooryard sowbug. Both live in damp places.

white flour. This quantity of the mixture, thinly but evenly applied, is sufficient to dust 700 square feet. *This mixture is a poison and should not be applied to portions of leafy or heading vegetables which are to be eaten, nor to other vegetables after the fruit is set.* Poison baits recommended for cutworms, snails, and slugs are partially effective.

A 5 per cent DDT dust applied to their hiding places gives very effective control. Avoid dusting the shrubbery; DDT will kill beneficial insects that help to control red spiders and several other important pests.

LAND PLANARIANS

Along the coastal areas of middle and northern California and particularly in the San Francisco Bay region,

there are two species of these peculiar, shiny flatworms that somewhat resemble slugs except that they are very much smaller, more slender, and flatter in shape, and do not have horns. Like slugs they travel on a slime path. The larger of these is a yellowish species which may attain a length of three inches, and the smaller one is black and only half as large when mature. They are most often found feeding on and in the fruit of strawberries of which they are very fond. Under moist conditions they may become numerous and do much damage.

Control: Less frequent watering reduces their numbers, and as summer approaches they disappear.

MILLIPEDES

Millipedes are long, wormlike animals that are related to centipedes, but differ in that they have two pairs of legs on each body segment. The common forms, found in gardens, have hard bodies, measure from one-half to one inch in length, and are dark brown or amber in color. The bodies of some species are round—others are somewhat flattened. They are active at night and during the day they hide in secluded locations—under boards, rocks, and flats. If their hiding places are disturbed they can often be seen with their bodies coiled in a very characteristic manner.

Millipedes like damp locations and are found in greatest abundance in moist situations that are rich in organic matter. Their food is supposed to consist of decaying vegetation, although where extremely abundant, they may feed on growing vegetation. On occasions, they have been known to feed on sprouting seeds, tubers, and bulbs.

Control: Control measures are seldom justified unless millipedes are present in large numbers. Dust or sprays containing DDT, chlordane, benzene hexachloride, or lindane are effective in controlling the pest.

These materials should be used according to the manufacturer's recommendations, and should be applied to the areas frequented by millipedes. Although the treatment is rather expensive, millipedes can be controlled by thoroughly wetting the soil about the infested plants with a 40 per cent nicotine sulfate solution, diluted at the rate of two teaspoonfuls to the gallon of water.

OAK MOTHS

The adult oak moth lays somewhat flattened, globular eggs, in masses, on the leaves, limbs and trunks of the trees. When first laid, the eggs are white but become darker as the hatching period approaches. While maturing, the larvae cast their skins about five times, and when full grown, measure about $1\frac{1}{4}$ inches in length. They have a brown or reddish head; the body is olive green, with black and yellow stripes running lengthwise on their back and sides.

The caterpillars pupate on leaves, limbs or trunks of trees, or on any near-by shrubs. The pupae are shining, smooth, whitish, or yellowish, with black markings. Where infestations are heavy, they may be easily found.

The adult moth is a pale brown, measuring about an inch in length.

There are two generations a year. The winter is spent as tiny larvae in the eggs or on the leaves of evergreen oaks. The overwintering caterpillars complete their development in May or June and the moths emerge, mate, and lay eggs which give rise to the summer

brood. Moths from this brood appear in October and November and lay eggs that give rise to the overwintering caterpillars.

Under severe conditions of infestation, either of the two broods seriously damages oaks—on occasion they defoliate trees over a wide area. While the moths occur all along the coast, from San Diego to well north of San Francisco, the damage is usually most severe in the region adjacent to the bay.

Control: The oak moth is subject to attack by many natural enemies which include parasites, predators, and a bacterial wilt disease. These natural factors are very important in limiting the damage done by oak moths, but where they fail trees can be protected by spraying with lead arsenate.

The composition of the spray is three pounds of lead arsenate to 100 gallons of water. The results will be improved if a depositor or sticker is added. If this is done, the manufacturer's recommendations on the lead arsenate container should be followed carefully. The spray should be applied in the spring, after the trees have fully leafed out, but before damage becomes apparent. On deciduous oaks the spray need not be applied before the second brood appears.



Here is a closeup of the adult of the oak moth, on bark of oak tree.

APHIDS



Above, a winged species of aphid frequently found on roses; below, the wingless species found in great numbers on many plants.

Aphids are small, fragile, soft-bodied insects with sucking mouth parts. Some have wings while some do not. They are black, green, yellowish, or pinkish and their bodies are naked or perhaps covered with a powdery wax. They live in colonies where they excrete quanti-

ties of honeydew, which attracts ants and on which a sooty mold fungus grows. Many species attack vegetables and other garden plants, causing deformation and curling of leaves. If not controlled, they make the growing of certain plants very difficult.

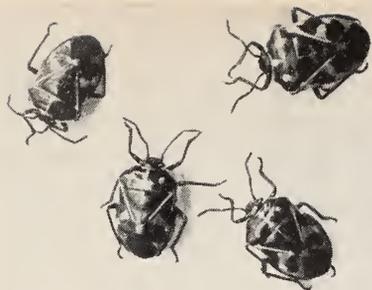
Control aphids with contact insecticides containing nicotine, pyrethrum, rotenone, organic thiocyanate, organic phosphates, highly refined mineral oil, or combinations of these materials. Because many of the aphids develop on the undersides of leaves, thoroughness of application is necessary. For good results, spray or dust as soon as aphid colonies are observed. If you wait until after leaves are curled, control is difficult because the aphids are hard to reach with the spray or dust. Destroy infested plants as soon as harvest of that crop is complete.

To prepare a nicotine spray use 1 teaspoonful of nicotine sulfate solution and 2 tablespoonfuls of soap to 1 gallon of water.

HARLEQUIN CABBAGE BUG

The harlequin cabbage bug is black, with bright red and white markings on its back and is about $\frac{3}{8}$ inch long when mature. The immature forms are also highly colored. Both the adults and the young injure plants by sucking the juice. The insect is a serious pest of cabbage and related plants. Feeding causes deformation, accompanied by whitish or yellowish spotting of the leaves. In heavy infestations the affected plants wilt, wither, and die.

Control of the harlequin cabbage bug is very difficult. Every effort should be made to keep it from becoming established. Wild radish and mustard are breeding plants and should therefore



Harlequin cabbage bugs must be killed as they do severe damage.

not be allowed to grow near a garden. Old cabbage, cauliflower, broccoli, or other cruciferous plants should be removed, since they furnish breeding and hiding places.

Hand-pick and destroy any bugs observed and also the egg clusters found usually on the underside of the leaves. A 10 per cent nicotine dust, or a strong nicotine and soap spray, is partially effective against the young, but not against the adults. A 0.75 per cent rotenone dust, or a 10 per cent sabadilla dust thoroughly applied is effective.

LEAFHOPPERS



Leafhoppers suck plant juices, and also carry virus diseases to many garden plants.

Leafhoppers are slender insects with the forewings thickened and often colored, and with minute bristle-like antennae. There are a number of species that attack garden plants. The adults are yellowish green to greenish and many species may have a definite color pattern. They range from about $\frac{1}{8}$ to $\frac{1}{4}$ of an inch in length. They are active jumpers, have a characteristic habit of running sidewise, and the adults are capable of rapid flight. The eggs are laid in the tender plant tissue. The young are wingless, pale in color, and are generally found on the undersurface of the leaves. Injury is caused by piercing and sucking out the plant juices. First evidence of attack is a white stippling due to the destruction of cells. In cases of severe attack this is followed by drying up and death of the attacked tissue. Besides direct injury, leafhoppers are the carriers of a number of very important plant virus diseases.

Among the garden crops that may be seriously attacked are potato, squash, beans, honeydew melons and related crops.

Control: In the garden it is not possible to destroy a sufficient number of leafhoppers to prevent the transmission of virus diseases. Sprays or dusts that contain pyrethrum, or organic phosphates, if thoroughly applied to all surfaces of the foliage, are effective against those leafhoppers that cause direct damage. A 3 or 5 per cent DDT dust results in excellent control, but may encourage an increase in the red spider population. Danger of red spider can be reduced if sulfur is incorporated in the dust. *A DDT-sulfur mixture should be used with caution as sulfur is likely to cause serious injury to some kinds of melons and related plants.*

MEALYBUGS (Aerial)

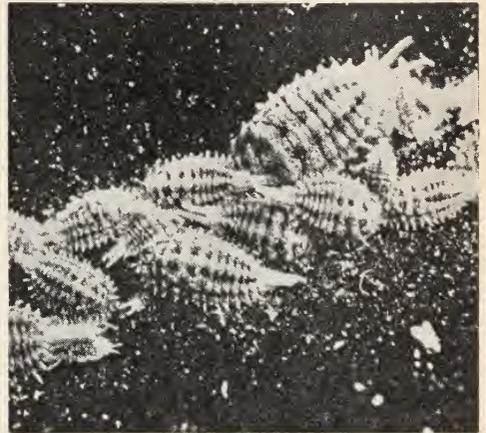
Mealybugs are among the most serious sucking pests of plant life. They are from $\frac{1}{8}$ to $\frac{1}{4}$ inch long, and have flattened, elongate, oval bodies which are covered with a white, powdery wax. This wax extends from the margins in a series of filaments, with usually two longer ones at the posterior end. They usually develop in colonies and are capable of slow crawling. They excrete large amounts of honeydew which not only attracts ants, but on which a sooty mold fungus grows. Breeding is most pronounced during the summer and fall, although the pest occurs on the plants during the entire year. They continuously injure house and greenhouse plants of all kinds.

The eggs, which are usually oval, pale yellow, or orange, are laid in cottony masses which may cover large areas of infested plants. Damage is done by the females. The mature males have abortive mouth parts and are tiny, white, two-winged insects with two conspicuous, long filaments at the tail end. During the mating season from near sunset to dusk on warm, bright days the males may be present in great swarms hovering in the air about plants infested by the females.

Control: Because of their waxy covering and the fact that many of them feed upon the roots in the soil, mealybugs are difficult to control. Summer oil emulsions, thoroughly applied to the tops of the plants, are effective. They should be used at the rate of 1 to $1\frac{1}{2}$ gallons to 100 gallons of water (3 to 5 tablespoonfuls to the gallon). To insure satisfactory results, the treatment should be repeated two or three times at intervals of 1 to 3 weeks. If other contact sprays are used such as organic

phosphates, the directions on the containers should be followed. Nicotine-soap sprays are of little value unless used in combination with oil sprays.

Many mealybugs and their eggs can be removed by hosing them off with a strong stream of water. If this treatment is repeated at intervals of every two to four weeks, the pests can often be held in check.



Above is a typical species of aerial mealybug with white, waxy body, growing in a colony on a flower stalk. Below, soil mealybugs may be found in masses around roots and are hard to control.

MEALYBUGS (Soil)

Ground mealybugs are very small and nearly white in color, due to a thin covering of white, powdery wax. They attack the roots of numerous plants including lawn grasses, practically all perennial shrubs and many annual plants. Where an infestation is heavy, the soil about the roots of plants will

contain white cottony masses. If these and the soil are carefully examined, the tiny, slow-crawling mealybugs no larger than a head of a pin can be seen. Injury to plants is caused by the sucking out of plant juices, which results in a weakening of the infested plants.

Control of soil mealybugs is very difficult. Where plants are growing, there is no highly satisfactory control. Some relief can be obtained by building a basin about the base of infested plants and thoroughly wetting with a nicotine-soap solution. Nicotine sulfate should be used at the rate of 2 teaspoonfuls to the gallon of water.

Where soil is known to be infested, control can be obtained by spading it and wetting it with a dichloroethyl ether solution. A dichloroethyl ether emulsion should be used at the rate of 3 teaspoonfuls to the gallon of water and applied to the infested ground at the rate of 3½ gallons to the square yard. The application should be made to moist soil, and should not be applied where plants are growing because the dichloroethyl ether is likely to injure them. Treated soil should not be planted for at least 3 weeks following the application.

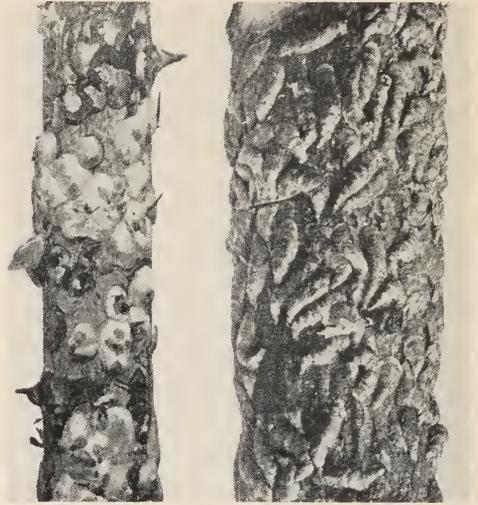
This insect thrives in unmolested soils. Cultivation is a very effective remedy wherever it may be employed. Repeatedly spading and turning the soil to dry out, or summer fallowing, will rid the areas of the pest.

It is readily brought into gardens on potted plants.

SCALES (Armored)

Armored scales, in general, are smaller than unarmored scales. Depending upon the species, they measure

from about ½ to ⅛ inch in diameter or length. They are protected by a thick shell or scale which covers the body, and range in color from nearly white or light gray to dark brown. The mature females may be oval, nearly circular, elongate, or oyster shell in shape. The male scales are much smaller



A thick shell protects these armored scales which suck out plant juices.

and often cannot be seen at all. Most species are flattened, although some are rather strongly convex. The scales when newly hatched are active and move about freely, but after the first molt they lose their legs and become stationary.

These scales injure plants by sucking the juice with their mouth parts which are adapted for this purpose. Some species inject a toxic substance into the plant, evidenced by a staining of the tissue about the scale, or by a rapid death of that part of the plant which is attacked. Unlike the unarmored scales, little or no honeydew is secreted. The pests are found most abundant on the stems and undersurface of the leaves, although they may also occur

on the fruit. There are from one to many generations a year, depending upon the species and the climatic conditions.

Control: On deciduous plants armored scales can be controlled during the full-dormant season, December to February, by thoroughly spraying with a winter or dormant oil emulsion, or even a summer oil emulsion, at the rate of 5 to 6 gallons to 100 gallons of water (16 to 20 tablespoonfuls to the gallon). In the growing season and on evergreen plants, summer oil emulsion sprays applied during the hatching period at the rate of from 1 to 2 gallons per 100 gallons of water (3 to 6 tablespoonfuls to the gallon) will control the pests. To insure satisfactory results, the applications should be repeated several times at 2 to 3 week intervals.

Contact insecticides, such as Black-leaf 40 and soap, will give some relief. For best results the directions as given for the summer oil emulsion should be followed. Wherever contact sprays are used, the directions as given on the containers should be followed. Where an infestation is localized on a plant, it is sometimes possible to remove the infestation by pruning.

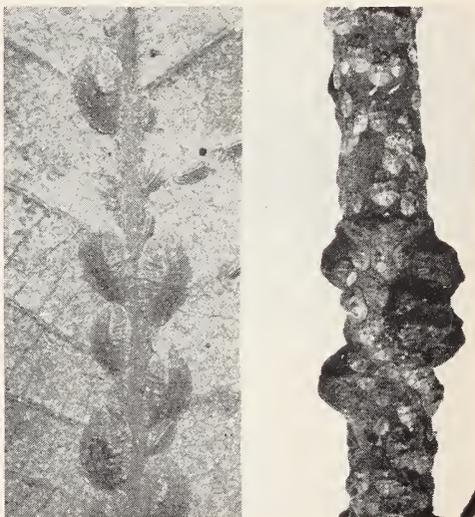
SCALES (Unarmored)

Unarmored scales are small insects with sucking mouth parts, and with the body protected with a rather soft shell. There are many economic species, and they vary greatly in shape. Some are oval and somewhat flattened, others oval and strongly convex, while others are nearly globular when mature. They are naked or partially covered with a powdery, waxy secretion. A few have an elongated, cottony egg sac. The

young can move about freely, but become more sessile (or attached) as maturity is reached, and many species are entirely stationary when fully developed. Most species secrete large quantities of honeydew which attracts ants, and on which a sooty mold fungus grows. A wide range of plants is attacked.

These scales are not a pest of vegetables or most annuals. Woody plants are chiefly attacked, and the scales are usually to be found in most abundance on the stems, branches, and undersurface of the leaves. Most species pass through two or more generations in a year, and the winter is spent in the immature stage.

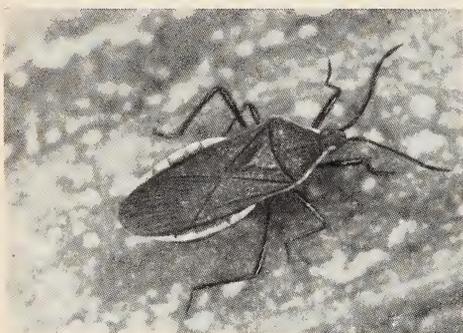
Control: On deciduous plants, unarmored scales can easily be controlled in the dormant season by thoroughly spraying with a winter dormant oil emulsion at the rate of 3 to 4 gallons to 100 gallons of water (8 to 12 tablespoonfuls to the gallon). During the growing season and on evergreen plants, summer oil emulsions may be used at the rate of 1 gallon to 100 gal-



The soft scales attack woody plants in particular, and secrete quantities of honeydew.

lons of water (3 tablespoonfuls to the gallon), or other contact sprays at the dosage recommended by the manufacturer. To insure satisfactory control in summer during the hatching period of the scales, several applications of the spray at two- to three-week intervals are necessary. If the infestation is localized, some relief can be obtained by pruning out the seriously infested portion of the plant.

SQUASH BUG



The squash bug is hard to control, and both adults and eggs should be destroyed.

Squash bugs are grayish-brown, somewhat speckled, sucking insects nearly $\frac{3}{4}$ inch long when mature. The visible margin of the abdomen as seen from above is orange or alternately striped orange and brown. The young at first are pale green with pinkish legs and antennae. Later, the forepart of the body is dark, and the rest becomes a pale grayish brown. The shining-brown eggs are usually laid in clusters on leaves and stems. Both the adult and the young suck the juices of plants. In serious infestations the plants wilt and die. These bugs are a serious pest of cucumbers, melons, pumpkins, squash, and related plants.

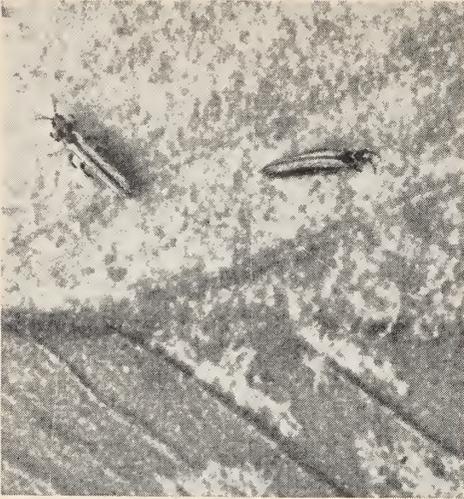
Control: The squash bug, like the harlequin cabbage bug, is difficult to

control; and every effort should be made to keep it from becoming established. The adults and eggs should be promptly hand-picked and destroyed. Squash and other host plants should be destroyed as soon as the harvest of that crop is complete. Spraying with a strong nicotine and soap spray (2 to 3 teaspoonfuls of nicotine sulfate to a gallon of water in which 2 or 3 tablespoonfuls of powdered soap has been dissolved), or dusting with a 4 per cent nicotine dust (10 per cent nicotine sulfate) kills many of the very young, but not the more mature and adult bugs. Pyrethrum dusts containing at least 0.2 per cent pyrethrins are somewhat effective against the young bugs. A 10 to 20 per cent sabadilla dust gives satisfactory control.

THRIPS

Thrips are small, slender insects, pale to nearly black, with mouth parts constructed primarily for sucking. They are about $\frac{1}{25}$ inch long and usually have two pairs of fringed wings, carried lengthwise over the back. Both the adults and the nymphs, or immature forms, of most species do damage. Their rasping and puncturing of the surface plant cells causes silvering of the leaves, fruit, and stems. Thrips have a habit of feeding in colonies. Attacked surfaces frequently become deformed, dry, and may drop.

Control: Thrips are controlled principally with contact insecticides such as nicotine and soap sprays. Use 1 teaspoonful of nicotine sulfate solution and 2 tablespoonfuls of soap to 1 gallon of water. Thoroughness of application is necessary. The treatment should be repeated every 10 days until the pest is thoroughly held in check. Organic



Thrips puncture plant cells causing silvering of leaves, fruit, stems.

phosphate sprays are also effective against thrips, as are DDT dusts and sprays. Destroy infested plants as soon as harvest is complete.

TOMATO PSYLLID

The tomato psyllid is closely related to aphids. It is about the same size as the latter and the adults resemble miniature cicadas. The eggs are very small, yellow, and are attached to the leaves by means of a short stalk. All damage is done by the scale-like nymphs or immature forms, which are yellowish orange to green in color, and flat and elliptical in shape. The nymphs are somewhat similar to those of certain whiteflies, and are normally found on the undersurface of the leaves. They have a row of wax glands. When abundant, the white wax which is secreted may be seen on the leaves and even on the ground about the plants. Nourishment is obtained by sucking up the cell sap.

Injury is caused by a toxic substance which is injected into the plant. This

causes a stunting of the plant and a yellowing and curling of the leaves; a condition known as "psyllid yellows."

The tomato psyllid attacks a number of different plants and is at times a serious pest of tomato and potato. Damage by the pest in California is localized and is limited to the cooler coastal regions.

Control: The tomato psyllid can be controlled with sulfur compounds. Treatment should be applied when the first evidence of infestation is detected, and should be repeated at two week intervals until the pest is thoroughly controlled. Dusting sulfur thoroughly applied gives good control. If a spray is desired, use one heaping tablespoonful of wettable sulfur, *or* three tablespoonfuls of liquid lime-sulfur and one tablespoonful of wettable sulfur, *or* a heaping tablespoonful of dry lime-sulfur to a gallon of water. The treatment as given for the control of aphids will also prove beneficial. In order to insure successful control, it is necessary that the insecticides be thoroughly applied, and that the pests on the undersides of the leaves be contacted.



Nymphs of the tomato psyllid are shown with white dots of excrement.

WHITEFLIES



The nymphs of the whitefly feed on the underside of leaves.

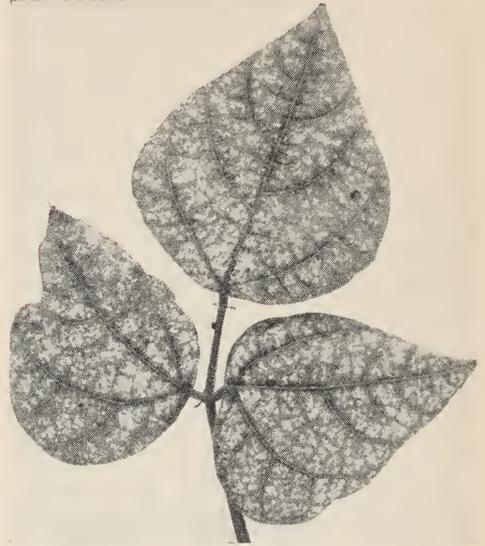
Whiteflies are sucking insects about $\frac{1}{16}$ inch long. The body and wings of the adults are covered with a fine, whitish, powdery wax, from which the name is derived. Although the adults feed, it is the scalelike nymphs, or immature forms, which cause the damage. They suck the cell sap from the plant tissue. In heavy infestations the leaves turn yellow, finally die and drop. The nymphs secrete quantities of honeydew, which attracts ants, and on which a sooty mold fungus grows.

Control: Whiteflies are controlled with contact insecticides. Oil-and-nicotine or oil-and-pyrethrum sprays are very effective. DDT sprays are effective, as are sprays that contain organic phosphates. All these are available as commercial preparations. A nicotine and soap spray is also of value. Since whiteflies occur mostly on the undersides of leaves, this undersurface must be thoroughly wet with the spray. Destroy infested plants as soon as harvest is complete.

RED SPIDERS

Red spiders are barely visible to the naked eye. Their color varies from very

pale yellow to orange, red, and greenish. They spin much webbing and are usually abundant on the undersides of leaves. They suck the cell sap from the surface tissue of plants. In severe infestations there is first a fine white stippling, then a yellowing of the infested parts, followed by complete destruction of the tissue. They do most damage during the warmest part of the year.



Stippling of the leaves is typical red spider damage. The tissue will then die.

Control: In the warmer interior valleys, red spiders can be controlled by thoroughly and evenly treating the infested plants with dusting sulfur. In the cooler coastal regions it may be necessary to spray with a 1 per cent light summer oil emulsion. The lower as well as the upper surfaces of the leaves must be thoroughly wet with the spray to insure satisfactory control. Infested plants should be destroyed as soon as harvest of that crop is complete. Indiscriminate use of DDT, DDD, and benzene hexachloride has resulted in serious increases in red spider population. The addition of $\frac{1}{4}$ to $\frac{1}{2}$ by volume

of sulfur to the commercial product will help control as well as prevent a buildup of this pest. Organic phosphate sprays are very effective in killing red spiders, but are not effective against the eggs, and so a second spray should follow after the eggs hatch, in 8 to 12 days.

TOMATO MITE

The tomato mite is free-living and microscopic. Under a magnifying glass this extremely small mite appears pear-shaped and whitish yellow. It crawls about slowly on the surface of the stems and leaves of the tomato plant, sucking the juices. These parts of the plant later appear brown or russeted. Starting on the stems near the ground, the infestation works up the plants gradually, causing the lower leaves to dry up and drop. In time the entire plant may be defoliated. This mite is among the most destructive tomato pests in California.

Control: The tomato mite is controlled by thoroughly and evenly treating the plants with dusting sulfur before serious damage occurs. As a rule



The lower leaves of this tomato plant are drying and dropping after mite injury.

the vines should be dusted between June 1 and July 15, and thereafter every 2 to 4 weeks. If the plant is also infested with worms, a dust mixture of sulfur and cryolite, or sulfur and calcium arsenate, or sulfur and DDT, or sulfur and DDD, may be used. If any of these dust mixtures are applied during the harvest period, the tomatoes must be washed or thoroughly wiped before being consumed. Sulfur has a harmful effect upon tomatoes that are canned, due to its action on the metal cans or lids, and because of this should be washed free of it.

Do not grow tomatoes near petunias, a favorite host of the mite.

ROOT-KNOT NEMATODE

The root-knot nematode, sometimes called "eelworm" or "garden nematode," is a microscopic worm which invades the roots of many garden plants and grows there as a parasite. The pest is widely distributed throughout California, and is particularly destructive in the warmer regions. It causes the formation of galls on the roots of susceptible plants. These galls interrupt the flow of sap so that the plants become unthrifty, grow pale, wilt, and sometimes die.

The root-knot nematode is usually most destructive in sandy soils. It is introduced into home gardens in infested seed potatoes, or on the roots of infested plants, or is carried in on infested soil.

Plants vary in their susceptibility to the root-knot nematode. Among the *less*-resistant hosts are such plants as beans, potatoes, tomatoes, melons, rose, snapdragon, and pansy. Such plants as corn, onion, strawberry, gladiolus, nasturtium, iris, lily, tulip, and narcissus are relatively resistant to attack.

When nematode injury is suspected, it can be determined by digging up the roots and examining them for galls. On most host plants the galls are conspicuous and occasionally grow to a diameter of an inch or more. Nematode galls are distinguished from the beneficial nodules of the nitrogen-fixing bacteria, which occur on leguminous plants. The latter are only loosely attached at the sides of the roots, while nematode galls involve all root tissues and cannot be separated from them.

Control: Where serious infestations of the root-knot nematode occur, resistant varieties of plants can be planted. Because warm weather is necessary for the nematode to be destructive, many susceptible plants can be grown in the winter at a time when the nematodes are least active.

Chemical control of the root-knot nematode in the home garden is possible. The treatment has certain limitations, but where properly applied successful control results. The most effective chemical is a soil fumigant which contains dichloropropene and is sold under the trade name of Shell D-D

and Dowfume N. These fumigants are packaged in containers for use in the home garden. Where used, the infested soil must be treated at least two weeks before the ground is planted. The mixture should never be applied closer than within 30 inches of growing plants. Where trees and shrubs are growing, never treat within the drip area of such plants.

A pint of the material is sufficient to treat an area of 175 square feet. The directions for use are given on the container and in a leaflet that can be obtained at the time the fumigant is purchased.

D-D must be used with caution. It is toxic to humans. If spilled on the skin, wash thoroughly with soap and water. Clothing that has become contaminated should be thoroughly cleaned before being worn again.

Another but less effective fumigant is ethylene dibromide which is sold as a 10 or 20 per cent concentration by volume. Direction for its use is given on the container and the *precautions as given for dichloropropene should be followed.*



Formation of galls on the roots of plants follows the infestation of nematodes. Resistant varieties, crop rotation and soil fumigation will help get rid of this pest.

WHAT SHOULD THE HOME GARDENER DO ABOUT *PLANT DISEASES?*

Diseases of vegetables and flowers may still prevent the satisfactory maturing of plants, even after the gardener has gone to extremes to control the insect pests.

There are many diseases to which home gardens are subject, but only a few which the gardener can do anything to remedy. This has led many experienced gardeners to dispense with most attempts at disease control. His reasons for this inaction are quite practical:

First, by the time symptoms of a disease are apparent, it is usually too late to do anything about it on the crop affected.

Second, there are many, many plant diseases, but most of them are specific diseases of a specific plant species. Similar symptoms on two plants do not necessarily mean the same disease is present in both. There are but few diseases which singly attack a number of different plants. This makes identification difficult and a control program complicated.

Third, growing conditions in California where the summers are dry, discourage many diseases which are troublesome in other parts of the country.

Fourth, there are a number of diseases, notably the viruses, for which no treatment is known.

What, then, should the home gardener do about diseases?

The Practical Plan

If the gardener wishes to make a specialty of a plant—perhaps roses or delphinium or dahlias—he will, of course, be interested in having the most vigorous plants and the most perfect blooms possible. He will go thoroughly into the culture of his specialty crop, and find the cause of and remedy for any unhealthy condition. He will know the diseases to which it is susceptible, and will be prepared to control them at the first symptom.

But the usual home gardener, who grows a diversity of flowering plants and vegetables, will be content with a simple and practical program, built around the following points:

1—Buy seed of disease-resistant varieties whenever such strains have been developed.

2—Rotate crops as a general practice. Particularly after removing diseased annuals, plant other species in that location for several years.

3—Where annuals have become diseased, pull up the plants and burn them.

4—Some plants just don't do well in certain areas. If the natural growing conditions are unfavorable to growing a healthy plant of one variety, be practical—grow something else.

5—Control, by dusting or spraying, a few of the commonest diseases which can be readily treated, and **DON'T WORRY** about the rest.

Types of Diseases

The plant diseases fall into three general groups: virus diseases, bacterial diseases, and fungus diseases. These are

The authors are indebted to C. Emlen Scott, Extension Specialist in Plant Pathology, for assistance in the preparation of this section.

caused by specific organisms, and are in addition to deficiency diseases caused by the lack of certain elements, or poor growth due to climate or soil conditions.

Diseases caused by viruses have no known cure. Only very rarely have they been reduced by controlling the insects which carry them (mosaics, carried by aphids; spotted wilt, by thrips; curly-top by leafhoppers).

Many bacterial diseases, including numerous wilts and blights, are seed-borne. Western seeds are comparatively free of the bacteria.

Fungus diseases include those most familiar to the gardener: powdery mildews of rose, sweet pea, and cucumber; rusts of snapdragon and bean; leaf spot of carnation and iris; as well as many other wilts, blights, and rots.

Fungicides and Their Use

The fungus diseases are combated by fungicides which may be mixed at home, or purchased at the garden supply store.

The active ingredient in the fungicide—that is, the part which actually effects the control—is often a very small amount of one of the elements: copper, sulfur, or mercury. This small amount is mixed with other ingredients to help spread it and make it stick.

Copper is usually used in the form of

bordeaux mixture as a spray, as copper-lime dust or copper carbonate dust.

Sulfur is used largely as a dust in its pure form. It also comes as wettable sulfur or lime-sulfur solution for spraying.

Mercury most frequently is used in a form known as corrosive sublimate (mercury bichloride), which is made into a solution. The organic mercuries, which are widely used, are Semesan and Ceresan.

Combination Sprays

There are now on the market several combination sprays which are advertised to control fungus diseases at the same time as insect pests. The gardener should read the labels on these to see what their claims and limitations are.

In developing combination insecticides and fungicides, the word "incompatibility" has come to be used. This means that when certain materials are combined one or both of two things may happen: a harmful substance may be formed or freed, causing injury to plants; a useful ingredient may be removed and effectiveness lessened.

For this reason the home gardener would be well advised to apply fungicides alone, as suggested on these pages, or to use the commercial mixtures strictly as directed, rather than to combine—with disappointing results—the insecticides and fungicides.

A MINIMUM DISEASE-CONTROL PROGRAM

On pages 37-39 are given the treatments for the most common diseases of the most common plants. *Suggestions are made only where a disease has been found, in California, to become serious enough to destroy the beauty of flowers or prevent development of vegetables to a satisfactory maturity.* Other diseases may be so minor as to make con-

trol impractical by the home gardener.

Only those diseases are given which can be treated with a chemical application. Many other diseases may exist which the gardener will have to remedy by planting disease-resistant varieties, and by practicing crop rotation.

The table may be considered a guide to a *minimum disease-control program.*

Formulas for Sprays

Bordeaux Mixture

Various concentrations of bordeaux mixture are used for different purposes. The following concentration is meant wherever bordeaux mixture is mentioned in the accompanying table:

Copper sulfate (bluestone). 4 ounces

Hydrated lime..... 4 ounces

Water..... 3 gallons

Dissolve the bluestone in a little hot water, using a wooden, earthenware or glass container. Dilute with half the water specified. Make a paste of the lime and add the other half of the water. Pour the two solutions together and mix thoroughly. Strain through cheesecloth directly into sprayer. This mixture should be made fresh each time it is used.

Commercial brands of bordeaux powder, and other insoluble copper compounds, are on the market. Follow directions carefully for their use.

Lime-Sulfur Spray

Commercial lime-sulfur solution is purchased and then diluted in cold water to the proper strength. A 1 per cent lime-sulfur spray means 1 part prepared solution to 100 parts of water. From 1 per cent to 3 per cent is usually the strongest concentration to be used on foliage, since it is very caustic. It may be used stronger in winter on dormant trees or roses.

In order that the information in our publications may be more intelligible it is sometimes necessary to use trade names of products or equipment rather than complicated descriptive or chemical identifications. In so doing it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.

A MINIMUM DISEASE-CONTROL PROGRAM

Garden Vegetables

CROP	DISEASE	TREATMENT
Beans	Powdery mildew Rust	Dust with sulfur. Sulfur dusting or spraying does some good. Better to get disease-resistant varieties.
Carrots	Late blight (carrots planted in August may become infected)	Keep tops completely covered with bordeaux mixture throughout growing season. Thoroughly spray 4 weeks after sowing and thereafter once a week.
Cucurbits: cantaloupe cucumber honeydew muskmelon pumpkin squash watermelon	Leaf blight Rust Anthracnose (leaves show black spots which enlarge and kill blade) Powdery mildew	Thoroughly spray with bordeaux mixture as soon as any leaf spotting is seen. On cucumbers and honeydew melons dust lightly with sulfur. On other cucurbits do not use sulfur, as it injures the plants.
Onion	Downy mildew (spots of violet-colored fuzz appear on leaves and stalks. The tissue fades and dies)	Spray at first appearance with lime-sulfur.
Pea	Downy mildew Powdery mildew	Preventive spray of bordeaux mixture before mildew develops. No treatment helps after mildew is seen. Dust with sulfur before the disease appears; or use lime-sulfur spray.

Flowering Plants

CROP	DISEASE	TREATMENT
Chrysanthemum	Powdery mildew	Dust with sulfur, or spray with a 1 per cent lime-sulfur spray.
	Rust	Dust with sulfur. Plant disease-resistant varieties.
Dahlia	Powdery mildew	Dust with sulfur, or use lime-sulfur spray.
Delphinium Larkspur	Bacterial blight	Plant disease-free plants and seeds.
Freesia	Stem rot, corm rot	Soak corms in 1:1,000 corrosive sublimate for 2 hours before planting. Use tablets which can be purchased from the druggist; 1 tablet dissolved in a pint of water is the right proportion. For larger quantities dissolve 1 ounce in 7½ gallons of water. Mix in wooden or earthenware container. <i>This chemical is deadly poison when taken internally.</i>
Gerbera	Powdery mildew	Dust with sulfur, or use lime-sulfur spray.
Gladiolus	Stem rot, corm rot	Soak in corrosive sublimate solution as described for freesia.
Lilac	Mildew	Dust with sulfur, or use lime-sulfur spray.
Narcissus	Leaf scorch (blighting of foliage starting at tip)	Spray with bordeaux mixture.
Phlox	Powdery mildew	Dust with sulfur, or use lime-sulfur spray.

Rose

Anthracnose
Black spot
Bud blight
Powdery mildew
Rust

A systematic program will do much to control all these common diseases, and also aphids, which are the most troublesome pest.

1. Spray bushes when dormant with lime-sulfur solution, a scant pint to 1 gallon of water; or with bordeaux mixture.
2. After growth starts in the spring, spray regularly every week or two, or when diseases and insects appear, with a solution of

1 1/2 tbs. lime-sulfur solution
 1 tbs. Dreff
 2 scant tsp. Black Leaf 40
 1 gallon water

Fermate added to this mixture according to directions on the package will materially reduce rust.

If injury to foliage appears, reduce amount of lime-sulfur.

3. A slightly less-effective treatment than No. 2 is to dust with dry sulfur combined with nicotine dust, or supplemented by nicotine spray.

Snapdragon

Downy mildew

Spraying with bordeaux mixture may help, but the cause is poor ventilation and high humidity.

Rust

Plant disease-resistant varieties. Spray with a dilute lime-sulfur solution.

Sweet pea

Powdery mildew

Dust frequently with dry sulfur, or use lime-sulfur spray. You may combine sulfur dust with nicotine dust to control aphids.

Zinnia

Powdery mildew

Dust with sulfur, or use lime-sulfur spray.

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J. Earl Coke, Director, California Agricultural Extension Service.