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Fact sheet

An Integrated Approach to Insect Management in Turfgrass:

White Grubs

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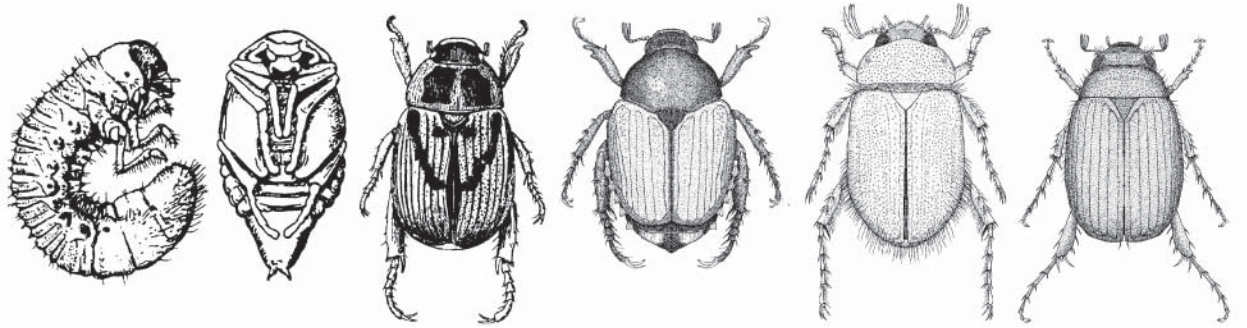

Fi.g 1. White grub larva, pupa, and adults of oriental beetle, Japanese beetle, northern masked chafer, and Asiatic garden beetle (from left to right; drawings courtesy of D. Shetlar).

Introduction: In the northeastern USA, a complex of white grub species are the most widespread and destructive turfgrass insect pests. In New Jersey and neighboring areas, the oriental beetle, [*Exomala* (=*Anomala*) *orientalis*] has become by far the most important white grub species. Other common species include the Asiatic garden beetle (*Maladera castanea*), the northern masked chafer (*Cyclocephala borealis*), the Japanese beetle (*Popillia japonica*), and somewhat less common, the green June beetle (*Cotinis nitida*), the European chafer (*Rhizotrogus majalis*), and May/June beetles (*Phyllophaga* species). However, species composition can vary considerably among sites.

Symptoms: White grubs (WG) damage turf by chewing off roots close to the soil surface. The voracious feeding of the larger late 2nd and 3rd stage grubs, when combined with hot and dry conditions, can result in quick and extensive loss of turf from late August through mid-October. In spring damage only occurs under exceptionally warm and dry conditions. All cool-season, and many warm-season grasses, are susceptible to WG. Being alert to the symptoms of WG infestations helps avoid unexpected loss.

Early signs of infestation include gradual thinning, yellowing, and wilting in spite of adequate soil moisture, and the appearance of scattered, irregular dead patches. The patches grow and join together until large turf areas are affected. Due to the WGs' tunneling activity, infested turf feels spongy underfoot and can be pulled up like a carpet, exposing the C-shaped WG. Secondary, often more severe, damage can be caused by vertebrate predators (e.g., crows, skunks, raccoons, moles), that tear up or tunnel under the turf to feed on the grubs.

Insect Description: Eggs of all species are shiny, milky white, and oval when first laid. Eggs swell by absorbing water from surrounding soil, and become more spherical in shape and dull-grey colored. Newly laid eggs of the common species are around 1/16" (1.5 mm) long.

Grubs of most species resemble one another except for size. The body consists of a brown head with chewing mandibles, a thorax with three pairs of short, jointed legs, and the abdomen. Thorax and abdomen are gray-white or cream colored, but the hind part of the abdomen often appears darker because of ingested soil and plant material in the gut. The transversely wrinkled skin is covered with scattered, short brown hairs. Feeding or resting grubs assume a characterstic C-shaped posture. Green June beetle grubs are more robust and parallel-sided than other grub species with relatively shorter stubby legs.

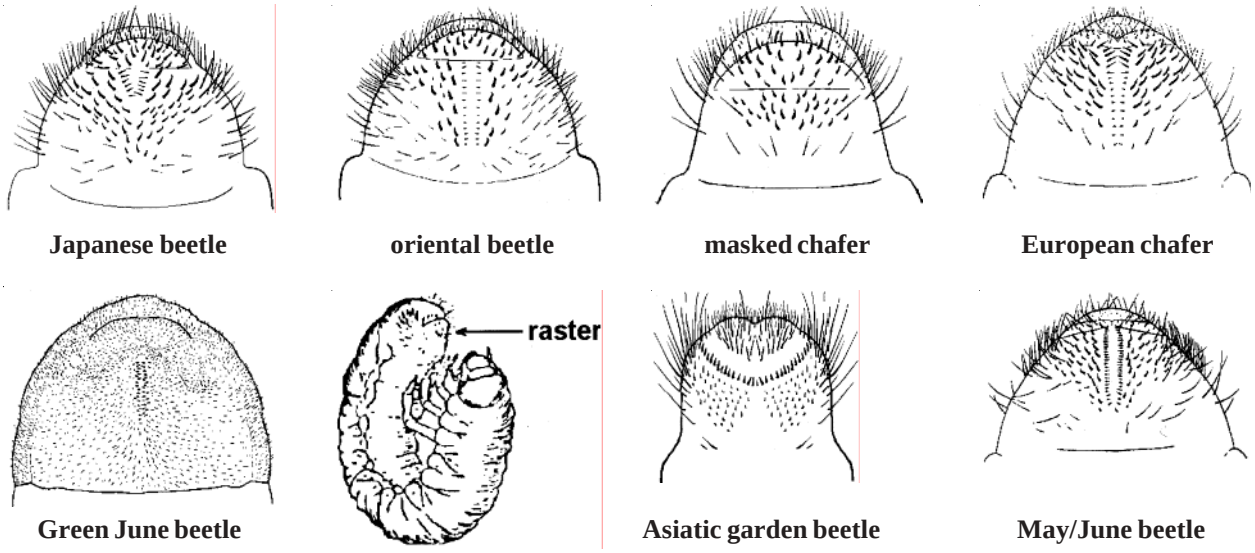

Fig. 2. Raster patterns of important white grub species in New Jersey (drawings courtesy of D. Shetlar).

All species have 3 larval stages, increasing in size with each molt. In freshly molted larvae, the head is wider than the thorax and abdomen, but as the larva grows, the thorax and abdomen fill out, becoming wider than the head. Mature larvae range in length from about ¾" (Asiatic garden beetle), around 1" (oriental beetle, Japanese beetle, northern masked chafer), to 2" (green June beetle).

White grubs can be identified to species by examining the raster – a pattern of spines, hairs, and bare spaces on the underside of the abdomen just in front of the anus (Fig.2). The shape of the anal slit also varies among species. A 10-15-power hand lense is adequate for viewing these species-specific features. The pupa is whitish at first, darkening with age, and assumes adult coloration just before the beetle emerges. The developing wings and legs are closely folded to the body. Pupal length in the common species ranges from 3/8" to ½".

The adult beetles are stout, oval beetles. Adult oriental beetles, Japanese beetles, and Asiatic garden beetles are around 3/8" (10 mm) long. Oriental beetles are mostly straw-colored with variable black markings on the thorax and wing covers, but vary from mostly straw-colored to almost entirely brownish-black. Asiatic garden beetles are dull chestnut brown with a velvety appearance and slight iridescent sheen. Japanese beetles have a shiny, metallic green head and body, darker green legs, coppery-brown wing covers, and 12 patches of white hair on the the upper side of the abdomen surrounding the wing covers. Northern masked chafers are 7 to 8/16" (11 to 12 mm) long dull yellow brown beetles with a darker, chocolate-brown band across head and eyes and dense hair on the underside of the thorax. Green June beetles are ¾ to 1" (19 to 25 mm) long. The color of upper body varies from dull brown with lengthwise green stripes to uniform, velvety forest green. The underside is shiny metallic green or gold.

Seasonal History and Habits: Adult beetles emerge between June and August. Adult Asiatic garden beetle and especially Japanese beetle feed extensively on the leaves of many different plants, but adults of most other species feed very little or not at all. After mating the females return into the soil to lay eggs (total of 20 to 60) in several batches over a period of 2 to 4 weeks, typically at 1 to 4" soil depth. The egg stage, 1st larval stage, and 2nd larval stage each last 2 to 3 weeks. Through September most of the grubs will molt to the 3rd larval stage. Northern masked chafer grubs tend to reach the 3rd larval stage about 2 weeks earlier, which can be critical for timing of treatments against this species.

Grubs may be found feeding throughout the root-zone. The majority will be within 2" below the thatch. As the soil cools in October, the grubs move to deeper soil layers to overwinter in a more or less inactive state. As the soil warms up in spring, the grubs return to the root zone to feed for another 4 to 6 weeks in April and May, before pupating in the soil at 2 to 8" depth. After 1 to 2 weeks, the new beetle emerges to restart the life cycle.

Monitoring: Mid-August, when the grubs are primarily 2nd instars, is the time to monitor for potentially damaging WG populations in the upper 3 to 4" of soil under the turf. Most conveniently turf/soil plugs are sampled with a standard golf course hole cutter (4.25" diam ~ 0.1 ft^2). More tedious is cutting square-foot samples with a flat-blade spade. The plugs can be broken up and examined on the spot (preferably on a tray). Split the soil end of the sample into halves, then quarters and smaller pieces to reveal the grubs that typically occur near the thatch-soil interface.

Record the number, species (check raster pattern), and life stages on a data sheet or map. Place the soil and sod cap

back and irrigate to promote turf recovery when dry. Because white grub populations have a patchy distribution, several samples should be taken in a grid pattern. Rarely does an entire turf area require treatment.

To save effort, sampling can be concentrated on suspected infestation areas, high-risk or low tolerance areas, or areas with a history of grub infestations. If historical information is not available and/or a more accurate idea of grub distributions is necessary, map and survey. Using graph paper, prepare a general map of the turf area including landmarks. Mark sampling spots at 6 to 10' (lawns) or 10 to 20' (sports fields) apart in a grid pattern. At each spot take a sample and record number, species, and stage of grubs found (also record 0s!). Experienced samplers can process about 20 samples per hour.

To determine whether treatment is required, transform the grub numbers into 'per ft^2'-values and compare to damage thresholds. Most published thresholds lie in the range of 6 to10 (Japanese beetle, oriental beetle, European chafer) and 15 to 20 (Asiatic garden beetle) grubs per ft^2.

Damage thresholds vary considerably with grass species, management type, and climatic conditions. The better maintained the turf and the more extensive the root system, the higher are the damage thresholds. E.g., in well-maintained and stress free tall fescue plots as many as 60 grubs per ft^2 may not cause turf damage. Experienced turf managers should develop their own range of thresholds for the various turf areas they are responsible for.

Cultural control: Good turf management (proper irrigation, fertilization, mowing) will result in vigorous turf with a deep, extensive root system that can tolerate higher grub densities without showing damage. While no grub resistant turfgrasses exist, species with a deeper root-system and higher heat and drought tolerance are generally more tolerant of grub feeding. Among the cool-season grasses, tall fescue is the most grub tolerant species whereas perennial rye grass is the least tolerant. Endophytic fungi do not provide resistance to grubs.

Watering during peak beetle activity in summer tends to attract egg-laying females, especially when the soil in surrounding areas is dry, and increases survival of eggs and young larvae. Later in the summer and in fall, however, irrigation makes the grass more grub tolerant.

Natural enemies: In addition to the various vertebrate natural enemies that unfortunately tend to cause turf damage when preying on WGs, there are numerous more subtle invertebrate natural enemies. Ground beetles, ants, and other beneficial insects prey on eggs and young grubs. Various parasitic wasps and flies parasitize the older grubs. Various naturally occurring pathogens (insect-parasitic nematodes, fungi, bacteria, protozoa) kill or weaken WGs. Preserve natural enemies as important buffers against WG outbreaks by using insecticides only when and where necessary to avoid intolerable damage.

Chemical Control – general: For best results with any insecticide, mow the turf and rake out dead grass and thatch before treatment to reduce the amount of insecticide bound up by surface debris. If the thatch layer is > 0.5" (1.25 cm) thick, consider removing it with a dethatching machine before applying a grub treatment.

Irrigate with 0.5 to 1" water immediately after treatment (or timely rainfall) to leach the insecticide into the root zone where the grubs are feeding. Irrigation also increases insecticide contact by drawing the grubs closer to the surface. If the soil is very dry, irrigation 1 day before treatment increases efficacy by bringing grubs closer to the surface and reducing thatch binding and evaporation of liquid treatments. But do not apply soil insecticides to saturated soil. Granular formulations need to be applied to dry grass to allow the granules to sift down into the thatch. Liquid and granular applications are equally effective, but granular formulations are more forgiving if post-treatment irrigation is delayed. Read instructions on insecticide label carefully.

To aid in locating control products, active ingredients listed in the following sections are followed by trade names in parentheses. Be aware that the active ingredients in these products may change. When purchasing control products, always check the label for the active ingredient.

Chemical control – curative: If soil sampling has revealed high WG populations, treatment may be necessary. This curative control approach works best if applied while the grubs are still smaller (i.e., mid August to early September). Once the grubs have reached the 3rd larval stage, they are much harder to control.

Spring applications (late April through May) are generally the least effective and rarely justified because the grass can outgrow most grub populations. Treatments need to be applied before the grubs pupate. Due to the grubs' annual life cycle, areas that had no infestation or were successfully treated in the previous summer/fall, will not need treatment in spring.

Successful treatments typically kill 75 to 90% of the grubs, but product performance varies with soil type, thatch thickness, and grub species. Therefore, evaluate treatments and keep records of product performance. Soil insecticide applications never work overnight. Affected grubs usually turn yellow or brown within a week of treatment. Wait at least 1 to 2 weeks before evaluating.

Don't wait longer than 3 weeks to allow for a follow-up treatment if the 1st treatment was ineffective.

If an application was ineffective, try a different compound. Development of grub resistance to insecticides is unlikely with the presently used insecticides, but some control failures may be caused by enhanced microbial degradation of the insecticide after repeated insecticide use. Avoid unnecessary applications and alternate insecticides.

Insecticides available for curative WG control include the organophosphates trichlorfon (Dylox®, Advanced Lawn 24 Hour Grub Control), diazinon (Diazinon®; not for golf courses, sod farms, turf areas > 1 A), and chlorpyrifos (Dursban®; only on sodfarms), and the carbamate carbaryl (Sevin®). For late applications and thatchy lawns, trichlorfon is the usually the best choice.

Chemical control - preventive: With preventive control, an insecticide with a long residual in the soil is applied as insurance, before a possible grub population develops. Insecticides used for preventive grub treatments are the neonicotinoid imidacloprid (Merit®, Advanced Lawn Season-Long Grub Control) and the molt-accelerating compound halofenozide (MACH 2®, GrubEX). Due to their long residual, imidacloprid and halofenozide can be applied as early as May and June, respectively. If applied that early, various other insect pests may also be controlled (billbugs, annual bluegrass weevil, greenbugs; halofenozide also cutworms, sod webworms).

If WG are the primary targets, the optimal application time for imidacloprid and halofenozide is June/July when the female beetles are laying eggs. As the larvae grow, they become less susceptible to these insecticides. Applications after mid-August are not recommended.

Beware that some WG species are less susceptible to these insecticides. Halofenozide provides only around 60% control of oriental beetle and European chafer grubs. Imidacloprid is somewhat less effective against masked chafers, European chafer, and green June beetle. Where these species prevail, applications should be done during the respective egg laying period and at the highest label rate. Halofenozide and imidacloprid are ineffective against Asiatic garden beetle grubs.

Because preventative applications have to be done before WG populations can be estimated through soil sampling, they are often applied over larger areas than required for grub control. This increases the cost of grub management and may in the long-term dramatically reduce populations of natural enemies by depriving them of prey or hosts.

Smart turfgrass managers restrict preventative applications to areas with extremely low damage threshold and tolerance, areas with a history of WG infestations, and areas with high beetle activity (egg-laying) in June-July.

Biological control: Presently available products containing the insect parasitic nematode species *Heterorhabditis bacteriophora* (e.g. Heteromask™, Grubstake™ Hb), *Heterorhabditis megidis* (e.g. Nemasys®H, Grubstake™ Hm), or *Steinernema glaseri* can provide very good control of Japanese beetle, but are not effective against oriental beetle, Asiatic garden beetle, or European chafer grubs. Apply nematodes with sufficient water and water in immediately (follow label instructions). Ideally, keep soil moist for 1 to 2 weeks after treatment. To avoid heat and direct sunlight exposure of the nematodes apply in early morning or late in the day. Nematode products must be handled and stored with more care than chemical insecticides (living organisms!), but have the advantage of no reentry interval due to their nontoxicity to humans.

Products containing spores of the milky disease bacterium *Paenibacillus popilliae* (e.g. Milky Spore) can be used for slow acting but longlasting suppression of Japanese beetle grubs. Because every grub species has its own naturally occurring milky disease strain, the commercial strain is only effective against the Japanese beetle. The product is applied in a grid pattern every 4 ft and must be leached into the root-zone with irrigation or rain. Grubs that feed directly under the application spots may become infected and produce billions of new bacterial spores. Under the right conditions (especially high Japanese beetle populations), the disease can become established and spread through an entire lawn within 1 to 3 years. The spores can persist in the soil for many years.

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