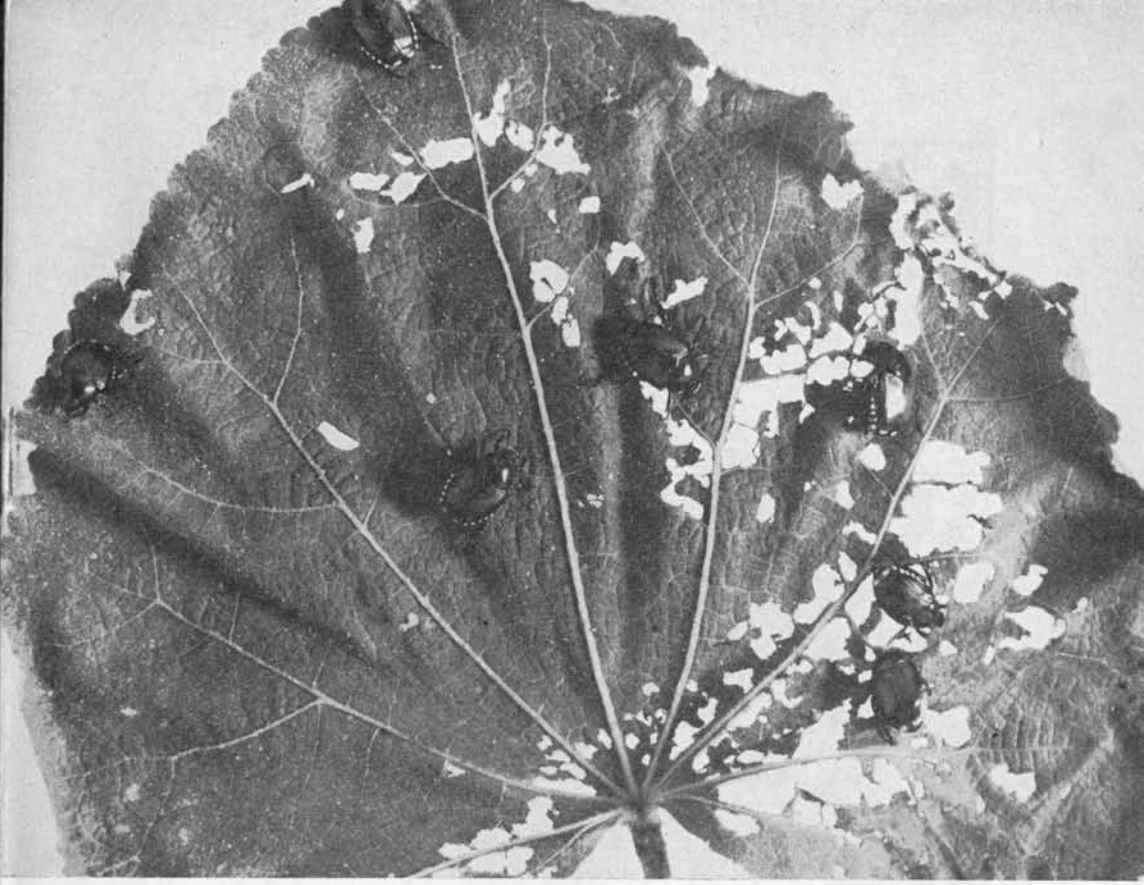

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of the

Japanese Beetle

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONNECTICUT

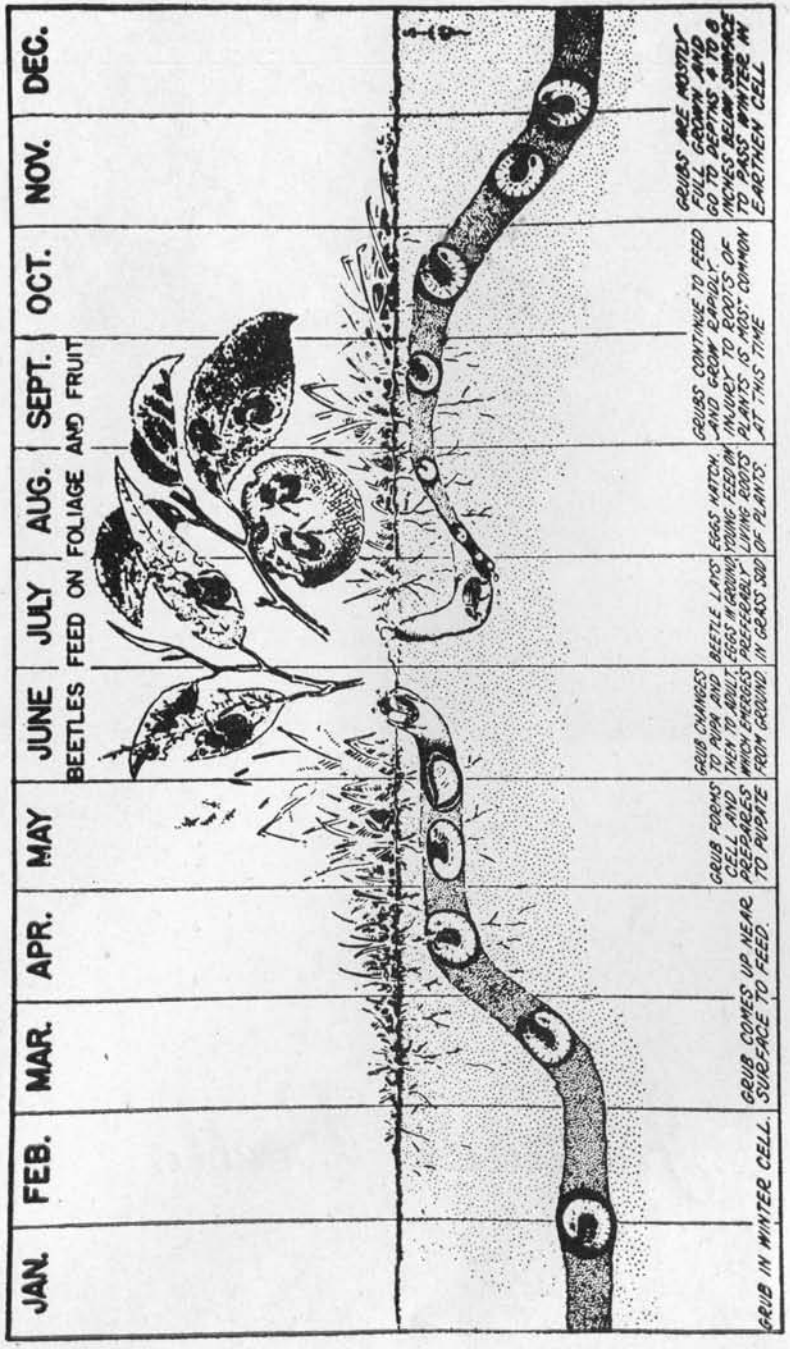

Diagram showing the seasonal life cycle of the Japanese beetle.
(After Bureau of Entomology and Plant Quarantine, U. S. Dept. of Agriculture.)

CONTROL of the *Japanese Beetle*

JOHN C. SCHREAD

Adult Japanese beetles begin to emerge in Connecticut about June 20 and in years of high temperatures and heavy rainfall increase in abundance quite rapidly during the first ten days to two weeks of July. However, in an average year the adult population does not reach its peak until late July and early August. From then until early September its numbers dwindle and, as the days grow cooler, the adults disappear entirely. During a warm autumn an occasional beetle may be seen as late as the latter part of October.

As the adults emerge from the ground, they crawl or fly to nearby vegetation and begin to feed. Some 250 to 300 plants are known to be attacked, including herbaceous plants, shrubs and trees. When the beetles are present in abundance, they may completely defoliate them and also destroy the flowers or fruit. On clear warm days adult Japanese beetles feed from about ten o'clock in the morning until about three in the afternoon, largely on the upper and outer parts of trees and tall growing plants in direct sunlight. Earlier and later in the day feeding is confined mostly to vegetation nearer the ground level. On cool cloudy days activity is at a minimum or entirely absent.

When the weather is warm and clear the beetles display extreme activity. They fly from plant to plant and frequently assemble in large numbers on one plant species and even on a single plant. Mating begins soon after the adult beetles leave the ground and continues intermittently throughout the life of the individual. Females prefer to deposit their eggs in thrifty well-kept turf such as occurs most commonly in parks and athletic fields and on golf courses and home lawns. Eggs may occasionally be deposited in cultivated ground, especially flower beds. An average of 50 eggs is laid per female during a life span of about five weeks.

When adequate soil moisture is present the eggs swell to twice their original size and at developmental temperatures hatch in ten days to two weeks. Larvae feed on roots of grass and other plants, mostly close to the surface of the ground. Each of the first two larval instars (stages) requires a feeding period of about three weeks. The third instar is reached in late September or early October. In a normal season the insect passes the winter in the third instar in an earthen cell several inches or more below the ground level. Occasionally a larva passes the winter in the second and even less frequently in the first instar. On very rare occasions an egg deposited very late in the season may go through the winter as such; however, none has been known to hatch the succeeding spring.

After completing their feeding period in the spring and prior to pupation, the larvae enter a 10-day prepupal stage during which time profound internal changes take place preparatory for pupation. The insect remains in the pupal state for 18 to 21 days. The adult then breaks the pupal skin, works its way to the surface of the ground and crawls or flies to nearby

vegetation to feed and mate. One year is necessary for the completion of the entire life cycle.

Japanese beetle grubs (larvae) occurring in abundance in turf (12 or more per square foot) may frequently result in complete destruction of the sod. The root system is destroyed by the insects, depriving the crowns of the grass plants and foliage of an adequate food and water supply, with the net result that the grass turns brown and dies. Severe damage is especially noticeable during dry periods.

It is quite obvious from what has been said above that the control of Japanese beetles involves two stages of the insect, the adult and the larva, with different habits. The control of either stage on an individual property will not guarantee the absence of the other. For example, you may spray the shrubs, trees and flowers to protect them against adult beetles and attain excellent results. This will not assure you of absence of larvae in the lawn because the adults may fly in from the vicinity and lay their eggs before being poisoned. Moreover, the elimination of a high grub population in the lawn will not insure freedom from injury by adults to the flowers, shrubs and trees for the same reason. It has been the general experience, however, that any reduction in the adult population in a given area means some reduction in the larval population in the turf, and vice versa. Hence, a logical system of control involves the application of insecticides to prevent beetle breeding on the premises as well as to protect vegetation.

CONTROL OF ADULT BEETLES

The adult population may be controlled by either DDT or Chlordane used as a 50 per cent wettable powder. The former used at the rate of 4 level teaspoons to a gallon of water and the latter at the rate of 2 level teaspoons to a gallon of water sprayed on vegetation at weekly intervals from July 1 to September 1 should give ample protection throughout the season. DDT may also be used as 5 per cent dust. When heavy rains follow application of these insecticides, it may be necessary to repeat the treatments more often.

It is not entirely necessary that all plants, shrubs and trees on premises be sprayed with each treatment. A saving of time and money is assured when only the vegetation on which the adults have assembled is sprayed consistently throughout the season. This treatment should include evergreens where the beetles may rest in abundance but usually do not feed. Owing to their gregarious habits the beetles frequently converge in large numbers on a single specimen of one of their favorite food plants to the exclusion of other members of the species in close proximity. Such a phenomenon may result in virtual defoliation of the plant attacked (while others are hardly touched) unless the foliage is protected by an insecticide.

When the toxicants are sprayed or dusted on edible crops, allow at least four weeks between the last spray and time of harvest. In any case, wash treated vegetables and fruits before using. It is not advisable to use the insecticides on leafy crops such as lettuce, spinach, Swiss chard, cabbage, etc., as the toxicants may become so thoroughly imbedded in the folds of the leaves that no amount of washing will remove them completely. DDT should not be used on cucurbits or tomatoes, nor should Chlordane be used on the former, as the materials are toxic to these plants.

CONTROL OF LARVAE

Control of Japanese beetle grubs is accomplished principally by means of chemicals. Comparatively recent developments in the insecticide field have provided several toxicants which have been demonstrated as readily adaptable for control of these grubs in turf.

DDT

Experiments have shown that DDT will not only reduce Japanese beetle grub populations when applied to infested turf, but will give five or more years of residual protection from re-establishment of the insects. A 10 per cent DDT dust used at the rate of 250 pounds to the acre or 6 pounds to each 1,000 square feet of grub-infested lawn, applied by a hand-operated or tractor-drawn fertilizer distributor, will give desired control. A 50 per cent wettable powder may also be used at the rate of 50 pounds in 1,000 gallons of water to the acre or 1 1/5 pounds in 25 gallons of water to 1,000 square feet of turf. Further reduction would be 8 level teaspoons in 1 gallon of water applied to 40 square feet of lawn area. Treatment may be made at any time when the ground is not frozen, preferably prior to early May or in late summer. If application is delayed in the spring, serious grub damage may occur before the insecticide becomes effective. When the insecticide is employed in early autumn, the grub population may have been sufficiently inactivated by low soil temperatures to allow the grubs to be only slightly if at all affected by the treatment until the following spring. Whenever a grub population is relatively small (5 or less per square foot of turf) grub-proofing to prevent further increase for a period of five or more years may be accomplished through the use of DDT as described. If the insecticide is applied to turf in the spring to control the current generation of grubs, this should be done by the middle of April so that no serious injury will develop.

Figure 1. Larvae of the Japanese beetle. In the badly-infested turf area where the picture was taken, there were 585 grubs per square yard.

Application of DDT, or any other soil insecticide, should be timed to precede a rainstorm, or

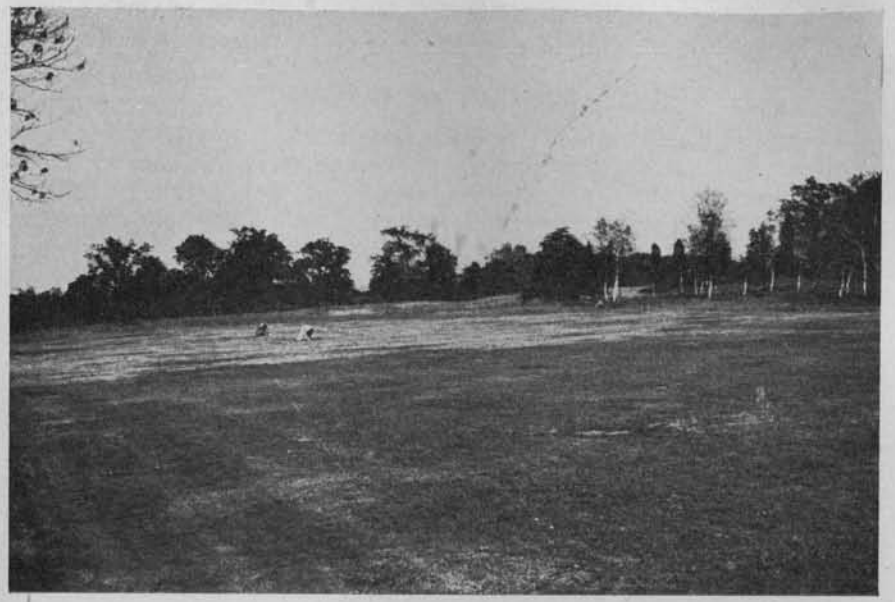

Figure 2. Golf fairway showing effect of DDT treatment for Japanese beetle grubs. Area in foreground was treated with DDT; light area in background is dead grass that was untreated.

a garden sprinkler should be employed to wash the insecticide into the turf. Such precautions are suggested to protect man and animals from the insecticides.

Chlordane

Chlordane has been demonstrated as a remarkably fast acting and dependable control when applied to turf. It may be applied as a 5 per cent dust at the rate of 200 pounds to the acre or 5 pounds to 1,000 square feet of turf. It may be used also as a 50 per cent wettable powder at the rate of 20 pounds in 1,000 gallons of water applied to the acre or ½ pound in 25 gallons of water to 1,000 square feet of turf. The latter may be further reduced to 7 level teaspoons of powder in 1 gallon of water applied to 40 square feet.

In treating a small home lawn with 5 per cent dust the insecticide may be applied as packaged or by diluting with fertilizer at the rate of 1 pound of dust to 2 pounds of fertilizer. A two- to three-foot hand-operated fertilizer distributor may be used to make the treatment.

Large scale treatments such as are sometimes required on golf courses, in parks, on ball fields, etc., may be adequately made (using straight 5 per cent dust or diluted with fertilizer at the aforementioned ratio) by using an eight- or ten-foot fertilizer distributor drawn behind a tractor or other mobile equipment convenient for the purpose.

Treatments will give fastest results if timed to precede a rainstorm or, when applied on a small scale, if artificial watering follows the treatment.

Furthermore, ample protection of children and household pets playing on a lawn treated with Chlordane, or other insecticides such as DDT or lead arsenate, is assured when copious amounts of water are used to wash the toxicant from the grass foliage into the soil.

Chlordane may be applied to turf at any time of the year when the ground is not frozen, preferably, however, in early spring. If treatment is delayed until late May, several successive drenchings of the turf with clear water after the insecticide is applied will give quick and satisfactory mortality of the grub population before irreparable destruction of the turf ensues. Treatment applied to a current infestation in late summer or early autumn will usually prevent severe fall injury to the grass. When Chlordane is applied to turf or cultivated land, agricultural lime should not be used at the same time.

As yet it is not known exactly how long the toxic effect of Chlordane may last in the soil, at the most perhaps not much beyond a year or two. It will, however, give notably quicker relief from grub infestations than other insecticides now available for general use. Consequently, Chlordane may be used when a fast-acting toxicant is essential to save turf from destruction, or it may be used in general grub-proofing practice where long time protection of turf is of minor importance.

Lead Arsenate

Lead arsenate as a control for grubs has been largely replaced by DDT and Chlordane. However, it may be used at the rate of 435 pounds to the acre or 10 pounds to each 1,000 square feet of turf. Although a heavy grub population may not be exterminated, the bulk of the population will be destroyed by the treatment, thus preventing noticeable and permanent damage to the turf. A light infestation may disappear completely. The object is to use only enough lead arsenate to kill the grubs and not enough to damage the plants growing in the soil. The material may be applied at any time, preferably in the spring when temperatures are high and the ground is not frozen, or in the early summer before Japanese beetle eggs hatch. Application of lead arsenate to turf as a spray under pressure or as a dust, watered in with a garden hose, are methods which have proved equally successful.

As in the case of DDT and Chlordane, lead arsenate should not be used if the soil is not kept in turf because of the possible adverse effect on certain plants. Consequently, soil treated with these insecticides should not be planted to vegetables or flowers. Lead arsenate kills earth worms; neither DDT nor Chlordane affects the earthworm population as seriously.

"Milky" Disease

The customary method of application of the "milky" disease spore dust of Japanese beetle grubs is to spot the material at three- to five-foot intervals in rows three to five feet apart, using a level teaspoonful of the spore dust per spot. The spore dust may also be mixed with loam, sand, lime, fertilizer or soil insecticide and spread evenly over the surface of the ground by hand or by means of a hand- or tractor-drawn fertilizer dis-

tributor at the rate of one pound of spore dust to 4,000 square feet of turf. If application is not made preceding rain, the spore dust should be washed into the soil with a garden hose, thus assuring greatest survival of the bacteria. Applications of spore dust may be made at any time of the year when the ground is not frozen. However, for best results, early fall application is preferred. When the spore dust is applied to a rapidly rising grub population, it cannot be expected to check the grubs sufficiently to prevent serious injury to turf. Under most conditions three or more years seem necessary for the "milky" disease to become effective.

Insect Parasites

The natural enemies of the Japanese beetle include a number of insect parasites, most of which have been imported from the native habitats of the beetle in Japan and Korea. Virtually all of them have become established in various parts of the area of continuous beetle infestation in the United States.

There are two species of introduced wasp-like parasites, *Tiphia vernalis* and *T. popilliavora*. Both species attack and destroy Japanese beetle grubs in the soil. The first of the two species occurs as an adult from early May through early June and the second species throughout August and early September. A large number of colonies of the two parasites have been released in Connecticut. They are well established and are increasing in abundance each year. They may be an important factor in grub reduction if they become widely enough distributed.

Another introduced species, *Centeter cinerea,* closely resembling the common house fly in appearance, is parasitic on adult Japanese beetles. Centeter appears as an adult from late June until about August first. It deposits its eggs on the upper surface of the beetle and the young which hatch gnaw their way into the body cavity of their host and destroy it. This parasite is well established at a number of points throughout the State and shows remarkable promise as a potentially important natural control of the Japanese beetle in Connecticut. At the present time the distribution of insect parasites of the beetle is being handled only by Federal and State agencies.