# May or June beetles infesting Oklahoma turf

Identifying the various species of *Phyllophaga* grubs infesting Oklahoma turf has allowed scientists to develop more precise timing for preventive treatments.

Environmental Institute for Golf

This research was funded in part by The Environmental Institute for Golf.

**Tom Royer, Ph.D.**
**Joseph Doskocil**
**Nathan Walker, Ph.D.**
**Steve Marek, Ph.D.**
**Greg Bell, Ph.D.**
**James Reinert, Ph.D.**

"White grubs" are the larvae of a group of Scarab beetles that are pests of managed turf and other crops. The white grub complex in turf includes northern and southern masked chafer, oriental beetle, Japanese beetle, Asiatic garden beetle, European chafer and several species of *Phyllophaga*, also known as May or June beetles (1). White grubs can cause direct damage to the turf from their feeding activities. Perhaps as important, predators, such as skunks, moles and armadillos, feed on white grubs and cause collateral damage to the turf from their digging activities (5).

All white grub life cycles include the egg, three larva instars, the pupa and the adult (Figure 1). Many complete their life cycle in one year, but *Phyllophaga* life cycles range from one to three years. The length of the life cycle depends on the species and where they are living. For example, *Phyllophaga crinita* takes one year to complete its life cycle in South Texas, but requires two years in northern Oklahoma (Figure 2).

More than 70 species of May or June beetles, some of which are turf pests, occur in Oklahoma. The problem is that there is little information on which species are potential turf pests. Why? Because the larvae of *Phyllophaga* are difficult to identify. The keys are outdated, and identification is based on physical characteristics of the grubs that can be recognized only by individuals with special training and experience.

Several new chemical classes of insecticides are registered for white grub control, and they provide control over a fairly broad time frame during the summer. However, these insecticides are most effective at controlling young grubs (first and second instars) and less effective on large (third instar) grubs. Often, grub control applications are timed to coincide with southern masked chafer egg hatch, which typically occurs one to two weeks after egg laying. However, many superintendents have discovered that they can apply the product earlier or later during the season and still obtain acceptable control. During 2004, some lawn-care companies reported that they were getting poor control of white grubs with products that had previously provided excellent control. We investigated and found that the problem grubs were May or June beetle grubs.

In Oklahoma, peak flights of southern masked chafer usually occur in late June. Because we did not know which species of *Phyllophaga* grubs are pests of turfgrass, we had no access to information on their life cycle, when they typically flew, or how frequently they occurred in managed bermudagrass turf. Thus, we did not know whether an insecticide application that is timed to control the southern masked chafer was optimal for *Phyllophaga* grub control. Therefore, we initiated this project to answer three questions:

- Which *Phyllophaga* species typically infest bermudagrass turf in Oklahoma golf courses?
- What is the average proportion of southern

masked chafer/*Phyllophaga* grubs in managed turfgrass?
- What are the seasonal flight patterns of turf-infesting *Phyllophaga* beetles in Oklahoma?

## Materials and methods

Phyllophaga *species in bermudagrass turf*

*Adult sampling.* We placed one ultraviolet light trap with a U-shaped bulb at each of seven cooperating golf courses to collect adult beetles. The trap was operated three times weekly for 24 hours from April 1 through July 31, 2005, or April 1 through Sept. 15, 2006. Captured beetles were collected, frozen and transported to Stillwater for identification and counting. Beetles were identified using adult keys (3), and identification was confirmed using the insect collection at the K.C. Emerson Insect Museum, Oklahoma State University. Additional beetle species were obtained from Kansas collections.

*Larvae sampling.* Because white grub larvae live below ground, turf must be detached from the soil to collect them. All but one of the superintendent cooperators were reluctant to let us to dig up their fairways (which is understandable), so we chose golf courses that were located near a commercial sod grower. This arrangement allowed us to collect larvae in bermudagrass on the sod farm by following behind a sod cutter, which was typically run every day. The one golf course that allowed us to dig gave us access to the driving range. Grubs were collected, transported to Stillwater and frozen for future processing. In addition, we measured a specific area of turf being cut and recorded the proportion of *Phyllophaga* to southern masked chafer within the sample.

*Identifying* Phyllophaga *grubs to species*

We identified larvae by extracting DNA from the larvae and comparing it to DNA obtained from identified adult beetles (4). This process involved taking one or two legs from identified adult beetles and putting them in liquid nitrogen to open them for extraction of the DNA in their leg muscles. The sample was then ground up and processed to extract, amplify and sequence a small section of the DNA. We also did this for any *Phyllophaga* grub that we collected from the sod farms. Once the DNA was sequenced, we used a computer program to match the sequences obtained from the larvae (which consisted of about 562 pairs of amino acids) to the sequences from identified adult beetles.

*Light-trap results (adults)*

We captured nearly 9,000 *Phyllophaga* beetles from our cooperating golf courses during the study.

In 2005, our first capture occurred on April 14. We identified 12 species from the 2,209 June beetles captured in 2005. The five most abundant species were *P. crassissima, P. glabricula, P. crinita, P. praetermissa* and *P. congrua*. Results differed depending on the location. For example, *P. glabricula* was most abundant in northeastern and western locations, whereas *P. crassissima* was most abundant in central locations, and *P. crinita* in southern and western locations. In 2006, we captured the first beetle on April 7 and continued

Light traps were used to collect adult beetles for identification. **Photos by T. Royer**

### *Phyllophaga* life stages

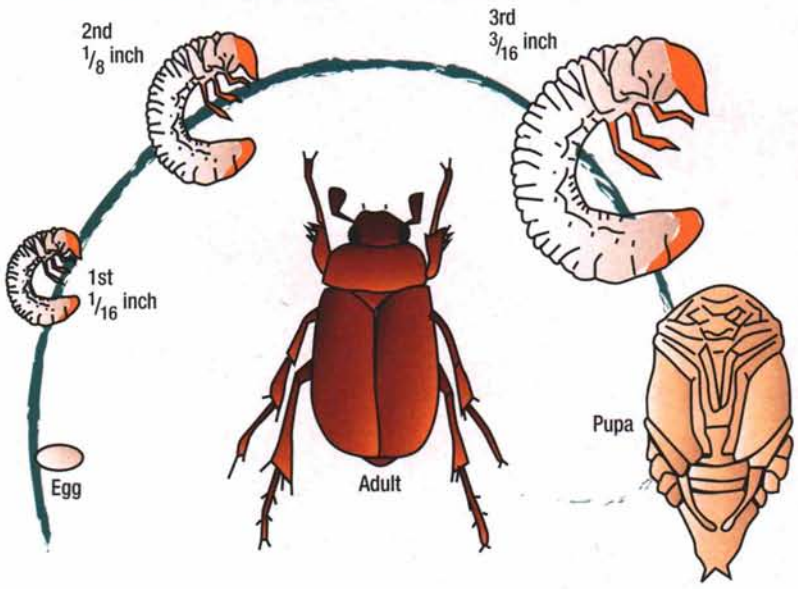


Illustration by K. Neis Adapted from North Dakota State University Extension

**Figure 1.** White grub life stages include the egg, three larval instars (with head width in inches), the pupa and the adult.

More than 70 species of May or June beetles (*Phyllophaga*) are found in Oklahoma.

White grubs are the larvae of Scarab beetles, including beetles of the genus *Phyllophaga*.

## One-year life cycle

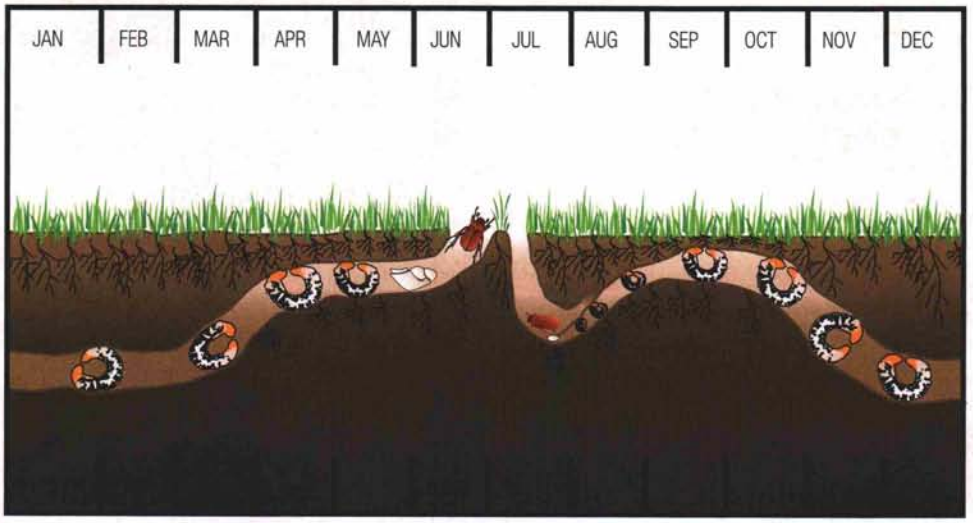


Illustration by K. Nels Adapted from North Dakota State University Extension

**Figure 2.** Some species of *Phyllophaga* have a one-year life cycle, whereas others take two or three years to develop and remain underground for longer periods of time.

collecting beetles into September. We identified 20 species of *Phyllophaga* from the 6,277 adults captured. The five most abundant species were *P. crinita, P. submucida, P. crassissima, P. congrua* and *P. torta*. Results differed depending on the location. For example, *P. crinita* was most abundant in central and southern locations, *P. crassissima* was most abundant in northeastern locations, *P. submucida* was the most abundant in southern and western locations, and *P. torta* and *P. congrua* were most abundant in southern locations.

## *Phyllophaga* locations

**Figure 3.** Different *Phyllophaga* species were captured in different regions of the state. *Phyllophaga crinita* was most abundant in central and southern locations, *P. crassissima* in northeastern locations, *P. submucida* in southern and western locations, and *P. torta* and *P. congrua* in southern locations. Orange stars denote the location of golf courses where traps were placed in 2005; blue stars denote additional locations monitored in 2006.

## Sod farm results (larvae)

We collected a total of 123 *Phyllophaga* larvae that we could use for sequencing. Results of genetic matching showed that nine species of the 20 species of adult *Phyllophaga* that were collected in our light traps also were found as larvae on the sod farms (Table 1). Interestingly, the most consistently collected larvae in turf were *P. crassissima* and *P. calceata*, yet *P. calceata* adults were collected in one location, and in very small numbers. It may be that *P. calceata* is not highly attracted to light traps. *Phyllophaga congrua, P. ephilida* and *P. hirtiventris* were only collected in northeastern Oklahoma. In many locations, we collected both southern masked chafer and *Phyllophaga* grubs, but in a couple of sod farms, *Phyllophaga* grubs were the dominant group.

## Flight times for turf-infesting *Phyllophaga* grubs

Once the *Phyllophaga* larvae found in sod farms were identified, we could chart the adult flight times of those beetles that actually infest turf and pinpoint their peak flight times (Figure 4). Some *Phyllophaga* species fly in April and May, others fly in May and June, still others fly in June and July and a few fly in June, July and August. However, peak flights for nearly all species occurred from April 30 through July 2.

## Implications and future research

This research allowed us to accurately identify the turf-infesting May or June beetle species in Oklahoma. The information will help us more

## Light-trap collections

| Beetle species | No. of beetles collected | No. of locations: Where adults were collected | No. of locations: Where larvae were collected |
|---|---|---|---|
| *P. bipartita* | 59 | 4 | 3 |
| *P. calceata* | 27 | 1 | 4 |
| *P. congrua* | 762 | 6 | 3 |
| *P. crassissima* | 1,879 | 9 | 5 |
| *P. crinita* | 3,696 | 4 | 3 |
| *P. ephilida* | 127 | 3 | 2 |
| *P. hirtiventris* | 16 | 4 | 2 |
| *P. submucida* | 1,071 | 5 | 3 |
| *P. torta* | 222 | 3 | 2 |
| Total no. beetles/location | 7,859 | | |

**Table 1.** Number of *Phyllophaga* that were collected in light traps from nine golf courses in 2005-2006 and were also found infesting turf as larvae.

precisely define the treatment window for white grubs in Oklahoma that offers optimal control with minimal insecticide applications.

Although we collected turf-infesting *Phyllophaga* species from early April through September, the flight peaks for most of them occurred from about June 1 through July 1. If applied too early, a preventive insecticide application might not provide effective control for grubs that hatch later in the season. Conversely, if applied too late, grubs that hatch early may actually become too large to be controlled effectively. Thus, we will recommend that the optimal time for applying a preventive white grub treatment in Oklahoma should be June 1 through July 1, which should control most of the turf-infesting May or June beetles that occur in Oklahoma and should be ideal for controlling southern masked chafer grubs.

Future research will be conducted to determine the prevalence, life histories and potential for damage of May or June beetles that infest turf.


### Funding

Financial support for this research was provided by The Environmental Institute for Golf, Oklahoma Turfgrass Research Foundation, Oklahoma GCSA, Bayer CropScience, The Scotts Co. and the Oklahoma Agricultural Experiment Station.

### Acknowledgments

This study was conducted in partial fulfillment of a master of science degree by J.P. Doskocil at Oklahoma State University. We offer special thanks to Robert Bauernfeind, Ph.D., at Kansas State University for providing additional May beetles for sequencing. We thank K.J. Black and H. Bruce for technical assistance.


### Literature cited


1. Crocker, R.L., W.T. Nailon Jr. and J.A. Reinert. 1995. May and June beetles. p. 72-75. *In:* R.L. Brandendurg and M.G. Villani, eds. Handbook of turfgrass insect pests. Entomological Society of America, Lanham, Md.
2. Hebert, P.D., A. Cywinska, S.L. Ball and J.R. deWaard. 2003. Biological identifications through DNA barcodes. *Proceedings of the Royal Society, London* 270:313-321.
3. Luginbill, P., Sr., and H.R. Painter. 1953. May beetles of the United States and Canada. U.S. Department of Agriculture Technical Bulletin No. 1060. Washington, D.C.
4. Miller, K.B., Y. Alaries, G.W. Wolfe and M.F. Whiting. 2005. Association of insect life stages using DNA sequences: the larvae of *Philodytes umbrinus* (Motschulsky) (Coleoptera: Dytiscidae). *Systematic Entomology* 30:499-509.
5. Vittum, P.J., M.G. Villani and H. Tashiro. 1999. Turfgrass insects of the United States and Canada. Cornell University Press, Ithaca, N.Y.


GCM


Tom Royer (tom.royer@okstate.edu) is an Extension entomologist and IPM coordinator in the department of entomology and plant pathology, Oklahoma State University, Stillwater. Joseph Doskocil is a graduate research assistant in the department of entomology at North Carolina State University, Raleigh. Nathan Walker is an associate professor of turf pathology in the department of entomology and plant pathology, Oklahoma State University. Steve Marek is an assistant professor in the department of entomology and plant pathology and Greg Bell is a professor of turf science in the department of horticulture and landscape architecture, Oklahoma State University, Stillwater. James Reinert is a professor of entomology, Texas Agricultural Research and Extension Center, Dallas.


## The research says

→ White grubs are the larvae of a group of Scarab beetles, including several species of *Phyllophaga* (May or June beetles), that are pests of managed turf and other crops.

→ More than 70 species of May or June beetles occur in Oklahoma, but little is known about which species are potential turf pests because *Phyllophaga* larvae are difficult to identify.

→ To determine the best timing for pesticide applications for controlling white grubs, it is necessary to identify the pest species, their locations and seasonal flight patterns.

→ By sampling throughout the state and using DNA testing to identify species, we identified nine *Phyllophaga* species as turf pests in Oklahoma.

→ We recommend that preventive white grub treatments be applied in Oklahoma from June 1 through July 1 to control May or June beetles in turf.

## Flight period

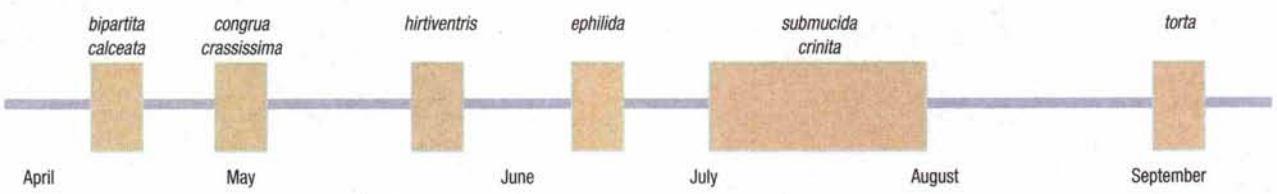


**Figure 4.** Flight period for turf-infesting *Phyllophaga* species collected on golf courses in Oklahoma, 2005-2006. The line represents time during which light traps were operated. Boxes represent peak numbers of beetle species collected, as listed above each box.