Houston, Texas; Southington Country Club, Southington, Conn.; Dedham Country and Polo Club, Dedham, Mass.; Sequoyah Country Club, Oakland, Calif.; York Country Club, York Village, Maine; Manufacturers' Country Club, Oreland, Pa.; Williamsport Country Club, Williamsport, Pa.; Humboldt Golf and Country Club, Eureka, Calif.; Hyde Manor Golf Club, Sudbury, Vt.; Milburn Country Club, Baldwin, N. Y.; Tumble Brook Country Club, Hartford, Conn.; Spartanburg Country Club, Spartanburg, S. C.; Augusta Country Club, Augusta, Ga.; Waseca Lakeside Club, Waseca, Minn.

OPERATING A NINE-HOLE COURSE WITH FIVE MEN.—I have not seen any discussion in THE BULLETIN as to the number of men required to operate a 9 or an 18-hole golf course, keeping the course in fair condition, and not throwing money away like water as appears to be done by the majority of clubs. I have found that we can operate our 9-hole golf course with a greenkeeper and four other men. One of these men is an all-round mechanic who likes to work out of doors in the summer. I figure that one man can take care of three greens and tees easily, including the weeding. Another man drives the tractor, which requires only two days a week, leaving him available also to drive our truck and cut the rough. The rough is cut on the average not oftener than once every two months. The cutting is done with a bar mowing attachment fitted to the tractor. This leaves the man also plenty of time to haul compost to the greens and run our manure grinder and pulverizing machine used in making compost. During seasons of the year when the grass is not growing rapidly, this man's time is devoted to the improving of bad spots on the fairways and rough, as well as to miscellaneous work which is always turning up on a golf course. We have found that with 5 men the labor charges against the course run between $4,000 and $5,000, depending on the length of the playing season. We are adding 9 holes to our course and building them with our own tractors and men. We have had some tough propositions to overcome, but it looks as if we would build these new 9 holes for about $30,000, which covers also the cost of the equipment bought to build the holes and maintain the course after it is finished.—*W. R. Hurd, 2d, United Shoe Machinery Athletic Association, Beverly, Mass.*

Brown-Patch Investigation

By R. A. Oakley[1]

Possibly it would be well first to outline a sort of background upon which to sketch this subject of brown-patch and its control. I have reference now to the disease we call the large brown-patch. As many of us know, there are two kinds of brown-patch. We have designated them the large brown-patch and the small brown-patch. But more about this later. For the present when brown-patch is mentioned, the large kind is meant unless otherwise specified.

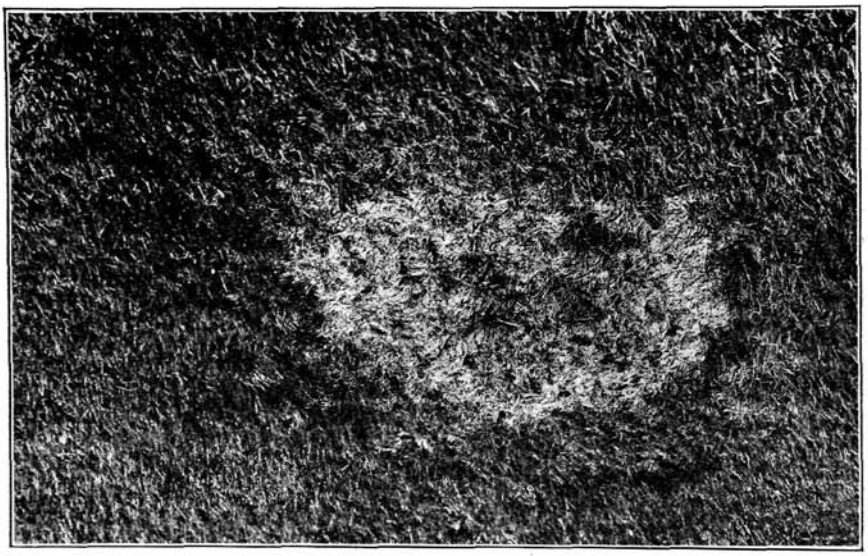
Some of us may not be entirely familiar with the history of the disease, or, in fact, with a demonstration of its destructive manifestations. Therefore I will give briefly something of its history.

In 1914 the late Fred W. Taylor, well known for his experiments with putting greens and putting green grasses, called Dr. Piper's attention to a condition that obtained on the lawn at his home in Chestnut Hill,

[1] In this article Dr. Oakley presents in substance his address delivered before the annual meeting of the Green Section in New York City January 5, 1924.

Pennsylvania. Circular areas of turf varying in size from approximately 4 inches to 2 feet in diameter had turned brown, and much of the grass within these areas was killed. While it was evident to us from the first that the patches were caused by some organism, it was not until 1915 that the causal organism was found. By the use of well-known laboratory methods, the organism was isolated—that is, separated from the organisms that were present in the turf with it. Careful examination proved it to be a fungus which lives and completes the various phases of its existence in the soil. The botanical or technical name of this fungus is *Rhizoctonia solani*. It is one of the organisms that cause blight in potatoes, and it attacks at least 500 different species of plants.

For the benefit of those who have not seen the brown-patch in action, it may be well to say that it attacks turf of bents and fescues, caus-



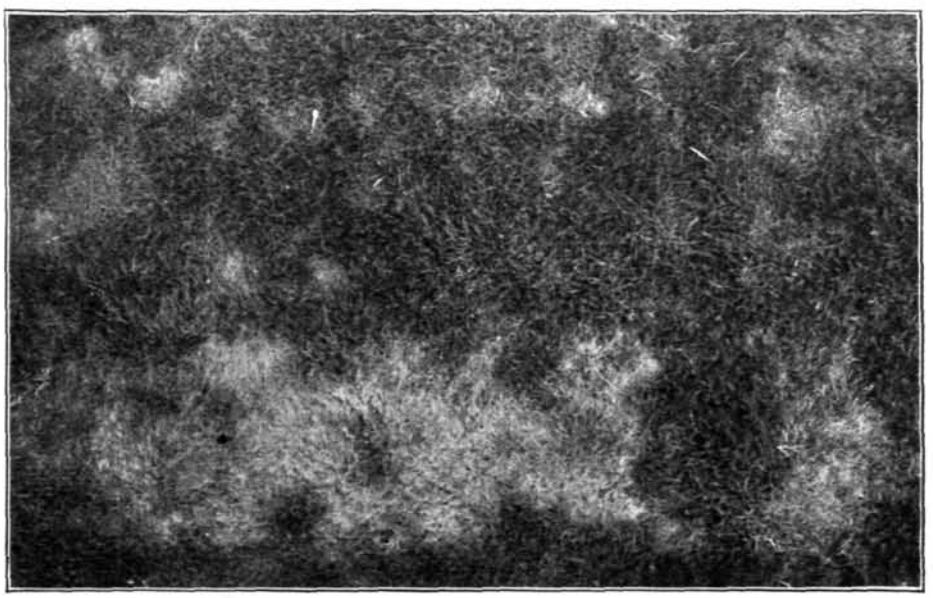
A single large brown-patch. Note the circular pattern and fairly definite margin.

ing areas of 4 inches to 2 feet or more in diameter to turn brown. It spreads from the original point of attack in more or less concentric circles. It is the cobweb-like growth of this fungus spreading over the leaves of the grass that kills or seriously injures them. This cobweb-like growth is called mycelium. It is plainly visible in the early morning when the fungus is active. Sometimes it is so abundant that it makes a fluffy mass of an inch or more in thickness.

The brown-patch fungus is rarely troublesome except in very hot weather, particularly hot humid weather. In the latitude of Washington, D. C., it is more or less prevalent from May to October. Careful observations indicate that the growth of the cobwebby mass, or the mycelium, is favored by hot, humid, quiet atmosphere. Bright sunlight seems to check its growth, and wind or any other agency which agitates it seems to make it less active. It is probable that the fungus makes most of its growth in the early morning before sun-up, but it has been observed in active condition as late as 10 o'clock on hazy or partly cloudy mornings.

In freshly attacked grass the patches appear with a distinct smoky margin and look not unlike they might have been caused by the pouring on of boiling water. Generally the patches are very distinct and in many cases regular in outline; however, when the attack is light the leaves of the grass may be only slightly brown and the margins of the spots not readily discernible.

In most cases where the patches are irregular in outline, this is due to the fact that two or more patches have united by spreading. The brown-patch fungus being a kind of plant, has the ability, as have other living organisms, of producing itself or providing for the continuance of its existence by the formation of reproductive bodies on the cobweb-like growth. They are called sclerotia, or resting bodies, and are of the nature of seeds. They are small black bodies of a corky texture, which



Brown-patch in fescue turf. The large diseased area is formed by the union of several individual patches.

have the ability to remain alive in the soil for a long time. From them, new growth is produced. The fact that these resting bodies are corky in texture is highly important, as it makes them very resistant to fungicides.

Let it be understood that not all species of grasses are subject to brown-patch. Some are immune, or at least nearly so, and, as luck would have it, they are not very good putting green grasses for our northern courses. Kentucky bluegrass, our best fairway grass, is practically immune. Crab grass, our worst putting green weed, goes scot-free, so to speak. Red fescue is very susceptible, as are likewise the bents. In the case of the latter, certain strains are more resistant than others. Redtop is not as susceptible as are the bents. *Poa annua* is very susceptible, as is likewise *Poa trivialis*. Bermuda grass seems to be immune, likewise white clover.

So much for the disease and its symptoms; now for its effects and treatment. Briefly, by proper treatment, which will be discussed later, it is possible to restore the grass within a few weeks after severe attacks.

Without proper treatment the grass would be, and frequently is, killed. As for the treatment, an efficient preventive is what is desired, one which when applied in the spring will prevent brown-patch for the entire season or at least for a long time. Such a treatment, to be effective, must kill or at least impair the vitality of the resting bodies, so that they will not produce the mycelium that injures the grass. But so far we have been unable to find a chemical that will kill the sclerotia and not impair the turf. The corky nature of the sclerotia makes them nearly impervious to the chemicals that are commonly used, a condition not encountered with a large number of other kinds of sclerotia which have been experimentally treated with fungicides. Thus far we have made little progress in the developing of preventive treatments with a view to killing the seed-like bodies.

Most of us are familiar with Bordeaux mixture and its use for controlling brown-patch. In a sense, it may be regarded as a preventive, but it must be used very frequently and systematically to be thoroughly effective as a preventive. Bordeaux does not appear to injure the seed-like bodies of the fungus in the slightest degree, but if it is on the leaves of the grass it will prevent the growth of the mycelium. Now this is the point to bear in mind, that to be effective Bordeaux must be on the leaves and not on the roots, as some have suggested. As far as we know, the disease attacks the above-ground parts of the grass only. The soil may be literally charged with Bordeaux, but if it is not on the leaves the fungus is not injured by it. Bordeaux dust is more economical to apply than the liquid. The latter has one advantage, however, in that it sticks to the leaves better than does the dust. While to be effective Bordeaux must be applied frequently, a light dusting, not to exceed 1 pound to 5,000 square feet, is all that is required in one application. Heavy applications are wasteful and likely to prove harmful if continued. Please bear in mind that too much Bordeaux can be used, and therefore I warn you to use care in this connection. The injury from excessive applications of Bordeaux does not appear until the following winter or spring; but it is likely to be serious. In fact, in bad cases the practical thing seems to be to remove the injured turf and plant or seed again. Bordeaux is the first fungicide we recommended for brown-patch, and thus far we have found nothing better.

Taken altogether, we have done quite a lot of experimenting in connection with brown-patch control. In the fall of 1921 we planted plats of pure strains of creeping bent and velvet bent, vegetatively, for the purpose of using the turf for brown-patch experiments. In 1922 and 1923 we tried a great many things on these plats; and let me emphasize this fact, that in no case was a treatment given except in the vicinity of a non-treated plat with which to compare the results of the treatment. Unfortunately for our investigations, the brown-patch was not very troublesome on these plats in either 1922 or 1923; so a number of the treatments did not have a fair test. The treatments that did not will be repeated. A list of the things we tried may be of interest to you. I shall not discuss all of the treatments, but will comment on some of them and merely mention the others.

Among the chemicals containing copper, we have tried Bordeaux mixture, copper sulfate (or bluestone, as it is commonly called), copper soap compound, and copper carbonate. We had hoped for the success of the copper soap compound, because it is a sort of sticky substance and

we thought it would stick to the leaves of the grass better than would the Bordeaux; but it did not prove to be as efficacious as Bordeaux. In fact, Bordeaux has proved the best of all the copper compounds we have used thus far.

A number of sulfur products were used, including flowers of sulfur, sulfuric acid, the polysulfides, sodium hyposulfite (or what photographers call hypo), and lime-sulfur spray mixtures. None was helpful, and some, especially flowers of sulfur, were positively detrimental. Both corrosive sublimate (mercuric chloride) and calomel (mercurous chloride) were tried, the former in various ways, in solution, directly, and absorbed by charcoal and other absorbants. There were no indications of beneficial results from the mercury salts. Speaking of charcoal, we tried it also, quite thoroughly I think, because so much had been said about it, but it neither helped nor hindered so far as we could determine.

Baking soda was tried, and it killed the grass quickly. The next time we try, if we ever do again, we will use a very light application, not more than two or three pounds to 1,000 square feet.

Zinc oxide, zinc sulfate, and zinc chloride were applied in light doses. The results in the main were harmful, particularly in the case of zinc oxide, which injured the grass permanently quite as badly as the copper salts.

Lime, of course, was tried particularly with the view of making the soil alkaline. On the adjoining plats we used aluminum sulfate, a substance similar to our common alum. This was used primarily to acidify the soil. We were trying to find out whether the brown-patch fungus prefers an acid or an alkaline soil. Our results to date have not shown it to have much preference. Formalin gave no promise of help. We tried many other things, among them potassium permanganate, with which we are still working.

In the latter part of the summer of 1923 we tried a number of complex mercury compounds, but we did not have sufficient brown-patch attacks after they were applied to give them a fair test. We hope to try them thoroughly the coming year. One in particular is being advertised quite extensively now and doubtless will be tested fully by golf clubs in the brown-patch belt.

What I have given you here is for the most part a list of disappointments; but we really got more than that out of our investigations. We have found that, contrary to our earlier belief, liberal watering, especially early morning watering, is beneficial in keeping brown-patch in check and, I might also say, in bringing about recovery of the grass after attacks.

This leads me to another feature of our investigations, that of treating brown-patch infected grass. Light top-dressings of good composts of a loamy nature to which is added some quickly available nitrogenous fertilizer—blood meal, for example, or some similar organic compound—are of great help. If, however, organic fertilizers are not procurable, ammonium sulfate may be employed, if used with care—not more than ½ pound to 1,000 square feet of green, and watered in immediately to prevent burning the grass. This treatment, I think, is entirely sound. and if it is followed it will help greatly to overcome attacks of brown-patch.

Our suggestions now for the treatment of the large brown-patch are therefore as follows. Be on a sharp lookout for it during hot, humid weather. Water your greens freely, in the early morning if you can,

but water them thoroughly no matter at what time of the day you can do it. Use Bordeaux systematically and with wisdom, in the manner above suggested. It is necessary that the Bordeaux dust or spray be on the leaves of the grass in order that it may be effective—do not forget this. Also do not forget that it is possible to poison grass with heavy applications of Bordeaux. When grass is attacked by brown-patch, top-dress it lightly with good compost to which a little ammonium sulfate, or preferably some quick-acting organic nitrogenous fertilizer such as blood meal, is added. This treatment hastens recovery of the grass.

Some of the strains of creeping bent are much more resistant to brown-patch than are others, and when properly treated these usually recover more quickly than the more susceptible strains.

When all is said and done, the large brown-patch can be fairly well controlled in a majority of cases, and controlled in such a way that the grass will not be permanently injured by it. But the small brown-patch —well, that is different. There are some who are of the opinion that it is not caused by an organism; but evidence that it is caused by an organism seems to me to be convincing. I do not think the causal organism is the same as the one in the case of large brown-patch. We know of no treatment that will prevent small brown-patch, but our tests indicate that the treatment suggested for grass attacked by the large brown-patch may be expected to give good results in the case of grass attacked by small brown-patch. We are continuing our investigations of both forms of brown-patch and hope to have a more cheerful story to tell you next year.

Watering the Fairways

Address Delivered by William F. Brooks, Minikahda Club, Minneapolis, at the Annual Meeting of the Green Section, January 4, 1923.

Mr. Chairman and Gentlemen: I want to pay a tribute to and to thank Dr. Piper and his associates for the splendid work which they have been doing and especially as it affects us in the northwestern part of the United States. Ours is a new country; most of the courses are new. There has developed recently a great interest in golf. I think there are 22 golf courses in the cities of St. Paul and Minneapolis today, and two-thirds of them have been built and organized within the last few years.

Now I hesitate to appear before an audience like this, of men so skilled and experienced in matters connected with the care of golf courses, but we in the northwest have been suffering in the last three or four years from extreme drouth, with which I hear some of you gentlemen living near New Jersey and the seaboard have not been affected.

With us, the past season has been the fourth consecutive season of excessive drouth. The records of the Weather Bureau show that in the area of which Minneapolis is the center, the rainfall for four years has been over five inches per year below normal. In the spring, when the rains were abundant, our fairways were in fine condition. As the summer heat came, however, the fairways dried up and the higher ridges became brown and burned hard.

In 1922 we conducted some experiments in breaking up or aerating by various methods the surface of the soil on these dry hard ridges. We tried a disk, but we found that an ordinary disk, with the blades set as nearly vertical as possible, would work all right on the higher ground, but as we dropped down into a hollow it would tear or mutilate the sod. We then tried a spiked harrow with the spikes set at an angle, but no matter