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Authors: Reynolds, William Casey, Reynolds, Diane Silcox, Puckett, Robert T., Wade, Taylor, and Elmore, Matthew T.

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Monitoring Destructive Scarab Beetles[1] in Texas Turfgrasses

William Casey Reynolds[2], Diane Silcox Reynolds[3], Robert T. Puckett[4], Taylor Wade[4], and Matthew T. Elmore[5]

Abstract. Turfgrasses grown for sod production, golf courses, recreational areas, and home lawns are frequently damaged by destructive insect pests that substantially reduce turfgrass quality. White grubs, the larval stage of scarab beetles, cause damage as they feed on grass roots. This is particularly problematic in areas of the southern and southwestern United States where turfgrass may already be impacted by drought stress. That white grubs are subterranean makes monitoring abundance time-consuming and damaging to the turfgrass; monitoring beetle flights can be an effective alternative. Black-light traps were used to monitor scarab beetles at seven turfgrass locations in Texas during 2015. In total, 23,345 scarab beetles were collected in weekly samples that were sorted to genus. *Phyllophoga* spp. was most abundant, followed by *Serica* spp., *Hybosorus* spp., *Cyclocephala* spp., *Tomarus* spp., and *Ataenius* spp. Beetle diversity and abundance varied by date and location, with many species having multiple peaks in flight intensity. Monitoring scarab beetle flights could reduce insecticide application by allowing turfgrass managers to time preventive applications targeting eggs and immature white grubs as opposed to repeatedly applying curative insecticides based on multiple peaks in abundance.

Introduction

Turfgrasses in landscapes, golf courses, and athletic fields cool urban centers, capture rainfall, prevent runoff, fix carbon, and provide other benefits. In addition to environmental benefits, turfgrass also impacts sod production, employment, recreation, etc. According to economic analysis for Texas sod production, 7,803 ha of turfgrass were grown in more than 35 counties during 2014 (Reynolds 2015). The study found that turfgrass production generated 2,128 jobs and $263 million in economic output, and a 2005 survey placed the estimated production cost of turfgrass at $5,694.53 per hectare (Falconer 2006). High-quality turfgrass produced for harvest and sale often attracts numerous insect pests that cause considerable damage and reduce profitability. Turfgrasses can be damaged after sale as homeowners, golf course superintendents, landscape professionals, etc. manage perennial plants in landscapes and recreational facilities that account for more than 647,497 ha in Texas alone (Cabrera et al. 2013).

[1]Coleoptera: Scarabaeidae
[2]Texas A&M Agrilife Extension Soil and Crop Sciences Department, 370 Olsen Boulevard, College Station, TX 77843-2474.
[3]Adama U.S. 3120 Highwoods Blvd #100, Raleigh, NC 27604.
[4]Texas A&M AgriLife Extension Entomology Department, Bldg 1804, College Station, TX 77843.
[5]Texas A&M Agrilife Extension, 17360 Coit Rd., Dallas, TX 75252.

Turfgrass-infesting scarab beetles are important pests in sod production, golf courses, recreational turf, and home lawns because unlike many other pests, they damage all species and varieties of grass (Vittum et al. 1999). The larval stage of the beetles, called white grubs, are white, curled, and C-shaped with yellowish or reddish-brown heads that feed on roots, thatch, and decaying organic matter (Ritcher 1966). They are especially problematic in arid climates such as the southern and southwestern United States where turfgrasses are drought stressed during the summer and fall. White grubs feeding on turfgrass roots further limit the ability of the plant to access water deep in the soil profile, resulting in additional stress and reduced ability to thrive.

Approximately 2,000 species of scarab beetles are found in the United States, Canada, and Mexico (Lawrence and Newton 1995, Quinn 2011), with at least 544 species in Texas (Riley 2003). Of these, at least 10 species produce white grubs that damage turfgrasses (Vittum et al. 1999). White grubs known to damage turfgrasses in Texas include *Phyllophaga* spp. (May/June beetles) and *Cyclocephala* spp. (masked chafers) and less frequently *Hybosorus* spp. (scavenger beetles), *Ataenius* spp. (turfgrass ataenius beetles), *Serica* spp., and *Tomarus* spp. (carrot beetles).

The subterranean larval stage of Scarabaeidae are problematic because feeding damage is not visible above ground until later in the season when much damage has already occurred and control is inadequate (Reinert 1979). To maximize effectiveness of insecticide, application targeting the larval stage of the pest must be properly timed based on beetle phenology. Monitoring beetle flights can allow for properly timed, preventive insecticide application that targets egg hatch when white grubs are most vulnerable and before damage to turfgrass occurs (Billiesen 2016). Timing insecticide application based on beetle flight activity is environmentally and economically beneficial because it reduces cost associated with multiple insecticide applications needed to control late-instar white grubs. Properly timed, single application of low use-rate, preventative insecticide (i.e., chlorantraniliprole at 0.2 kg ha^{-1}) as opposed to multiple applications of high use-rate, curative insecticides (i.e., carbaryl at 8.9 kg ha^{-1}) also minimizes off-target impacts by reducing the amount of insecticide in the environment. However, the efficacy of this preventative strategy relies on timely monitoring of beetle flight and subsequent egg hatch.

The objectives of this research were to determine which genera of scarab beetles occur in production and management of Texas turfgrasses and examine variations in peak flights based on genus and location. The information can help turfgrass managers properly time preventive insecticide applications that target egg hatch and larval stages of these destructive insect pests.

Materials and Methods

The study was initiated from 1 March to 1 May 2015 by placing Universal Black Light Traps (Bioquip, Rancho Dominguez, CA) at seven locations throughout Texas (Table 1). The locations were chosen to represent various areas of Texas where different environmental conditions and scarab beetles were likely present.

Traps at each location were placed near turfgrasses with a history of beetles and collected weekly during the study until no beetles were collected for at least two consecutive weeks in November 2015, indicating the termination of flights. Each trap consisted of a 26.7-cm-tall x 35.2-cm-diameter polypropylene bucket with a

Table 1. Site Information and Description for Scarab Beetle Collections during 2015 at Seven Locations in Texas

Location	Facility	Latitude, longitude	Collection dates
Austin	Texas A&M Agrilife Office	30.2582, -97.6786	1 May – 29 Nov.
Bryan	Golf Course Facility	30.6737, -96.3080	1 Apr. – 25 Nov.
College Station	Texas A&M Turfgrass Research Lab	30.6176, -96.3662	1 Mar. – 25 Nov.
Dallas	Texas A&M Turfgrass Research Lab	32.9868, -96.7671	29 Mar. – 4 Nov.
Pilot Point	Turfgrass Production Field	33.4223, -96.9315	8 Mar. – 4 Nov.
The Woodlands	Golf Course Facility	30.1554, -95.5385	22 Mar. – 25 Nov.
Wharton	Turfgrass Production Field	29.3086, -96.0231	22 Mar. – 25 Nov.

volume of 0.03 cubic meters. A 22-watt Circline black-light bulb (Bioquip, Rancho Domingues, CA) powered by a 120-volt AC power supply was mounted at the top of each container to attract beetles. A strainer was used to immediately clean debris from each weekly collection, and insects were packaged into plastic freezer bags and transported to a Texas A&M University laboratory for storage in a -18°C freezer until sorted. Soil and air temperature were monitored daily using Onset HOBO ProV2 data loggers (Onset Computer Corporation, Bourne, MA) set to collect daily average, minimum, and maximum soil and air temperatures.

All beetles were surface cleaned manually by either placing them on a piece of cheese-cloth stretched over a small bucket, or by holding them under running tap water. The beetles were separated morphologically, and each morphologically distinct group was placed into a labeled zippered bag. With the help of identification keys and Mr. Ed Riley (Assistant Curator, Texas A&M University Insect Collection), each group was identified to genus, and the number of insects in each genus was recorded by collection date and location. Representative specimens were retained and vouchered at the Texas A&M University Insect Collection at College Station.

Results

Weekly collections of scarab beetles at seven locations during 2015 indicated that populations varied widely by genus and location (Table 2). *Phyllophaga* spp. were most prevalent, with 13,934 beetles total collected at the

Table 2. Numbers of Genera of Scarab Beetles Collected at Seven Monitoring Locations throughout Texas during 2015

Location	*Phyllophaga*	*Serica*	*Hybosorus*	*Cyclocephala*	*Tomarus*	*Ataenius*
Austin	278	0	4	82	1	0
Bryan	438	2,691	46	419	1	79
College Station	703	61	216	159	14	280
Dallas	5,174	0	0	191	0	0
Pilot Point	1,101	0	946	179	1,312	0
The Woodlands	119	35	79	420	0	33
Wharton	6,121	13	1,242	872	2	34
Total	13,934	2,800	2,533	2,322	1,330	426

seven locations. This was followed by *Serica* spp. (2,800), *Hybosorus* spp. (2,533), and *Cyclocephala* spp. (2,322). *Tomarus* spp. (1,330) and *Ataenius* spp. (426) were found less frequently. *Phyllophaga* and *Cyclocephala* spp. were the only two genera found at all seven monitoring locations. *Hybosorus* spp. were found at all locations except Dallas, while *Tomarus* spp. were found at all locations except Dallas and The Woodlands. *Serica* and *Ataenius* spp. were found at Bryan, College Station, The Woodlands, and Wharton, but not at Austin, Dallas, or Pilot Point, TX.

In addition to differences in genera at each location, there was a wide range of differences in quantities. The number of beetles at each location varied from 6,121 *Phyllophaga* spp. at The Woodlands, to one to four *Hybosorus* and *Tomarus* spp. Four locations (Austin, Dallas, Pilot Point, and The Woodlands) had no beetles of at least one genus collected during 2015.

Beetle flight intensity varied by date (Figs. 1-7). Peak flights occurred as early as 2 April 2015 at The Woodlands for *Cyclocephala* spp. and as late as 1 October 2015 for *Tomarus* spp. at Pilot Point, TX. Peak flights of *Phyllophaga* spp. occurred first at all locations except The Woodlands where *Cyclocephala* spp. flight activity was at least 2 weeks ahead of *Phyllophaga* activity. Traps at College Station, Dallas, Pilot Point, and Wharton, TX showed multiple peaks in *Phyllophaga* activity that ranged from 9 weeks apart at Wharton to 12 weeks apart at Dallas. By comparison, peaks in *Cyclocephala* spp. flight activity at The Woodlands occurred much closer together, between 4 and 6 weeks apart.

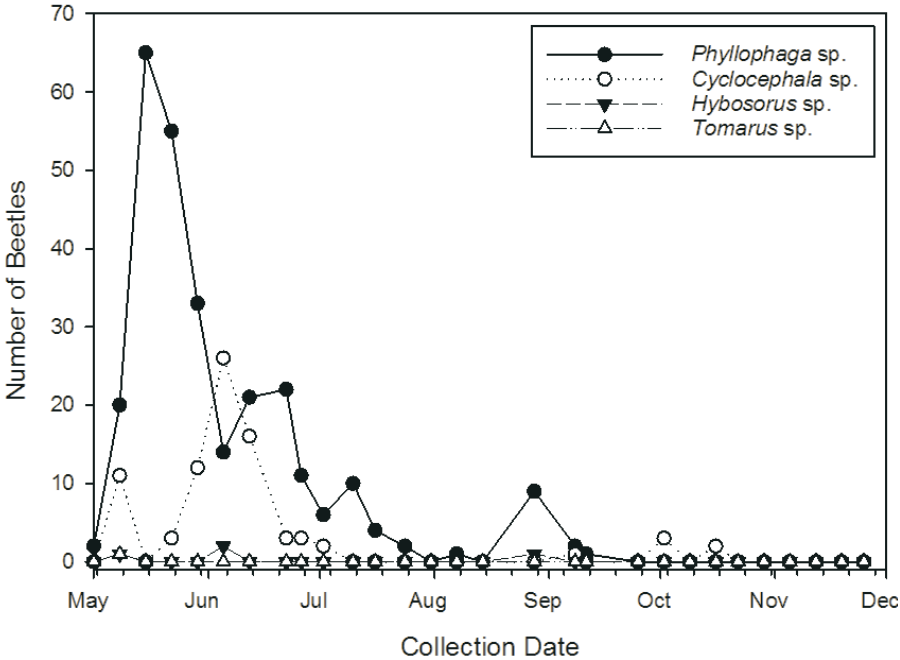

Fig. 1. Scarab beetles present in weekly collections from a black-light trap at Austin, TX, from May through November 2015.

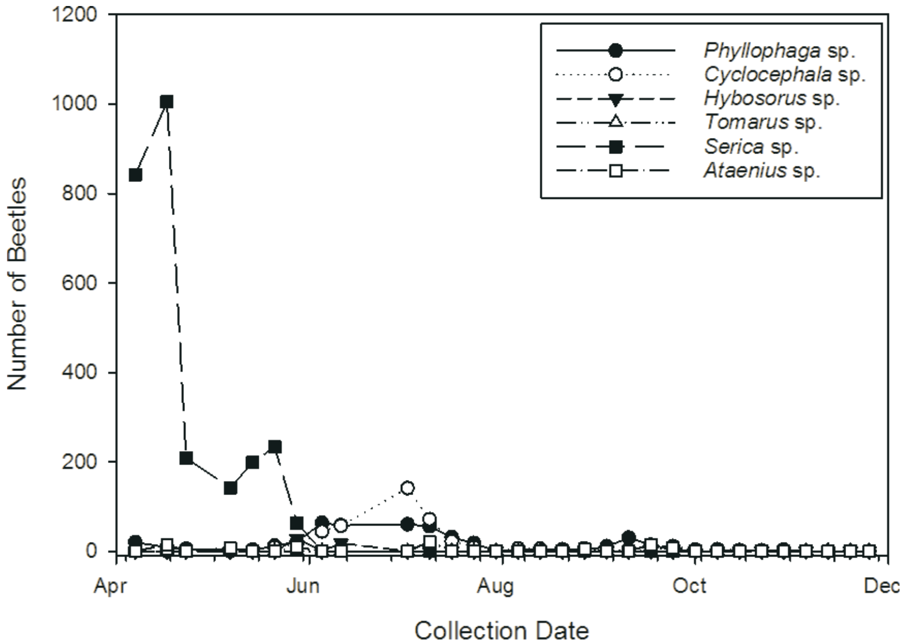

Fig. 2. Scarab beetles in weekly collections from a black-light trap at Bryan, TX, from May through November 2015.

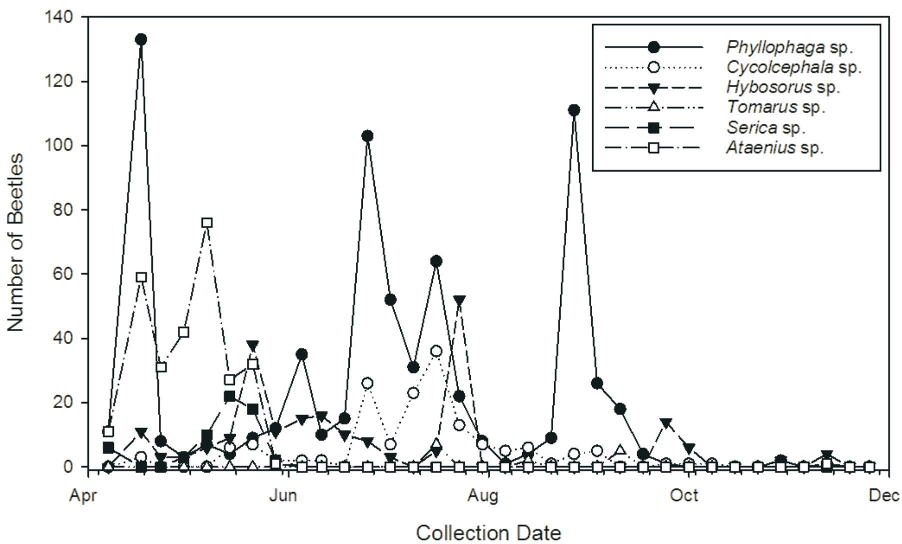

Fig. 3. Scarab beetles in weekly collections from a black-light trap at College Station, TX, from May through November 2015.

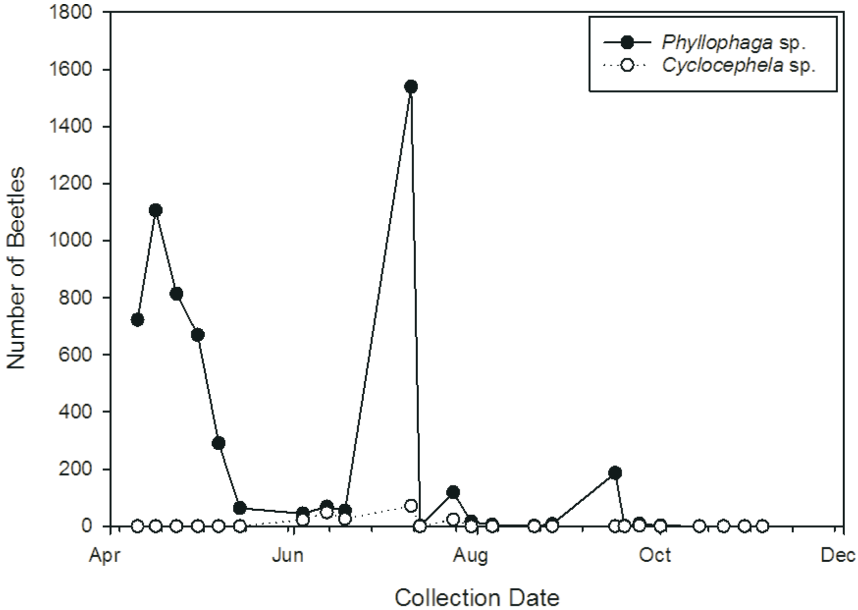

Fig. 4. Scarab beetles in weekly collections from a black-light trap at Dallas, TX, from May through November 2015.

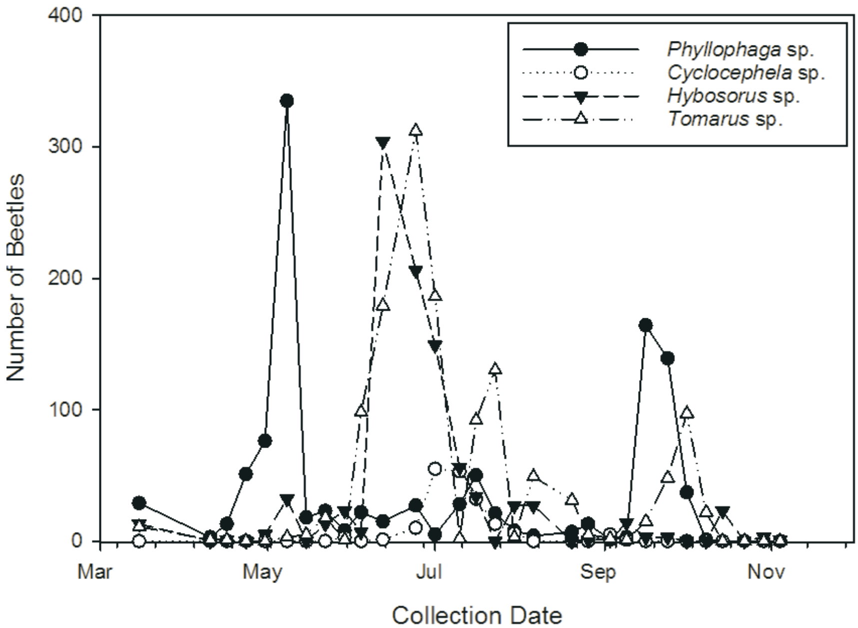

Fig. 5. Scarab beetles in weekly collections from a black-light trap at Pilot Point, TX, from May through November 2015.

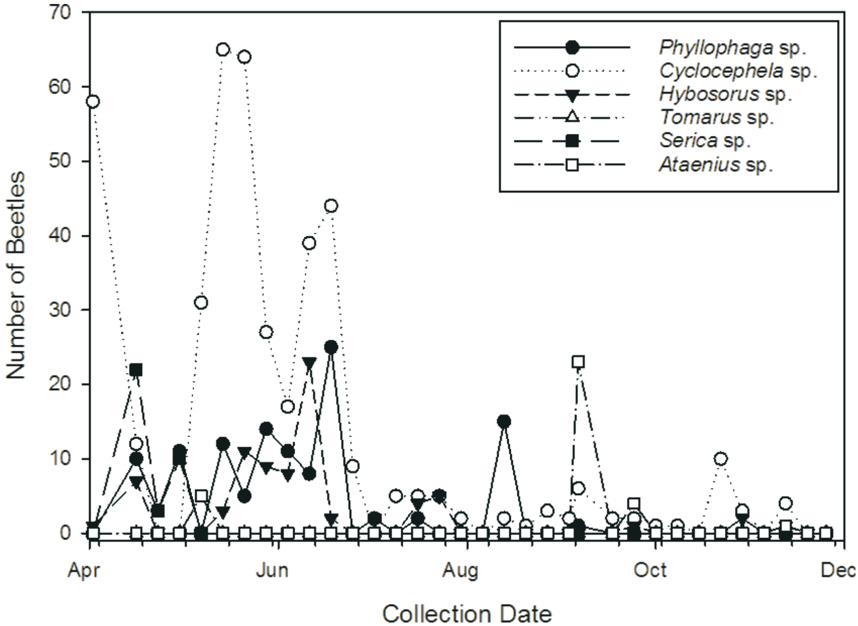

Fig. 6. Scarab beetles in weekly collections from a black-light trap at The Woodlands, TX, from May through November 2015.

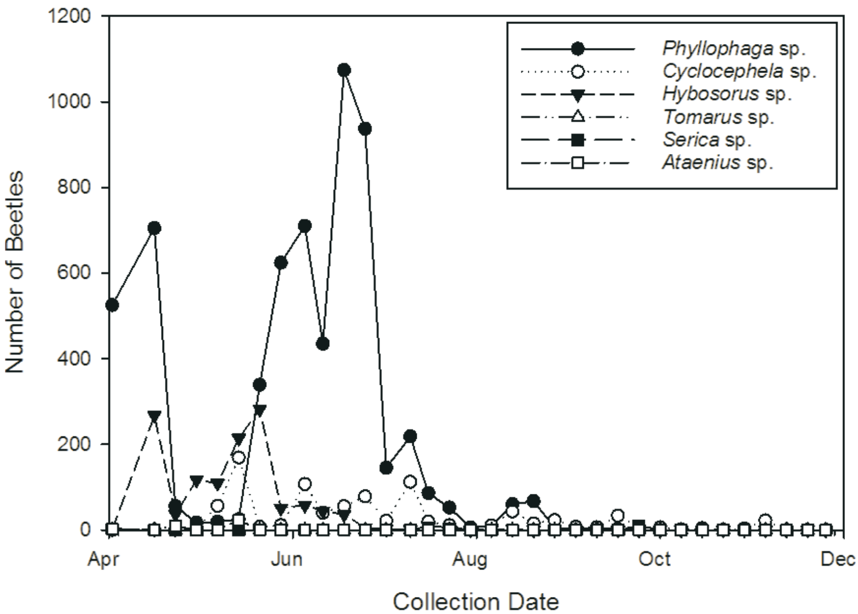

Fig. 7. Scarab beetles in weekly collections from a black-light trap at Wharton, TX, from May through November 2015.

Beetles of *Hybosorus*, *Tomarus*, *Serica*, and *Ataenius* genera were least prevalent (Table 2, Figs. 1-7). Bryan was the only location where a significant number of *Serica* spp. were collected, and peak flight in Fig. 2 showed that most (79%) were collected before mid-April. Conversely, peak flights of *Hybosorus* and *Tomarus* spp. at Pilot Point were as late as 24 June to 1 July 2015. As a result, monitoring data from Table 2 and Figs. 1-7 indicated much diversity in beetle numbers and peak flights throughout Texas. Average soil temperature for 1 week preceding the initial peak flights of beetles at each location ranged from 19.9 to 23.5^{o}C, while average air temperatures ranged between 19.6 and 23.6^{o}C.

Discussion

Understanding abundance and timing of adults would enable proper timing and application of appropriate treatments to manage scarab beetle larvae. As shown in Table 1 and Figs. 1-7, scarab beetle abundance and flights in Texas varied. *Phyllophaga* spp. (May/June beetles) had peak flights during May and/or June at every monitoring location. Additional peaks in flight activity occurred later in summer and fall. Results are consistent with previous research on turfgrass in Oklahoma where *P. crassissima* (Blanchard), *P. crinita* (Burmeister), *P. congrua* (LeConte), *P. submucida* (LeConte), and *P. torta* (LeConte) were captured during 3 months of summers of 2005 and 2006 (Doskocil et al. 2008). *Phyllophaga* spp. previously reported in Texas included *P. rubiginosa* (LeConte), *P. hirtiventris* (Horn), *P. crassissima, P. crinita,* and *P. congrua* (Crocker et al. 1999). Of the species, *P. congrua* most damages turfgrass (Crocker 1989). Beetle species in the *Phyllophaga* genus have 1-, 2-, or 3-year life cycles and damage turfgrasses throughout the summer and fall (Vittum et al. 1999). Of the species reported by Crocker (1989) in Texas, each has a 2-year life cycle during which they pupate in fall and adults fly the following spring (Reinhard 1950).

Larvae of *Cyclocephela* spp. (masked chafers) are important pests of turfgrasses and cause significant damage to bermudagrass (*Cynodon dactylon* (L.) Pers.) golf courses and St. Augustinegrass (*Stenotaphrum secundatum* (Walt.) Kuntze) lawns of homes in Florida (Reinert 1979). The southern masked chafer, *Cyclocephala lurida* (Bland), commonly occurs in Texas and damages cool- and warm-season turfgrasses (Reinert 1979, Crutchfield and Potter 1995, Zenger and Gibb 2001). Like *Phyllophaga* spp., they have multiple flights throughout the summer, and peak activity was documented in the traps (Figs. 1-7) on several occasions. Other genera of scarab beetles such as *Hybosorus* spp., *Tomarus* spp., *Serica* spp., and *Ataenius* spp. were less abundant and found in light traps at fewer locations. While the genera are typically considered less problematic in managed turfgrasses, damage by the beetles has been observed (Arnett et al. 2002).

The complexities of the various species and life cycles, as well as biotic and abiotic environmental factors can make managing white grubs difficult. This is especially true in high-value turf on production farms, golf courses, and some residential and commercial settings where damage thresholds are low. In these settings, turfgrass managers commonly use one of three management strategies to manage white grubs. One strategy is to monitor white grubs and treat curatively after the threshold has been reached. Industry and university recommendations for thresholds of the number of white grubs per 0.1 m^2 range from one to 10 (Bowen 1980, Baxendale and Gaussoin 1992, Bruneau 1993). While this method is effective, it is time-consuming, laborious, and destructive because it requires uprooting the turfgrass to look for white grubs. Another curative strategy is to treat only after significant damage has occurred. This reduces the amount of time and labor associated with destructive sampling but also results in waiting for visible damage to turfgrass, which in many settings may be unacceptable.

Curative insecticides labeled for use in turfgrasses include products containing bifenthrin, carbaryl, chlorpyrifos, lambda-cyhalothrin, and trichlorfon. Several factors need to be considered when relying solely on insecticide, one factor being that white grubs in mid- to late summer are often large and difficult to control. Furthermore, in climates in southern and southwestern United States where rainfall often is limited during summer months, it may be difficult to adequately water insecticide into the soil where it is more effective at coming into contact with white grubs. It is important to note that many insecticide products are applied at high rates (i.e., carbaryl at 8.9 kg ha^{-1}) and might affect non-target organisms (Cockfield and Potter 1983). Lastly, the multiple flight peaks and life cycles of the various species of scarab beetles (Figs. 1-7) might require numerous applications of curative products to control all species and feeding by white grubs.

In addition to the two curative approaches, turfgrass managers can also use a preventive approach, which is especially useful in areas with a history of damage from white grubs or in areas where lower product application rates might be desirable. Preventive products applied before egg hatch often can provide long-lasting, residual control of multiple white grub species including May/June beetles, southern masked chafers, turfgrass ataenius beetles, and Japanese beetles, *Poppillia japonica* Newman. Preventive products use active ingredients such as chlorantraniliprole, cyantraniliprole, or halofenozid that are effective at lower rates (i.e., chlorantraniliprole at 0.2 kg ha^{-1}) than curative products (i.e., carbaryl at 8.9 kg ha^{-1}). It is also important to note that some active ingredients such as halofenozide and chlorantraniliprole are less detrimental to non-target organisms than are older, curative active ingredients (Kunkel et al. 1999, Larson et al. 2011). However, timing application before egg hatch is imperative for achieving maximum control.

Monitoring beetle flights adjacent to high-value turfgrass is effective for pinpointing times of peak flights that often vary by location and environmental factors. Information from this field study of turf-infesting scarab beetles can be valuable for helping turfgrass producers and managers determine when insecticide application should be most effectively timed to maximize residual control, minimize impacts on non-target organisms, and reduce damage by white grubs to turfgrasses.

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