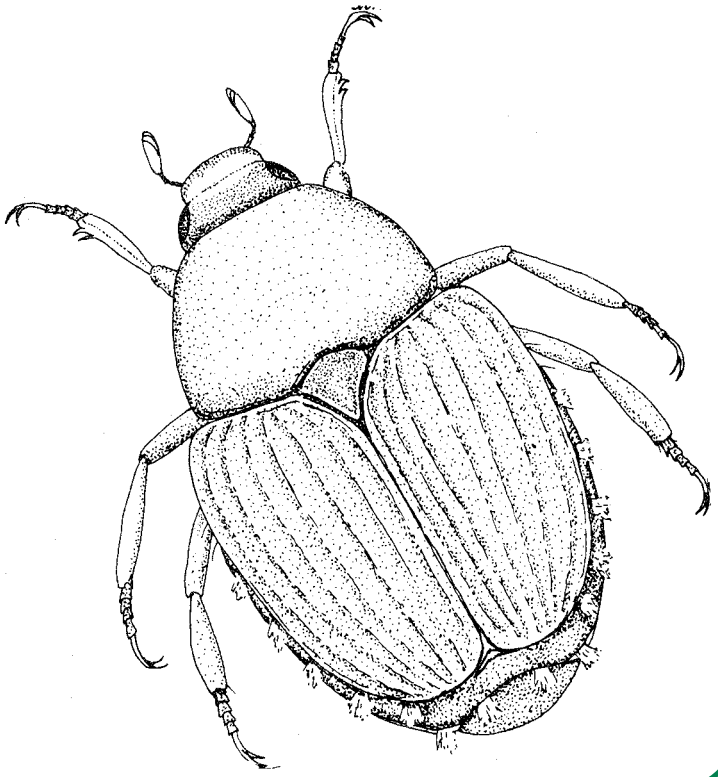
Agricultural Extension Service
The University of Tennessee

PB946

The Japanese Beetle and Its Control



Acknowledgments

Appreciation for assistance in the production of the original printing is gratefully extended to Lyle Klostermeyer, who provided assistance in the procurement of information relative to the biology, habits and infestation levels of the beetle in Tennessee; Sue Hope for the illustrations of the various stages of the Japanese beetle; to the USDA research staff for technical assistance provided in publications on the Japanese beetle; and Gray Haun of the Tennessee Department of Agriculture for regulatory information.

We also extend our appreciation to Kara Kenney, Sue Gardner and Jenny Croker for typing, scanning or editing several sections of this manuscript. The layout and design were prepared by Callie McPherson.

Table of Contents

The Japanese Beetle and Its Control

Karen M. Vail, Associate Professor, Frank Hale, Associate Professor, and Harry E. Williams, Professor Emeritus, Entomology and Plant Pathology, The University of Tennessee, and formerly by Catharine Mannion, Research Entomologist, Tennessee State University

The Japanese beetle, *Popillia japonica* Newman, has been in the United States since 1916 and in Tennessee since 1936. Adult beetles severely damage some ornamental plants, shrubs, garden plants and field crops (Figure 1). The immature stages feed on roots of grasses and other plants. Approximately 80 Tennessee counties are infested with established populations (Figure 2), although there is no geographical or climatic barrier that will prevent the spread of the beetle into all 95 Tennessee counties.

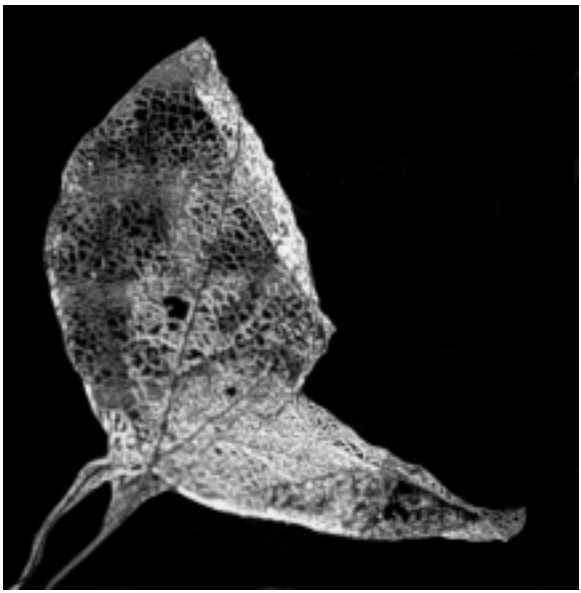
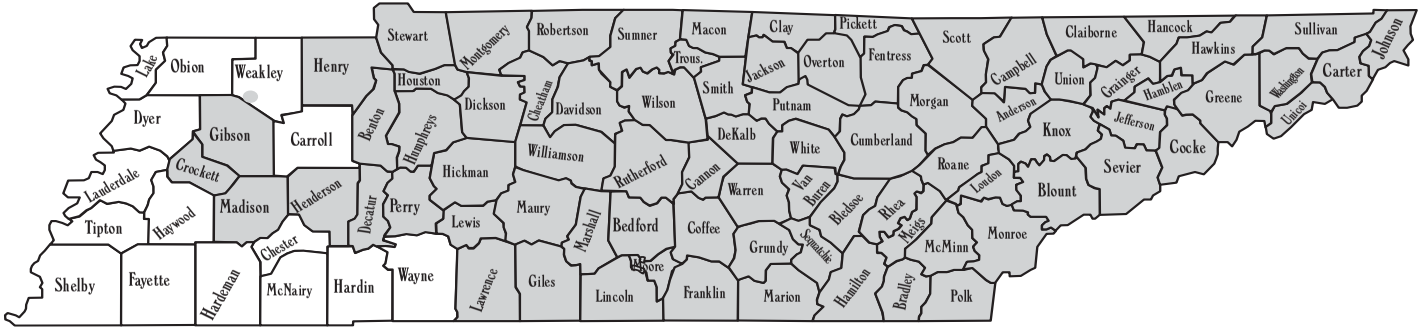


Figure 1. Adult Japanese beetles chew the leaves between the veins, leaving a lace-like skeleton. *Photograph by Frank Hale.*

Figure 2. Japanese beetle-infested areas of Tennessee in 1997.

= Japanese beetle-infested areas



Anderson
Bedford
Benton
Bledsoe
Blount
Bradley
Campbell
Cannon
Carter
Cheatham
Claiborne
Clay
Cocke
Coffee
Crockett
Cumberland
Davidson
Decatur
Dekalb
Dickson
Fentress
Franklin
Gibson
Giles
Grainger
Greene
Grundy
Hamblen
Hamilton
Hancock
Hawkins
Henderson
Henry
Hickman
Houston
Humphreys
Jackson
Jefferson
Johnson
Knox
Lawrence
Lewis
Lincoln
Loudon
McMinn
Macon
Madison
Marion
Marshall
Maury
Meigs
Monroe
Montgomery
Moore
Morgan
Overton
Perry
Pickett
Polk
Putnam
Rhea
Roane
Robertson
Rutherford
Scott
Sequatchie
Sevier
Smith
Stewart
Sullivan
Sumner
Trousdale
Unicoi
Union
Van Buren
Warren
Washington
a portion of Weakley
White
Williamson
Wilson

The Adult Beetle

The adult beetle is a broadly oval insect nearly one-half inch long and one-fourth inch wide (Figure 3). The body is a bright metallic green with the legs a darker shade of green. The wing covers (elytra) are a coppery brown and extend almost to the tip of the abdomen. There are two small tufts of white hair just behind the elytra on the last abdominal segment and five tufts of white hair along each side of the abdomen. The under surface is covered with short gray hairs.

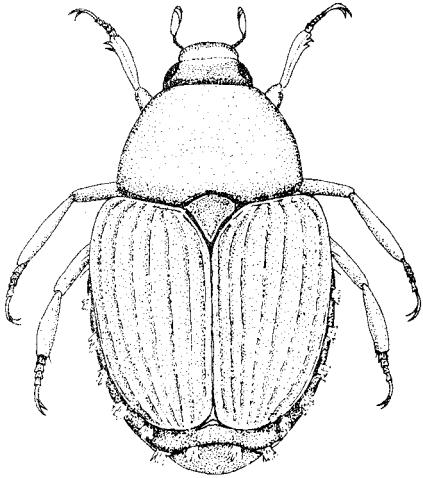


Figure 3. The adult Japanese Beetle (5X).

Both sexes have the same coloring and markings, but the males are usually smaller than the females. The shape of the tibia and tarsus of the first pair of legs can distinguish the sexes. The tarsus of the male is slightly shorter and stouter than the tarsus of the female. The tibial spur of the male ends in a sharp point, while the tibial spur of the female is longer and more rounded (Figure 4).

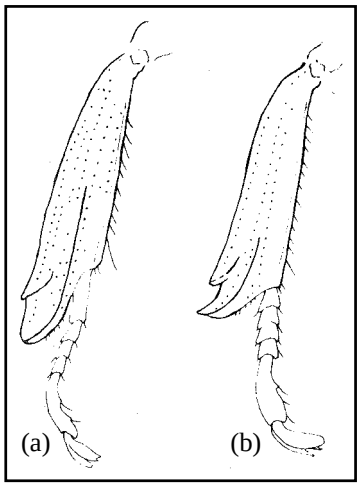


Figure 4. Front leg and tarsi of the Japanese beetle greatly enlarged, showing the difference between (a) female and (b) male beetles.

The Egg

Eggs vary in color from translucent to creamy white and under high magnification, the surface appears to have tiny hexagonal punctures. Newly laid eggs are ellipsoidal and measure about 1/20 to 1/16 inch in diameter. As the egg matures, it absorbs water, causing it to swell. The egg eventually doubles in size and becomes almost spherical in shape. At this time, the developing embryo can be seen through the shell. Eggs hatch in about 10 days to two weeks after they are laid, depending on temperature.

The Grub

A completely white grub, about 1/16 inch long, with chewing mouthparts, emerges from the egg. Each of the three thoracic segments has a pair of legs, and there are 10 abdominal segments. The last two rows of spines on the ventral side of the last abdominal segment, or the raster, are arranged in the shape of a 'V', a characteristic that distinguishes Japanese beetle from other scarabaeid grubs in the United States (Figure 5). The closed end of the V is towards the anterior end of the grub and the open end of the V is towards the posterior end of the grub.

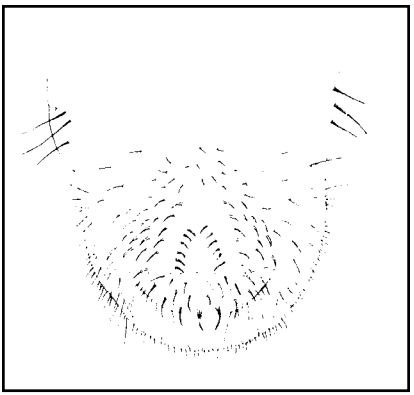


Figure 5. Arrangement of hairs and spines on the underside of the last body segment of Japanese beetle grubs. The inverted 'V' shape arrangement of the last two rows of spines distinguishes this grub from all other grubs.

The color of the grub's head changes from white to yellowish-brown within a few hours after hatching. The grub is usually found in an earthen cell, curled in a crescent shape. As the grub grows and feeds on organic matter and fibrous roots, the accumulations of fecal matter in the hindgut give the posterior of the abdomen a grayish-black appearance.

The grub continues to feed and grow, passing through three instars to become a mature grub. The average length of the first, second and third instar is about 1/4, 1/2 and 1 inch, respectively. When mature, the grub ceases to feed and ejects any accumulated fecal material. The body gradually becomes pale and shrunken. This prepupal stage is a semi-active condition between the grub and pupal stage.

The grub remains in the soil for approximately 10 months. Development through the three instars requires about 136 days at a constant 25 C (78 F). The first instar lasts two to three weeks and the second instar lasts three to four weeks. Most of the grubs become

third instars (Figure 6) in the fall and reach full maturity the following spring. Within the earthen cell, the grub passes through the prepupal stage in about 10 days. Because the grubs are sensitive to dry conditions, there must be 10 inches or more rainfall evenly distributed during the summer months for the grubs to develop normally.

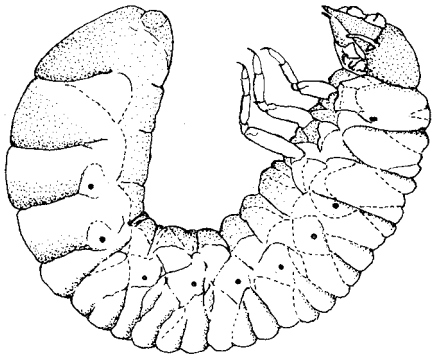


Figure 6. Full-grown Japanese beetle grub (6X).

The Pupa

The grub transforms into a pupa within the old larval and prepupal skin. The pupa resembles the adult beetle, except that the legs, antennae and wings are closely folded to the body (Figure 7). The pupa is about 1/2 inch long and 1/4 inch wide. The body, which at first is a pale cream, gradually becomes a pronounced tan before turning into the metallic green of the adult.

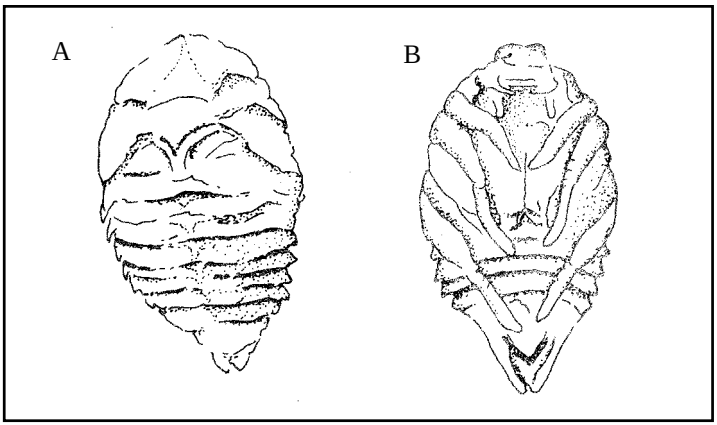


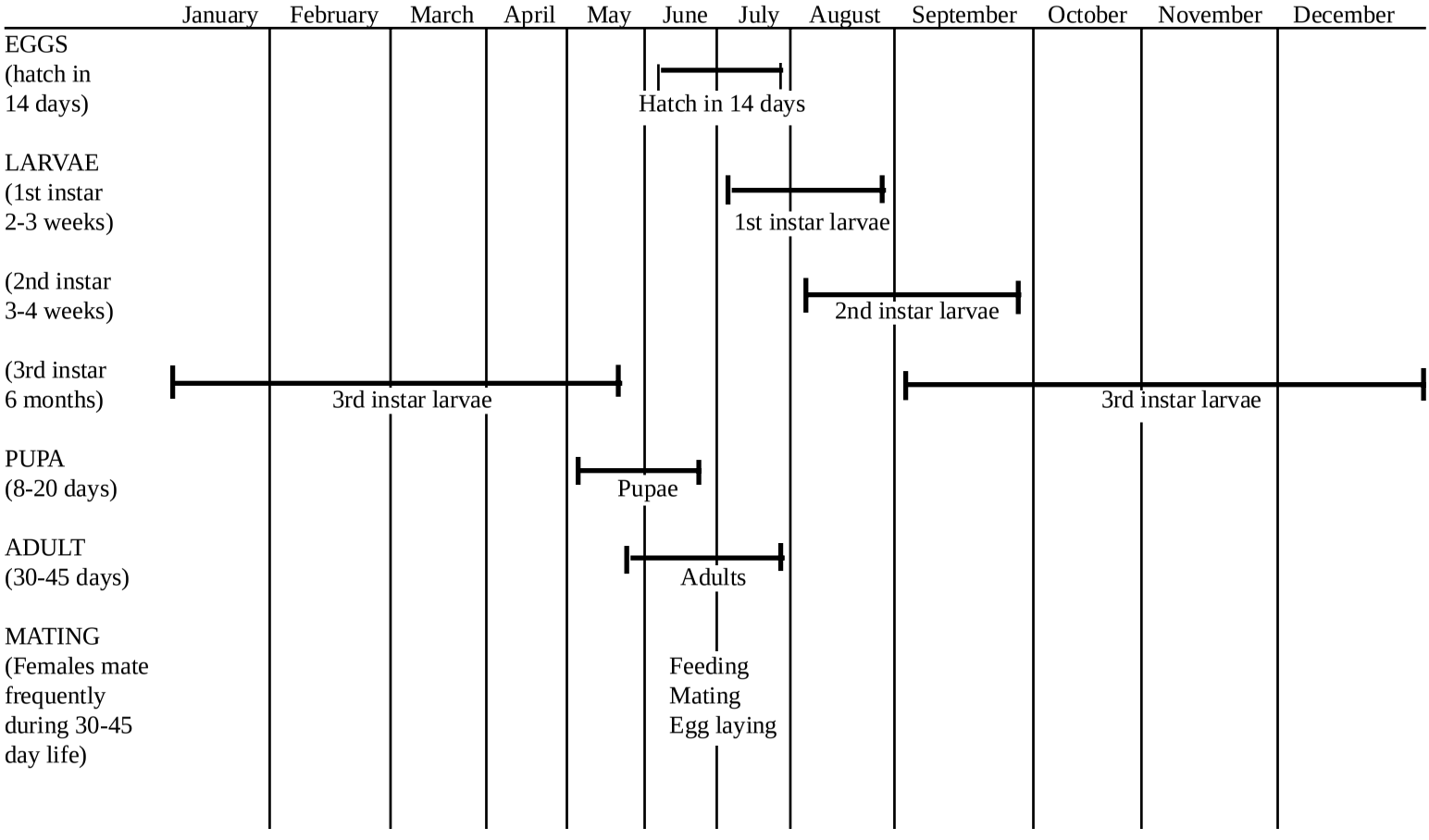
Figure 7. Pupa of Japanese beetle (4X).

When the change from pupa to adult is complete, the adult beetle splits the enclosing exuviae and emerges. The adult is soft and delicate at first and usually remains in the earthen cell formed by the grub for several days before emerging from the soil. The duration of the pupal stage is about eight to 20 days, depending upon soil conditions and temperature.

Seasonal Activity

In most climates, Japanese beetles have a one-year life cycle. Adult beetles begin to emerge from the soil as early as the third week of May in the warmer climates and throughout June in the colder climates (Figure 8). The peak emergence is usually four to five weeks after initial emergence begins.

Figure 8. Seasonal life cycle of Japanese beetle in Tennessee



The emerging adult beetles crawl or fly onto low-growing plants and begin to feed. On warm, sunny days, the beetles feed and fly vigorously. They are naturally gregarious and tend to aggregate on host plants. Many times neighboring host plants, presumably of equal attractiveness to the beetle, are left untouched.

Mating occurs soon after emergence and occurs frequently throughout the 30-60 days of adult life. Mating usually takes place on host plants. Males may also fly low over the ground, searching for emerging females. In an attempt to copulate with newly emerged females, males will congregate around a single female. The congregated mass of beetles resembles an animated ball comprised of a single female and 25 to 30 males.

In the late afternoon, mated females burrow into the soil to a depth of 1 to 4 inches to deposit one to four eggs. The females may come out of the ground the following morning or remain in the soil for three to four days. A female may enter the soil 16 or more times to deposit a total of 40 to 60 eggs during her life.

The eggs hatch in 10 to 14 days and the grub forms a cell in the soil slightly larger than its body. The grub feeds on the rootlets that grow into the cell. As the grub grows, the cell is enlarged to permit free movement. Moisture and temperature will affect the vertical movement of the grub. During the summer and early fall, when temperatures are warm, the grubs feed primarily in the top 2 inches of the soil. In areas of turf (i.e., lawns, golf courses and pastures) many of the grubs remain in the soil-thatch interface where moisture is abundant.

In the late fall when the soil temperatures drops to about 60 F, the grubs move downward and remain at a depth of 4 to 6 inches throughout the winter. The grub becomes inactive during this period. As the soil warms in the spring, the grubs move upward to the root zone and resume feeding.

Feeding by Adults

Although adult Japanese beetles feed on more than 300 plant varieties, the beetles exhibit a definite preference for some varieties. Damage to the preferred varieties is usually more severe than to the less-preferred varieties. Ornamental trees and shrubs, garden plants and field crops are frequently severely damaged by adult feeding. Table 1 includes those plants that may be severely damaged when adult beetle population levels are high.

Adult beetles chew out the tissue between the leaf veins, leaving a lace-like skeleton. Thin leaves with fine veins and petals of flowers are frequently cut out and consumed in large, irregularly shaped portions. Severely injured leaves turn brown and drop off the plant. Beetles aggregate and feed extensively on favored host plants, generally feeding on the upper and outer foliage and working downward on the plant. The beetles prefer to feed on plants exposed to full sunlight. Feeding is heaviest on warm, clear summer days between 9 a.m. and 3 p.m. and at temperatures between 83 and 95 degrees F. Relative humidity below 60 percent retards flying and induces the insect to feed extensively. There is little feeding or flying on cool, windy or cloudy days, and no flight on rainy days.

Table 1. A partial list of the plants most susceptible to adult Japanese beetle attack.

SCIENTIFIC NAME	COMMON NAME
Acer palmatum	Japanese maple
Acer platanoides	Norway maple
Aesculus hippocastanum	Horsechestnut
Althaea officinalis	Marsh mallow
Alcea rosea	Hollyhock
Asparagus officinalis	Asparagus
Betula populifolia	Gray birch
Castanea dentata	American chestnut
Clethra alnifolia	Sweet pepper bush
Glycine max	Soybean
Hibiscus palustris	Common rose mallow
Hibiscus syriacis	Shrub Althea
Juglans nigra	Black walnut
Kerria japonica	Globe flower
Lagerstroemia indica	Crepe myrtle
Malus baccata	Crabapple
Malus floribunda	Japanese flowering crabapple
Malus sylvestris	Apple
Malva rotundifolia	Mallow
Oenothera biennis	Evening primrose
Parthenocissus quinquefolia	Virginia creeper
Platanus acerifolia	London planetree
Polygonum orientale	Princeplume smartweed
Polygonum pennsylvanicum	Pennsylvania smartweed
Populus nigra italica	Lombardy poplar
Prunus armeniaca	Apricot
Prunus avium	Sweet cherry
Prunus cerasus	Sour cherry
Prunus domestica	Garden plum
Prunus persica	Peach
Prunus persica var. nucipersica	Nectarine
Prunus salicina	Japanese plum
Prunus serotina	Black cherry
Rheum rhaponticum	Garden rhubarb
Rhus toxicodendron	Poison ivy
Rosa spp.	Rose
Salix discolor	Pussy willow
Sassafras albidum	Sassafras
Sorbus americana	American mountain ash
Tilia americana	American linden
Ulmus americana	American elm
Vaccinium corymbosum	Highbush blueberry
Vitis aestivalis	Summer grape
Vitis labrusca	Fox grape
Vitis vinifera	European white grape
Zea mays	Corn

The attractiveness of plants as food for adult beetles varies during the summer. Beetles feed on low-growing plants soon after emergence and eventually move to fruit and shade trees. When the leaves become older and tougher, the beetles return to low-growing succulent foliage.

Feeding by Grubs

Japanese beetle grubs predominately feed on the roots of grasses but will also feed on the roots of a wide variety of garden and field crops and ornamental plants. In turf, the symptoms include a general wilting appearance (yellowing, loss of turgidity) and a gradual thinning of the turf stand. More severe infestations result in death of the turf. Heavily damaged turf can be lifted from the soil because all of the connecting roots have been destroyed.

Injury to healthy or well-maintained turf is usually not apparent when there are fewer than 10 grubs per square foot, but unhealthy, poorly maintained turf may show injury with four or five mature grubs per square foot. Severe damage usually becomes apparent in September and October and again in April and May, when third instars are feeding heavily. If conditions are suitable and food is plentiful, horizontal movement of the grub is limited; however, when food is scarce, grubs are capable of moving horizontally many feet.

Control of Japanese Beetle

Japanese beetle traps are not recommended, even though large numbers of adult beetles can be caught in the traps. Trapping alone will control only a small percentage of the beetles and will attract more Japanese beetles to the area! Once in the area, they feed on susceptible plants and cause more damage than if a trap had not been used.

Optimal Growing Conditions and Habitat Manipulation —- Diseased and injured trees and plants are especially susceptible to attack by beetles. Therefore, keep your trees and plants protected from disease and injury. Also, prematurely ripening or diseased fruit is very attractive to beetles. Remove these fruit from the trees and the ground. The odor of such fruit will attract beetles, which can then attack healthy fruit.

Although the Japanese beetle feeds on more than 300 species of plants, it feeds sparingly or not at all on many cultivated plants. The various kinds of plants on your property can significantly influence the susceptibility of your property and plants to Japanese beetle damage. Having a well-dispersed mixture that favors non-preferred species can reduce the level of damage caused by Japanese beetles.

Resistant Flora — When beetles are abundant, damage to plants can be minimized by using species that are immune to or seldom attacked by the beetle. When planting a new ornamental plant or modifying established plantings, make more extensive use of trees, shrubs and other plants that are tolerant or resistant to Japanese beetle. Select plants that are least likely to be seriously injured. Use the list in Table 2 as a guide for determining what plants to use to minimize Japanese beetle damage. Be aware that the plant species listed in Table 1 are more susceptible to Japanese beetle attack.

Table 2. Plants resistant to adult Japanese beetle feeding.

SCIENTIFIC NAME	COMMON NAME
Primary	
Magnolia sp.	Magnolia
Cercis sp.	Redbud
Cornus sp.	Dogwood
Acer rubrum	Red maple
Acer saccharinum	Silver maple
Quercus rubrum	Northern red oak
Quercus velutina	Black oak
Quercus alba	White oak
Acer negundo	Boxelder
Euonymus alatus	Burning bush and other types of euonymus
Ilex sp.	Holly
Buxus sp.	Boxwood
Tsuga sp.	Hemlock
Fraxinus sp.	Ash
Liriodendron tulipifera	Tulip tree, tulip poplar, yellow poplar
Secondary	
Chamaecyparis sp.	False cypress
Taxus sp.	Yew
Juniperus sp.	Juniper
Thuja sp.	Arborvitae
Picea sp.	Spruce
Pinus sp.	Pine
Forsythia sp.	Forsythia
Syringa sp.	Lilac
Clematis sp.	Clematis
Liquidambar styraciflua	Sweetgum

Insecticides

A combination of grub control measures in turfgrass areas (Table 3) and foliar spray applications for adults (Table 4) should give good results.

Soil insecticides for grub control are typically used when the grubs are close to the soil surface and actively feeding, which occurs in late summer to early fall and again in mid-spring. Most soil insecticides should be applied in mid-August if the thresholds have been reached. The residual life of the soil-applied chemicals is relatively short, making an application necessary each season.

Due to their mode of action, recommendation for application for some insecticides, i.e. imidacloprid and halofenozide, is early summer. Both of these insecticides target early instars and, therefore, can be applied prior to oviposition (June through mid-July).

Insecticides may not be needed if thresholds (10 grubs per square foot of healthy turf or 4-5 grubs per square foot of unhealthy, poorly maintained turf) have not been exceeded. Sample several square foot sections of turf by using a shovel or spade to cut out a square foot section (Figure 9) and lift the turf back to count the grubs. The Japanese beetle grub's 'V' shaped raster pattern distinguishes it from other scarabaeid grubs found in the United States (Figure 5).

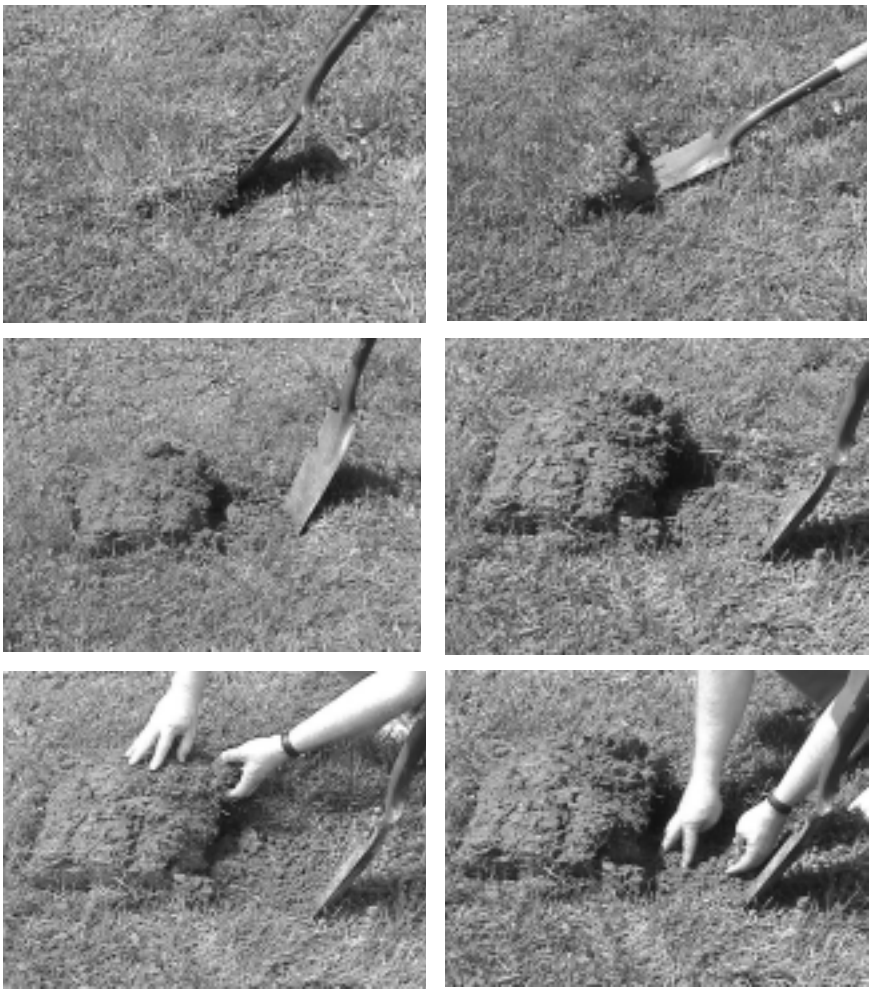


Figure 9. Sampling for white grubs. Sample several square foot sections of turf by using a shovel or spade to cut out a square foot section and lift the turf back to count the grubs. *Photographs by Frank Hale.*

Protect Honey Bees from Insecticide Exposure

Honey bees are essential to pollination of your fruit and vegetable crops. Adequate pollination of more than 50 of these crops is dependent upon the foraging activities of healthy honey bee colonies located within 1.5 miles of your fruits and vegetables. Beekeepers invest a tremendous amount of time, labor and money to maintain a healthy

colony of honey bees. Honey, beeswax and the fruits of pollination are indispensable in our agricultural economy.

Observe these rules to reduce exposure of honey bees to insecticides:

- Do not apply insecticides when honey bees are foraging in the blossoms.
- Mow cover crops of clover or dandelions under trees to be sprayed.
- Apply sprays or granules rather than dusts.
- Do not apply sprays directly over honey bee colonies.
- Use insecticides that are less toxic to honey bees whenever possible.
- *Notify beekeepers at least two days in advance of large-scale spraying.*

Biological Control

When used improperly, insecticides can pose serious hazards to people, wildlife and the environment. There is also increasing concern about the fate of insecticides in the environment and the potential of pesticide runoff contaminating water sources. Because of these growing concerns, the use of effective, commercially available biological control agents is desirable. Unfortunately, few biological control agents are consistent in their effectiveness or readily available.

Entomopathogenic Nematodes — These nematodes are found naturally in the soil, are microscopic and have the ability to seek out host insects in the soil. Entomopathogenic nematodes are unique in that they have a mutualistic, symbiotic relationship with a bacterium. Upon penetrating a grub, the nematode inoculates the grub with the bacteria. The bacteria grow and reproduce quickly inside the grub, ultimately killing the grub from septicemia. Nematodes feed on the bacteria and continue growing and developing and eventually producing thousands of nematodes that return to the soil environment. The two nematodes that have been shown to be most effective against Japanese beetle grubs are *Steinernema glaseri* and *Heterorhabditis bacteriophora.* The latter is commercially available.

When using nematodes, remember that they are alive and have a fairly high oxygen requirement. They are typically sold on a carrier, which they can survive on for a month or two under cool conditions. Adhering to storage directions is critical. The nematodes can be applied with any standard insecticide applicator; but screens may need to be removed. Once mixed with water, nematodes must be applied fairly quickly. Follow accompanying directions carefully for best results. Nematodes are sensitive to desiccation and to sunlight, so irrigation after application is important.

Milky Spore — Milky spore is the common name for spores of the bacterium, *Bacillus popilliae.* This bacterium was first registered in the United States in 1948 for use on turf in suppression of the Japanese beetle grub. Upon ingestion, these spores germinate in the grub's gut, infect the gut cells and enter the blood, where they multiply. The buildup of the spores in the blood causes the grub to take on a characteristic milky appearance.

Milky spore disease builds up in turf slowly (over two to four years) as grubs ingest the spores, become infected and die, each releasing one to two billion spores back into the soil. Milky spore disease can suppress the development of large beetle populations. It works best when applied in community-wide treatment programs. Research results have been inconsistent in demonstrating the effectiveness of milky spore.

Parasites — Releasing natural enemies or parasites of an exotic insect is a successfully proven method to reduce pest populations. Introduced parasites must undergo rigorous testing to demonstrate they are host-specific (i.e., parasitize only the target pest) and safe to use before approval is given for their release. Two such parasites of the Japanese beetle, *Tiphia vernalis* and *Istocheta aldrichi*, were brought to the United States from Asia. In the 1920s and 30s, researchers released these parasites and determined that they successfully established in areas inhabited by the Japanese beetle. These parasites can still be found in some of these areas. Both may be important in regulating the population dynamics of Japanese beetle, particularly in the Northeastern U.S.

These parasites are not yet commercially available; however, you can contact your local Extension agent to see if they are established in your area. If they are, planting the appropriate food plants will attract these parasites and increase the rates of parasitization, and thus help control the Japanese beetle on your property. In the last 10 years, *Tiphia vernalis* has been found in Ohio, North Carolina, Indiana and most recently in Tennessee. It is typically found in areas of high populations of Japanese beetle, making evaluation of its effect on the insect population difficult. However, in areas where it is established, it is likely playing a role in reducing Japanese beetle populations.

Tiphia vernalis — This small, parasitic wasp of Japanese beetle grubs resembles a large, black, winged ant. Its current distribution is believed to be throughout the Northeastern United States and south to North Carolina and Tennessee. After a brief period of feeding and mating during the spring, the female wasp digs into the soil in search of a Japanese beetle grub. Once contact is made, the wasp paralyzes the grub by stinging it and then deposits an egg on the grub. When the egg hatches, the emerging wasp larva consumes the grub.

Food sources: Adult wasps of this species feed almost exclusively on the honeydew of aphids associated with the leaves of maple, cherry and elm trees and peonies. In North Carolina and Tennessee, the nectar of tulip poplars has been found to be an important food source for the adult wasps.

Istocheta aldrichi — This solitary fly is an internal parasite of the adult Japanese beetle. The female flies are capable of depositing up to 100 eggs during a period of about two weeks. The eggs are usually laid on the thorax of the female beetles. Upon hatching, the maggot bores directly into the beetle's body cavity, killing the beetle. These flies are capable of suppressing Japanese beetle populations before they have time to reproduce.

Food sources: *I. aldrichi is* commonly seen feeding on aphid nectar deposited on Japanese knotweed *(Polygonum cuspidatum)*, a persistent perennial weed native to Japan.

Quarantine Procedures

Currently, individual state quarantines require treatment or production practice-based certification for nursery stock originating in infested areas before plants are shipped to uninfested areas. The USDA, the National Plant Board and the regulated industry support a plan of harmonizing the quarantine and certification requirements for Japanese beetle to assure that the pest risks are acceptably managed. Under the U.S. Domestic Japanese Beetle Harmonization Plan, the movement of nursery and greenhouse plants from infested areas to areas with a Japanese beetle regulatory strategy will require 1) a state phytosanitary certificate, or an equivalent certification of quarantine compliance to states that consider Japanese beetle a quarantine pest; or 2) a nursery stock certificate with an additional declaration or equivalent documentation attesting to compliance with the harmonization plan to states that consider Japanese beetle a regulated non-quarantine or quality pest.

Trapping strategies are suggested for states to verify or assess their Japanese beetle infestation level (pest status). Required control procedures are based on the pest status of the state receiving the plant material. Check with your Extension agent or regulatory agency to determine the necessary certification and procedures to ship plant material from areas infested with Japanese beetle. Information on Japanese Beetle certification procedures can be found at http://www.state.tn.us/agriculture/regulate/plants/jb.html.

Table 3. Control of grubs.

INSECTICIDE	RATE	REMARKS
Bendiocarb Turcam 76WP* 2.5 G*	 1 to 1.5 oz./1,000 sq. ft. 1.9 to 2.8 lb./1,000 sq. ft.	Irrigate with 1/4 to 3/4 in. of water.
Halofenozide MACH 2 1.5 G MACH 2 2L GrubEx 1.5G	 2.3 lb./1,000 sq. ft. 2.2 fl. oz./1,000 sq. ft. See label for spreader settings	MACH 2 Granular is labeled for use on all turfgrass sites, while MACH 2 Liquid is registered for use on commercial sites including: golf courses, sod farms, commercial lawns and cemetaries. Make only one application from June through mid-July.
Imidacloprid Merit 75WP Merit 0.5G Marathon 60WP Advanced Lawn Season Long Grub Control 0.2G 1.47RTS	 6.4 oz./acre 1.4 lb./1,000 sq. ft. 0.4 lb. AI/acre 2.87 lb./1000 sq. ft. Ready to spray	For optimum control, make application prior to egg hatch (June through mid-July) because it is most effective against younger grubs. Follow with sufficient irrigation or rainfall within 24 hours of application. Merit not for use on commercial sod farms. Marathon soil treatment only in nurseries and greenhouses.
Trichlorfon Dylox 80SP Dylox 6.2G Advanced Lawn 24-Hour Grub Control 6.2G	 3.75 oz./1,000 sq. ft. 3 lb./1,000 sq. ft. 3 lb./1,000 sq. ft.	Dylox not for use on sod farms.

* Restricted-use pesticide

Table 4. Control of adults.

INSECTICIDE	RATE	REMARKS
Bifenthrin Talstar F GC F Lawn & Tree F Nursery F	 2 to 4 fl. oz./10 gal. 0.5-1 fl. oz. /gal. 0.5-1 fl. oz./gal. 20 fl. oz/acre	Rates are for an application volume of 1 gal. per 1,000 sq. ft. for Talstar, GC Flowable and Lawn & Tree Flowable.
Carbaryl Carbaryl 80S 4L Sevin 80WSP SL Others	 1.25 lb/100 gal. or 1.25 Tbsp/gal. 1 qt./100 gal. or 1 fl. oz/3gal. 1.25 lb/acre 1 qt./100 gal. or 1 fl. oz./3 gal.	 Carbaryl injures Boston ivy, Virginia creeper and maidenhair fern.
Beta-cyfluthrin Tempo SC Ultra	1.5 fl. oz./100 gal.	
Cyfluthrin Decathlon 20WP Tempo 20WP Advanced Garden Lawn and Garden Multi-Insect Killer 0.75 concentrate	 1.9 oz./100 gal. 1.9 oz (11 scoops)/ 100 gal. 1 Tbsp./gal.	
Lambda-cyhalothrin Scimitar CS GC WP	 1.5 to 5 fl. oz./100 gal. 1.5 to 5 fl. oz./100 gal. 1.2 to 4.8 oz./100 gal.	

Precautions: Avoid spraying flowering plants when honey bees are foraging on the plants. Spray flowering plants in the evening.

Sources:

USDA APHIS program Aid No. 1599, “Managing the Japanese Beetle: A Homeowner’s Handbook.”

USDA Agricultural Handbook No. 236, “The Japanese Beetle in the United States” and USDA Home and Garden Bulletin No. 159, “Controlling the Japanese Beetle.”

TDA Japanese Beetles in Tennessee. http://www.state.tn.us/agriculture/regulate/plants/jb.html

FOR POISON INFORMATION

CALL

1-800-222-1222

ATTENTION

1. Read the label of any pesticide before applying.
2. Do not rely on pesticides alone; employ all cultural methods of control.
3. Regulations and guidelines concerning use of pesticides are subject to change without notice. Consult the label of the product for usages and rates before applying. If recommendations in this manual conflict with the label, please follow the label instructions.
4. When a range of rates and application intervals are recommended, use the lower rate and longer interval for mild-moderate infestations and the higher rate and shorter interval for moderate-severe infestations.
5. Use of trade or brand names in this manual is for clarity and information.The Tennessee Cooperative Extension Service does not imply approval of the product to the exclusion of others which may be similar, suitable composition, nor does it guarantee or warrant the standard to the product.
6. Please read the label before using a product.

Precautionary Statement

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label. Persons who do not obey the law will be subject to penalties.

Disclaimer Statement

Pesticides recommended in this publication were registered for the prescribed uses when printed. Pesticides registrations are continuously reviewed. Should registration of a recommended pesticide be canceled, it would no longer be recommended by the University of Tennessee. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product.

PB946-3M-7/02 (Rev) E12-4615-00-003-03