noticed. Because there is no natural disease occurrence in Wisconsin, we have to set up a research plot where the disease pressure is naturally high. Last fall our first field plot was established at Urbana-Champagne, IL (collaborator: Dr. Andy Hamblin) and was inoculated with an Illinois *P. grisea* isolate. Unfortunately, no disease developed in the plot. That is one difficulty in carrying out the field experiment with this type of disease. That means that we do not fully understand the epidemiology of the pathogen. Very specific conditions (temperature, humidity, moisture, plant condition, and other unknown factors) must be met for the pathogen to cause visible disease symptoms.

Since this project is important for several reasons (the completion of Joe's Ph.D. dissertation, a USGA funded project, and job security), two sites at Carbondale, IL and Lexington, KY where disease incidences were previously reported were selected this year even though they are many miles from us. Dr. Ken Diesburg (Southern Illinois University, Carbondale, IL) and Dr. David Williams (University of Kentucky, Lexington, KY) graciously accepted our request to help prepare a research plot at their turfgrass research facilities.

At first, 4500 plants were split, transferred into plastic pots and filled with soil by Joe Curley, Steve Abler and summer undergraduate students at the O. J. Noer (Brandon Kobilka, Kevin Schneider, Jonathan Rivers, Scott Johnson, and Andy Rubsam). The plants were grown in the greenhouse for three weeks. Then a four-day journey with four people (Joe Curley, Jonathan Rivers, Scott Johnson, and myself) began. The clonally propagated plants and our luggage were packed up into two vans and left Madison at 6:00 am.

As drove down south, the last digit number for air temperature that I remembered was 104°F. It was hot and humid at Carbondale. Despite the weather conditions, the plot looked very good. We transplanted the plants until a bit of light allowed us to see each other. The next morning we finished the rest of transplanting before noon and spent several afternoon hours discussing plot maintenance (irrigation, cutting height, fertility, and inoculation).

We arrived in Lexington late that evening. The next morning we went to a research farm to meet with Dr. David Williams at the University of Kentucky-Lexington. The farm was huge (1500 acres) and well organized under a high security system. Field research projects from many different disciplines including turf were all in one place. It took a full day to finish all transplanting and this included David's field technician and a graduate student. Due to their excellent plot preparation, everything went very smoothly.

I want to thank the collaborators and helpers for their sincere dedication. In spite of their busy time with their own work, they prepared the plots very well and even provided us extra hands so that all of our planned work was successfully completed on time. Our collaborators' genuine participation and patience to carry out our cooperative research projects should be acknowledged. I want to express my special appreciation to two undergraduates for showing their responsibility, endurance, and maturity to help complete the project despite the unpleasant weather and a long day's hard work.

For me, it was a new and joyful experience, meeting and working with people, tasting local foods, and solving biologically complex problems via orchestrated cooperation with diverse expertise. The trip will be vividly remembered. What I am anxiously longing for right now is a phone call from our collaborators informing us that gray leaf spot rampages through our plots.

Slime Molds: Stranger Than Fiction

By Steve Abler and Dr. Geunhwa Jung, *Turfgrass Diagnostic Lab, Department of Plant Pathology, University of Wisconsin-Madison*

Every summer I receive several calls, emails, and samples from turfgrass professionals and home-owners about peculiar, disgusting, and colorful growths on their lawns or in their mulch beds that appeared seemingly overnight. Most people don't know whether these masses of goo are a living organism, a prank, vomit, or blob that fell from outer space to devour everything in its path*. When I tell the concerned turf grower that they are dealing with a slime mold, the usual response is, "Is that some kind of fungus?" To that question, I answer with a confident, "yes... well, ...sort of."

Figure: Slime mold sporangia on Kentucky bluegrass leaves.

Biology of Slime Molds

Slime molds have been traditionally studied by mycologists (fungus experts) because their sporangia resemble fungal fruiting bodies. On the other hand, slime molds have motile zoospores and obtain nutrients like animals. The current generally accepted consensus is that the slime molds belong in the kingdom Protista which is comprised of single-celled organisms that have internal digestion. Although the exact taxonomic placement of these organisms is still being worked out, there is little confusion regarding the life cycles of slime molds.

I will explain the life cycle beginning at the spore stage which serves as the long-term survival structure for the slime molds. Spores remain dormant until conditions are suitable for germination at which time the spores germinate into single-celled zoospores that lack cell walls. Most zoospores have flagella which they use to swim and find bacteria, fungi, and organic matter to feed on. Individual zoospores pair up with another zoospore, and fuse together to form a small plasmodium. The plasmodium is the main vegetative structure of the slime molds that is present on the surface of the soil, thatch, mulch, etc. The plasmodium is the "blob" stage of the slime mold which is able to ooze, usually unnoticed, along the ground and feed while conditions remain favorable for growth. These plasmodia are biologically strange because they are basically a mass of cells that lack cell walls (they do have cell membranes) that all work together to creep like a giant amoeba. When weather conditions become unfavorable, or some biological cue prompts them to, the plasmodia creep up on vegetation, mulch, or other debris and form colorful sporangia. The sporangia are basically plasmodia that produce cells walls to wall off nuclei, thus forming the spores with which began our life cycle tour (Smith et. al., 1989). The fact that sporangia are formed on top of mulch and vegetation probably aids in spore dispersal via wind, water, and mechanical transfer. Sporangia are easily visible to the naked eyes and are the basis for all of the calls and samples that are sent to the TDL.

Slime Molds on Turfgrasses

Slime molds are relatively common in damp areas and longer cut turfgrasses present on golf course roughs, athletic fields, and home lawns from mid-summer to the onset of winter. Slime molds are not host specific, and probably prefer the longer grass because the thatch and elevated moisture beneath the turf canopy is an ideal habitat for the bacteria, fungi, and organic matter that they feed on. The two species of slime mold that are commonly found on turf are *Mucilago spongiosa*, which has white or cream-colored sporangia, and the more common *Physarum cinereum*, that has gray to purple sporangia (Couch, 1995). Additionally, the extremely common slime mold *Fuligo septica* usually occurs on mulch, but sometimes is found on nearby turf. The appearance of this slime mold has been likened to scrambled eggs, or the less appealing dog vomit (Volk, 2004).

Symptoms of slime molds on turf include roughly circular to irregular patches of turf a couple inches to a few feet in diameter that appear a wide range of colors, but are generally white, gray, or purple. Conspicuous sporangia of the slime mold are easily seen on the surface of individual leaves with the naked eye (See figure). As sporangia age, they become brittle and easily break open to release the more darkly pigmented (brown to black) spores they contain. These spores are easily spread by water, wind, and anything brushing up against them. The good news for turfgrass managers is that slime molds are not directly pathogenic to turfgrass plants and are non-toxic to people or pets. The only thing they do that is in any way detrimental the plant is to shade some of the photosynthetic leaf area. The shading of the turf leaves is a minor problem and chlorosis of individual leaf blades is rarely noticed. Signs of slime molds usually fade quickly as the weather becomes drier.

Most fungicides control slime molds, but are not recommended because of the non-pathogenic nature of the organism. Slime molds can be removed from turf leaves by mowing, spraying them with a hose, or dragging a hose across affected areas when weather conditions are going to be dry. Conversely, these techniques may serve to spread the slime mold if weather conditions following the removal remain wet. The other alternative is to leave the slime mold alone and enjoy the color that these mysterious organisms add to your turfgrasses.

*For reference, see the 1958 film *The Blob*

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My Favorite Part of Wisconsin

By Monroe S. Miller, *Golf Course Superintendent, Blackhawk Country Club*

I frequently make reference to the driftless area of Wisconsin, both in conversation and in writing here in The Grass Roots. That's the part of Wisconsin where I grew up and still love so much. I always have assumed everyone knows where that is and what it means.

Wrong on both counts. Finally, one of you asked what I meant by that phrase.

First, my apologies for being presumptuous. Not everyone is interested in geography, especially when you are not from the place in question. And not everyone studied Soil Science, a discipline at the UW-Madison where essential geography is taught so you are able to understand the genesis and morphology of soils in Wisconsin. That study leads to an appreciation of landscape features common to various part of our state, too.

The driftless area of Wisconsin is the southwestern portion of the state. It refers to the part of Wisconsin that was NOT covered by a glacier during the last glacial advance, 14 - 15,000 years ago.

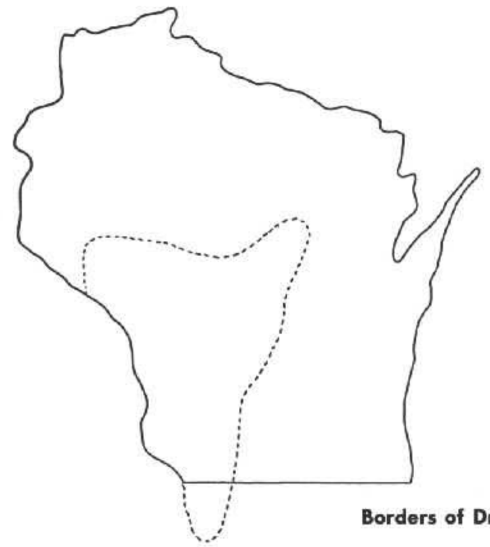
The term "driftless" comes from the word "drift." Drift is another term for glacial till, the material that is carried along by the glacier (actually inside the glacier itself). Drift is actually a very good word when referring to the material that has been deposited by glaciers on the ground surface.

So, by putting the suffix "less" behind drift, you get the descriptive word that means the absence of glacial till or drift in an area. The term "driftless area" suddenly makes a lot of sense because there isn't any glacial drift or till in southwest Wisconsin.

I can remember learning that geologists believe that the southwest portion of Wisconsin could be the only area of its kind in the world that was surrounded on all sides by a continental glacier but not glaciated itself.

When the last glacier was coming down from the north thousands of years ago, it followed the path of least resistance - the soft bedrock of the Lake Superior and the Lake Michigan basin directed the lobes of the glacier to the south and the southwest. The lobes rejoined in Illinois and Iowa, leaving small driftless areas in northwest Illinois and in northeast Iowa that look the same as southwest Wisconsin.

The lack of glaciation in southwest Wisconsin results in the hill and valley country you see today. It is never more beautiful than it is in autumn, a perfect time for a ride through this area of unique geology. And few places can sport more scenic golf courses than the driftless area of Wisconsin.



Borders of Driftless Area

How Technology Has Changed the Game of Golf

By Katie Connelly, University of Wisconsin-Madison

Editor's Note: *Katie wrote this paper as part of an independent study conducted with Dr. Wayne Kussow. A former member of the UW women's golf team, Katie is now playing on the Futures Tour.*

How can a game that involves a player, a club, a ball, and a hole look so simple, yet be so heavily driven by technology? As we watch Tiger blast drives over 300 yards down the fairway and Ernie Els nonchalantly shoot thirty-one under par to set a new tournament record, we assume that it they can do it, so can we. With all the choices of golf clubs and golf balls and each one of them being touted as the latest, greatest technological advance, how can one not play as well as Tiger or any other tour player?

For centuries, the game of golf has been evolving at a steady rate with technological advancements in all aspects of the game: golf course architecture, maintenance, clubs, balls, teaching, and even players. However, at the 1997 Masters, the evolution of golf was stimulated by the record-breaking performance of Tiger Woods. Tiger "raised the bar" for both performance and the expectations of golfers, which in turn, has positively influenced the new wave of golf technology that has been developed in the past few years.

As Tiger demolished the field by a 12-shot margin of victory at 18 under par, the world of golf was both amazed and shocked. Golf had not witnessed this kind of accomplishment for more than two decades past since the era of Jack Nicklaus. How could someone so new to the game win a major by such a large margin over everyone else? Instead of honoring the great performance of Tiger, the world of golf introduced the idea of "Tiger-proofing" to prevent anything like this from ever occurring again. The ideas of "Tiger-proofing" were to make courses longer and more difficult, put restrictions on clubs and balls, and basically prevent longer, better players like Tiger from ever winning any tournament by such a large margin again. "Tiger-

proofing" was meant to protect the history of the game, when in fact, it sparked one of the greatest technological advancements in the history of the game.

Golfers wanted longer courses and instead of the normal yardage of 6500 yards for a golf course, the public expected courses of a minimum of 7000 yards. The general consensus was that the longer the course, the more difficult it would be for the longer players, but in actuality this idea would backfire by only punishing the average golfer. When courses are lengthened and "tricked up," this actually benefits the longer hitters because they tend to be the better players and the better players are the more accurate players. Therefore, to meet the demands and higher expectations of golfers, golf course architects reviewed courses and implemented new designs to lengthen already existing courses and develop more difficult courses.

Today, the new ideas and features of golf course design are not meant to penalize the golfer, but to meet the newly instilled demands of the game of golf. To accommodate for the elasticity in length of different golfers, more tees can be made for golfers to have a wider range of tee selection to choose from that conforms to their own games. Besides making more tees, courses can narrow tee shot landing areas in the fairways and strategically place hazards in or near the landing areas to place a greater emphasis on accuracy. There are also many options when designing the greens because the axis, depth/size, and contouring of the greens can demand more accuracy as well. With all of these improvements and changes in golf course design, there comes a cost and an increase in acreage requirements. There are increases in land acquisition costs, construction costs, and maintenance costs. Another question raised is who absorbs these costs?

With all of the new features of golf course design, one of the most important factors/ideas that golf course architects consider is that as the ball goes farther, the more likely it will go sideways. With greater chances of the ball going sideways, safety becomes a major issue because the need for more separation between golf holes is a must. On an already existing course that consists of 50 acres, this can be tough to accommodate because of the little space to work with. Courses with limited space can strategically place more hazards into its shorter layout and make adjustments in maintenance practices and irrigation to demand accuracy from its players.

Maintenance practices are also changing with the progression of the game of golf. In an effort to parallel technology and the advancement of the game, courses are making greens faster, heightening the roughs in narrower landing areas, softening sand in the bunkers, and adding mounds to inflict awkward lies. Faster greens are a major issue for golfers because the quickness tests the true ability of the player. Instead of using riding mowers that tend to exert 75 pounds, more courses are utilizing walking mowers, which exert 225 pounds to help increase the speed of the greens. When a heavier mass is rolling across the green while cutting them, the grass is compressed to make a firmer, quicker putting surface.

Another method used to increase the speed of greens is to use a growth retardant to slow down or decrease the amount of grass that grows. Using less irrigation on the greens will dry them out, and putting sand on the greens will make the putting surface firmer to implement faster greens. Superintendents also credit the discontinued use of metal spikes to better, smoother putting surfaces.

As the demands are met for longer and more difficult courses, the demand for new, improved clubs and balls is inevitable. When golf started out, and for centuries after, golf clubs were all made of wood. At a fairly leisurely pace, other materials began to be used for both the heads and the shafts. There were fiberglass shafts, aluminum shafts, and steel shafts. Club heads eventually began to be made out of both wood (hence, "woods") and steel (hence, "irons"). But in recent years, more and more exotic materials have been used. Today, the most popular material for golf club heads, both woods and irons, is titanium. Titanium is both light and strong - so light that club heads can be made larger than they have even been before, while still meeting golf regulations regarding club head weight. A large club head gives the golfer a larger "sweet spot" because it is at the spot that the club is perfectly balanced and will send the ball in the air most efficiently.

Titanium is so light, that other, heavier metals such as tungsten or brass, must be added to the irons to give them the right weight. Golf club manufacturers take advantage of this by carefully positioning the additional metals at the center of gravity where they feel it will be the most beneficial during the swing. Strength and lightweight are what have also brought graphite into the forefront as the material of choice for golf club shafts. Steel shafts, on the other hand, used to be nearly impossible to break or bend due to their heaviness and durability. If the steel shaft was bent, it could be twisted and bent back into place to be used again like normal because the shafts were so thick. Today, manufacturers extrude the steel shaft to make the walls thinner, while using stronger materials to make the shafts lighter. A lighter shaft means a faster swing, and more energy transferred to the ball.

A good golfer can achieve a club head speed of 100 miles per hour. When the club hits the ball, the ball flattens, losing a third of its diameter. The club head, no matter what it is made out of, is much harder than the ball and does not change shape; instead, it loses speed, going from 100 miles per our to just 81 miles per hour. The missing 19 miles per hour worth of energy is transferred to the compressed ball. Naturally, the compressed ball does not remain compressed long. It very quickly springs back into shape, pushing backward onto the club head at the same time. That push slows down the club even more - to about 70 miles per hour - and speeds up the ball, so that the ball will fly away from that 100-mile-per-hour swing at a massive 135 miles per hour. How far and how fast you hit a golf ball depends not only on your swing and on the club, but also on the ball itself.

The first golf balls were feather-stuffed leather bags called "featheries." They were soon replaced by gutta-percha balls, made of dried gum from the Malaysian sapodilla tree. After that came solid, one-piece rubber balls, then two-piece rubber balls, which have solid rubber interiors and plastic or balata covers. Finally came three-piece balls that consist of a small, solid