the pathogen from the dark stromal area on the surface of the bags.

These observations have permitted us to develop some concepts regarding how *S. homoeocarpa* may survive and cause epiphytotics. These are provided below.

1. Data suggest that *Sclerotinia homoeocarpa* in soil have a slow-growing near-dormant phase that may not be infective. The lack of infection is suggested by the fact that the pathogen in our buried bags, which was in the slow-growing phase, did not cause disease during the time when natural epiphytotics were occurring. It is very difficult to isolate the fungus in this phase; this difficulty has no doubt interfered with research on the presence, etiology and epidemiology of this disease.

2. It may well be that *Sclerotinia homoeocarpa* has two phases - a near dormant, heretofore undescribed, phase and the expected rapidly growing phase described by other researchers. It is tempting to speculate that the slow-growing (near-dormant) phase may be a survival mechanism and that the rapid-growing phase is the infective one. If so, then the mechanisms that cause the shift between the two phases could be the trigger for the onset of epiphytotics that are typical of the disease.

Upcoming Work

Turf Bags. Some of the bags buried in 1998 will be allowed to overwinter and will be recovered in the spring. We will examine the effects of overwintering and determine what, if any, dormancy structures are present in the bags and the surrounding turf. This fall, more bags containing inoculum from our strain, as well as bags containing small cores of naturally diseased turf will be placed in the field similar to last year. Some bags will be recovered in 1999 and some will be left to overwinter to 2000.

Genetic Diversity. - Genetic assays will be performed during the winter on the isolates on various turf species were obtained from Massachusetts, Michigan, Nebraska, New Jersey, New York, Pennsylvania, and Canada. Assays will include RAPDs (Randomly Amplified Polymorphic DNA) and anastomosis groupings, as well as any new techniques that are applicable. We will compare the similarities and differences between isolates from the same area and host species relative to ones from different geographical areas or hosts.

Greenhouse Assays. Flats of creeping bentgrass and possibly other species of turfgrass will be grown in the greenhouse and inoculated with the isolates of *S. homoeocarpa* to assess pathogenicity of the isolates. Dead or infected turf will be inspected for structures related to infection by means of microscopic examination following clearing and trypan blue staining. We will observe how different strains might behave differently.

Selective Medium for *S. homoeocarpa*. We will continue to investigate new methods for recovering and enumerating the dollar spot pathogen. Due to competition from *Trichoderma*, *Gliocladium* and *Penicillium* spp., the dollar spot pathogen rarely shows up even when we know it is present. Therefore, we need to eliminate these faster growing species in order to recover and enumerate *S. homoeocarpa*. This may be useful, perhaps, for predicting epiphytotics.

The Impact of Golf Courses on Soil Quality

Kansas State University

Steve J. Thien

Start Date: 1998
Number of Years: 5
Total Funding: $50,000

Objectives:

1. *Study the construction of a golf course in a grassland ecosystem.*
2. *Quantify indicators of soil quality and follow their change during the construction and establishment of a golf course on a natural grassland site.*
3. *Changes to soil quality indicators will be described, quantified, and used to predict areas where future golf construction and/or management actions may require special attention to minimize their negative environmental impact.*

This project is monitoring some soil quality criteria needed to assess the long-term impact and sustainability of golf courses on the environment. The research was initiated on native grassland destined to become Colbert Hills Golf Course, near Kansas State University in Manhattan, Kansas. Colbert Hills has been designated as a *living laboratory* by KSU to highlight its utility for research in environmental resources and turf management. This situation presents a unique opportunity to characterize site resources prior to construction and follow the long-term impacts and changes brought on by consthuction, use, and management of the facility. The golf industry needs this information to realistically understand its environmental impact, to formulate knowledgeable responses to public inquiries, to establish management strategies for new courses, and to provide knowledge for future planning and growth.

Relevance of Soil Quality to Golf Courses. Golf courses are only as sustainable as their weakest natural component, which can often be soil quality. The inherent sustainability of managed areas can be viewed as inversely proportional to the level of management needed to maintain it. Golf courses that diverge the most from their natural surroundings require the highest levels of management inputs to remain sustainable.

Soils play a central role in determining the sustainable land use potential of golf courses. Soil influences such critical properties as; leaching, aeration, fertility, water relations, rooting, microbiological activity, and chemical use, detoxification, and effectiveness. A carefully selected set of properties, matched to the intended use of the soil, can be monitored as indicators of soil quality change. As these soil quality indicators degrade, they become the primary factors preventing superintendents from achieving course conditions expected by their management and players. The influence of siting, constructing, developing, and using a golf course on these indicators will ultimately determine both the sustainability of a course and the level of management necessary for day-to-day operations. This project is initiating a process of tracking changes to soil quality indicators during the life of a golf course.

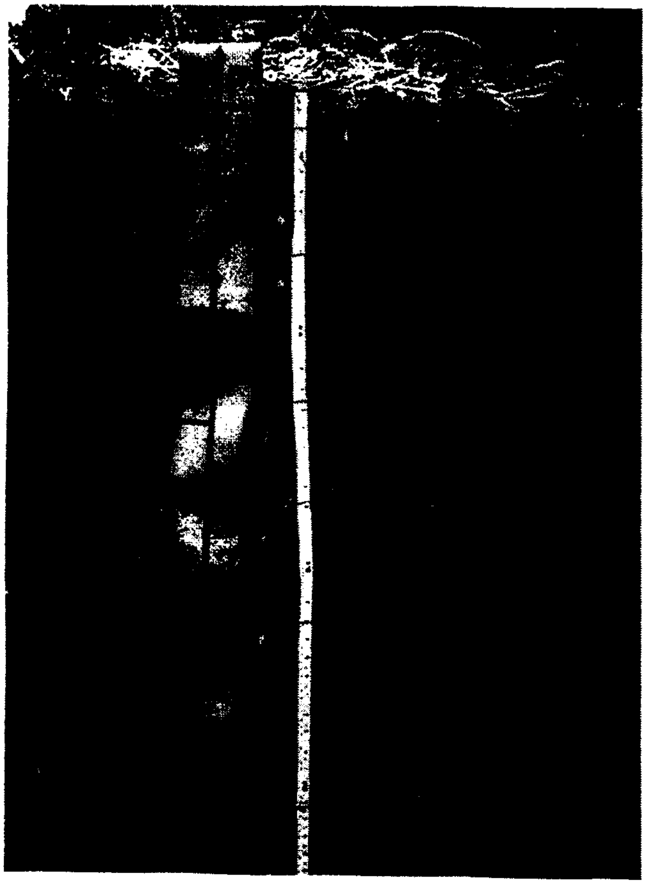

Figure 6. For each soil type identified, a pit was dug and the soil profile was fully characterized according to NRCS field standards. Loose samples for further analysis were collected from each horizon down to bedrock or to a depth of at least 2 meters

To evaluate the relative sustainability of different soils, soil scientists use indicators of soil quality. Selection of soil quality indicators should be related to soil use but reliable indicators for golf course soils have not yet been studied. This study will extend the concept of soil quality by identifying those indicators specifically important to the construction and sustainable use of a golf course.

1998 Research. Construction on Colbert Hills began in May 1998. Prior to construction, we made field observations and collected soil samples to establish base-line values for critical indicators of soil quality.

Starting in the spring and summer of 1997, soil scientists from Kansas State University and the USDA Natural Resources Conservation Service (NRCS) identified and mapped nine soil series on the site. By combining soil maps and architectural drawings of the course, we have located soil types according to their fairway and rough locations. Two sites for each soil type were selected and marked by global positioning for future referencing. One site was located in a fairway and one in an adjacent rough. The fairway site will be subject to the expected disturbances accompanying course construction. The site in the rough will be undisturbed.

For each soil type identified, a pit was dug and the soil profile was fully characterized according to NRCS field standards. Loose samples for further analysis were collected from each horizon down to bedrock or to a depth of at least 2 meters.

Sampling and Analyses Began and/or Completed.

1. Soil map of Colbert Hills A soil map has been nearly completed at a scale = 1:7920 (8 inches per mile). At this scale, the map is 4 times more detailed than maps typically found in soil survey reports.
2. Soil characterization open pit identification of horizons, depth, texture, color, structure, consistency, and pore and root distribution as per the USDA-NRCS Soil Survey Investigations Report No. 42, Version 3.0, Soil Survey Methods Laboratory Manual (1996).
3. Soil series identification of surface texture, slope, depth, drainage, permeability, physiographic location, and parent material.

Soil sample collection and laboratory analysis. Operations performed using standard methodology, as published in the American Society of Agronomy Monograph No. 9, Methods of Soil Analysis (1965). For each horizon present we have determined: depth, bulk density, pH, (1:1 water), pH (2:1 CACL2), total nitrogen (%), total carbon (%), microbial biomass nitrogen ($\mu g\ g^{-1}$, microbial biomass carbon ($\mu g\ g^{-1}$).