# DIFFERENCES IN TURFGRASS ARTHROPOD DIVERSITY IN GOLF COURSE FAIRWAYS AND ROUGHSAS A FACTOR IN OUTBREAKS OF *Ataenius spretulus* AND *Aphodius granarius* (Coleoptera: Scarabaeidae)

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**Abstract**

The black turfgrass ataenius, *Ataenius spretulus* (Haldeman), and a similar looking beetle, *Aphodius granarius* (L.), are pests of golf course turf. The larval stage of these beetles chew the roots of the turfgrass, causing irregular areas of dead turf in golf course fairways, but not in the adjacent rough. To determine if the differences in arthropod diversity between the fairway and the rough influenced the spatial distribution of A. *spretulus* and A. *granarius* both surface and soil dwelling arthropods were sampled.
The activity of surface insects was monitored using 48 pitfall traps across the border between the fairway and rough. The arthropods were collected from the pitfall traps weekly and were identified to family if possible. To sample soil dwelling arthropods a standard golf course cup cutter was used. A total of 12 soil cores were removed from thefairway and 12 from the rough each week. The soil cores were placed in heat extraction units and the arthropods collected from these units were counted and classified. The results from both sampling methods will be discussed.

## Introduction

### Life History

The small white grubs of the black turfgrass ataenius, *Ataenius spretulus* a native insect to North America, are an important pest of golf course fairways, greens and tees in the eastern and mid-western United States as well as some provinces of Canada. (Niemczyk and Dunbar 1976). The species was first known to damage turf in Minnesota in 1927 (Tashiro 1987) but was not well documented as a turf pest until after 1970, when damage from black turfgrass ataenius rose sharply. This increase in outbreaks is apparently due to developed resistance to insecticides such as chlordane, dieldrin and others (Weaver and Hacker 1970, Niemczyk and Wegner 1982). *Ataenius spretulus* completes two generations a year in regions south of Ohio (Wegner and Niemczyk 1981). In northern Ohio and Michigan, *A. spretulus* appears to complete one generation per year (Wegner and Neimczyk 1981, Smitley 1994). Overwintering adults deposit eggs in May. Larval densities reach their peak in June. A second generation of adults emerges in July. In areas that experience two generations per year, eggs are found again in July and August. In August the larval densities peak again, pupating in early October.

*Aphodius granarius* (L.) is very similar to *Ataenius spretulus* in appearance for both adult and larval stages. European in origin, *Aphodius granarius* was recently identified as a pest of golf courses in Ontario, Michigan, Colorado, and Ohio where it was originally misidentified as *Ataenius spretulus* (Tashiro 1987). Adults of *A. granarius* are distinguished from adults of *A. spretulus* by the presence of transverse carinae on the hind tibia. The larvae of each can be identified by the rastral pattern (Tashiro 1987). *A. granarius* grubs feed on turfgrass and cause blotchy patches of turf to die in the fairway in a pattern similar to that of the black turfgrass ataenius. *A. granarus* is thought to complete two generations in Ontario and Ohio, and a single generation in New Jersey and Michigan (Tashiro 1987, Smitley 1994). In Michigan, *A. granarius* adults overwinter and become active again in May. The larvae are present in June, about four weeks earlier than those of *A. spretulus* (Smitley 1994).

**Damage**

The larvae of *A. spretulus* and *A. granarius* cause sporadic, severe damage to golf course greens and fairways by chewing the roots of cool season grasses, such as Kentucky bluegrass, killing the turf in irregular patches (Potter 1998). *A. spretulus* and *A. granarius* adults and larvae are most dense in the short turf of the fairway, while many surface predators such as Carabidae and Formicidae are not abundant in short turf (Smitley et al. 1998). Similarly, numbers of general surface predators increased in the adjacent rough, where turfgrass is maintained at a height of 25 cm, compared with 5 cm in the fairway. The densities of *A. spretulus* and *A. granarius* are inversely proportionate to the number of insect surface predators (Rothwell and Smitley 1998, Smitley et al. 1998). These differences in densities still exist in the absence of pesticides, although differences may be even greater when pesticides are used on the fairway (Rothwell and Smitley 1998, Smitley et al. 1998). This skewed distribution of insect populations towards separate preferred habitats points to predation as a major factor in biological control of *A. spretulus* and *A. granarius* in turfgrass.

Previous studies show that mowing height is an important factor in the environmental preferences of *A. spretulus* and *A. granarius* and their predators. The skewed nature of the distribution of grubs towards the fairway has been linked to predator preferences for the adjacent rough. When mowing regimes are changed, *A. spretulus* and *A. granarius* move into the new fairway while surface predators move into the new rough (Rothwell and Smitley 1998). Although an explanation of outbreaks of *A. spretulus* and *A. granarius* remains unattainable, studies have shown the relationship between these grubs and general arthropod predators to be extremely important (Smitley et al. 1998). A close look at the arthropod communities could provide answers to ecological questions about insect induced turfgrass damage. By closely examining the diversity of such a manageable environment it may become easier to predict insect outbreaks and/or damage by sampling and assessing the existing turfgrass community. A working knowledge of the arthropod community can lead to assigning indicator species for turfgrass health and reducing the risk of unnecessary and costly pesticide applications.

The arthropods thought to make up this prey base for the predator consists mainly of mites and collembola. Collembola are primitive insects that live in the soil and feed on fungi and bacteria. Mites typically feed on plant material, but some are predaceous. If these two large groups of insects are more abundant in the rough than in the fairway, it may affect the number of predators found in each turf system. More prey means more predators, and if the prey base is large in the rough, the predators will find no need to forage for food in the fairway, resulting in higher numbers of grubs in the fairway.

**Objectives**

In Michigan, *Ataenius spretulus, Aphodius granarius* and their potential predators in golf course fairways and roughs were studied to determine their spatial distributions (Rothwell and Smitley 1998). Observations of differences in insect predator activity in the fairway and rough have raised the question of why are predators more abundant in the rough? The objectives of this research are to:

1. Determine population densities of predatory insects in the fairway and in the rough.

2. Determine population densities of prey insects, including *A. spretulus* and *A. granarius* in the fairway and in the rough.

**Methods**

At Groesbeck Golf Course in Lansing, Michigan a single hole was chosen for this experiment. Due to possible desiccation of the arthropods in the soil samples, it was crucial to have a field site that was relatively close to Michigan State University. Six blocks were set up around a central irrigation factor. Each block contains both pitfall traps and an area to take cup cutter samples. The cup cutter samples were taken near the pitfall traps, but in slightly different places each time, to minimize disturbance to the block.

1. Monitoring of Surface Arthropods

Pitfall traps are commonly used to monitor surface activity on golf courses. The traps were 8 dram glass vials filled with ethylene glycol and placed flush with the surface. Eight pitfall traps were placed across the border between the fairway and the rough, four to each turf type, once in each block. The pitfall traps were placed at .5, 1, 1.5, and 2 meters away from the border. They were replaced once a week. The specimens were counted and classified.

2. Sampling for Subsurface Arthropods

Two cup cutter samples were pulled from each turf type in each block. They were replaced by pre-cut soil cores so as not to permanently disturb the turf environment. The sample cores were hand searched for visible arthropods in the field. After hand searching, the soil cores were placed in coded plastic bags and transported back to the lab. A heat extraction method was used to draw small arthropods out of the sample. The samples were emptied onto screens in Tulgren type funnels and placed under 40 watt bulbs. The bulbs were connected to a rheostat and gradually turned up each day. Jars of alcohol were placed under the funnels to collect small arthropods that crawled out of the sample. All specimens were carefully collected, counted and classified.

In the lab, the insects and arthropods were collected from the samples, counted and identified to family whenever possible. Under a microscope, mites and collembola were separated for identification. Also separated were any insects or arthropods that could not be sight identified to family. These specimens were classified as 'others' in the data analysis.

**Results**

From the pitfall traps, seven categories of insects were counted (Fig 3). All surface arthropods collected were adults, with the exception of three rove beetle larvae, which are highly mobile and fell into the traps. This is not normal, however, and the larvae were not counted as part of the total surface sample. Using a generalized linear model, and assuming a Poisson distribution, a regression analysis was done on the count data and a significant difference between the treatments of fairway and rough was observed for all seven categories (Table 1). This was also true of the soil samples. The arthropods collected were placed in six categories, and were run against the same generalized linear model, assuming a Poisson distribution. A statistical significance was found between the treatments for each of these categories as well (Table 1).

The differences between the treatments were large in both the collembola and the mites, which were consistent within treatments, but noticeably different between treatments (Fig 1). The differences in the predator counts were less extreme, but still significant (Fig 2). Overall, the communities in both the fairway and the rough appear to be different, and a split plot analysis of the data will provide us with not only the effects of grass type, but also the effects of distance from the border and time (Fig. 3).

**Discussion**

Because this study is only in it's first year, I am hesitant to make any conclusions based on this data. It appears that the prey base is larger in the rough, as hypothesized, but this is in no way a conclusive experiment. The increased number of predators found in the rough may also point toward a larger prey base. If the prey base in the rough is indeed larger than that of the fairway, it seems logical that the predators would remain in the rough, rather than foraging in the fairway for prey. This behavior would open the door for insects like *Ataenius spretulus* and *Aphodius granarius* to infest the fairway and remain unchecked by natural predators.

**Literature Cited**


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**Figures and Tables**

**Fig. 1** Prey Means ± Standard Error

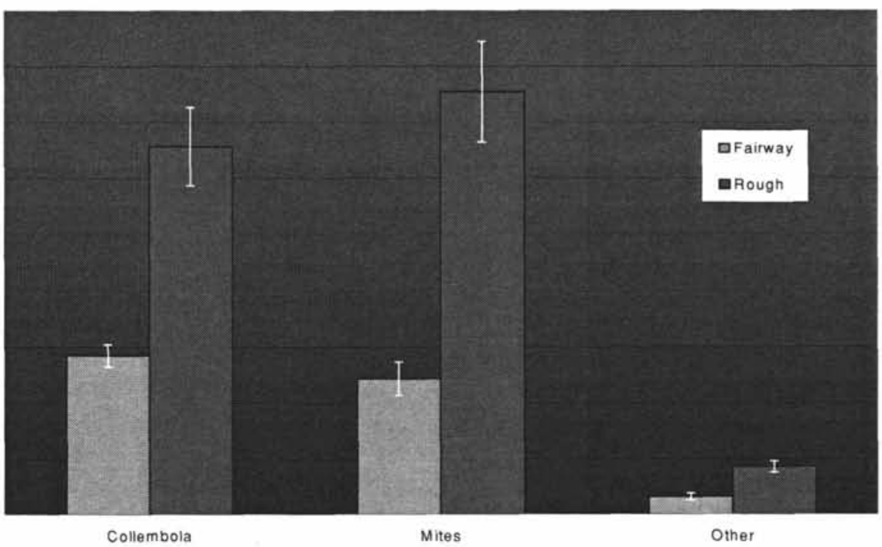

**Fig 2** Predator Means ± StandardError

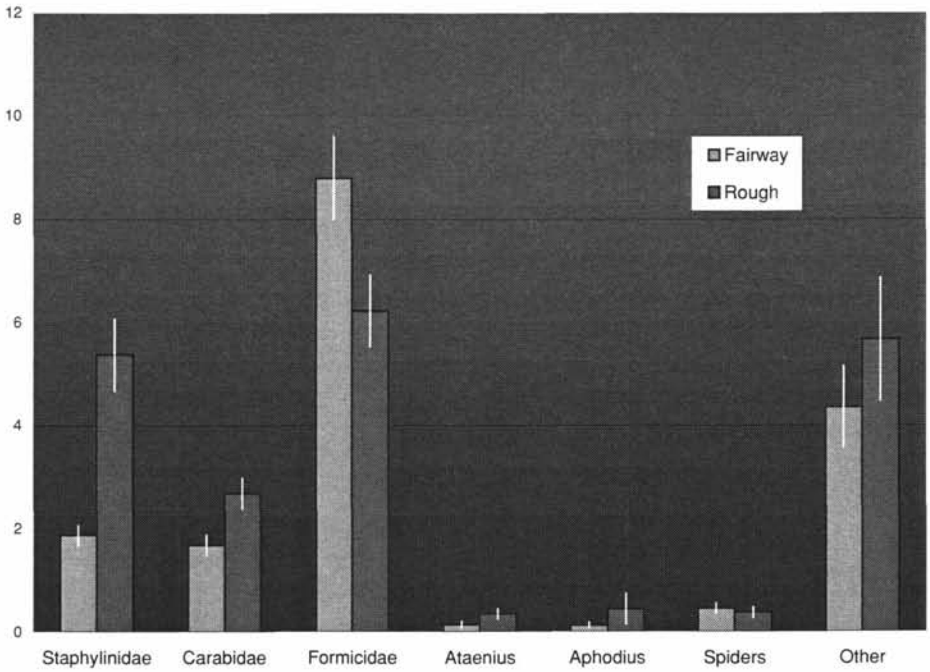


**Table 1** Raw Data from Groesbeck Golf Course, Lansing, MI

| | Means and Standard Deviations | |
|---|---|---|
| | Fairway | Rough |
| Ants (surface) | 8.79 ± 6.03 | 6.22 ± 4.86 |
| Mites | 24.4 ± 22.4 | 75.5 ± 68.9 |
| Collembola | 28.5 ± 16.2 | 65.7 ± 54.1 |
| Carabidae | 1.69 ± 1.79 | 2.69 ± 2.13 |
| Staphylinidae | 1.88 ± 1.7 | 6.44 ± 5.37 |
| Spiders | .458 ± .682 | .375 ± .672 |
| Other (surface) | 4.35 ± 5.57 | 5.66 ± 8.24 |
| Other (soil) | 3.29 ± 4.41 | 8.60 ± 13.4 |
| Ataenius | .146 ± .461 | .351 ± .812 |
| Aphodius | .125 ± .392 | .438 ± 2.32 |

**Fig. 3 Community Outlook – Raw Numbers**