THE BULLETIN

of the

UNITED STATES GOLF ASSOCIATION GREEN SECTION

Vol. 6 Washington, D. C., June, 1926 No. 6

Contents

THE BULLETIN is published monthly by the United States Golf Association Green Section, P. O. Box 313, Washington, D. C., at Room 7213, Building F, 7th and B Streets N. W.

Address all MAIL to P. O. Box 313, Pennsylvania Avenue Station, Washington, D. C.

Send TELEGRAMS to Room 7213, Building F, 7th and B N. W., Washington, D. C.

Subscription Price: To golf clubs that are members of the United States Golf Association Green Section, $4.00 per year (included in membership fee).

Entered as second-class matter April 21, 1926, at the postoffice at Washington, D. C., under the Act of March 3, 1879.

Golf Course Hydraulics for Laymen

By J. N. Todd

It is thought that a few definite suggestions from an engineer that can be applied by a layman in planning water supply for golf courses would be acceptable. The best plan, of course, is to consult an engineer for the solution of a particular problem.

The subject of water supply for golf courses may be divided into two parts, the supply and the distribution. In this discussion it will be presumed that the supply is fixed, whether from a pumping plant or from a city water main, and only the distribution system will be discussed. Every problem in water supply should, of course, be dealt with on its own merits, but there are certain fundamental principles and practices that can be applied to most cases.

Flowing water causes friction. Friction reduces pressure. The same volume of water flowing through a small pipe will cause more friction than through a large pipe. For example, if water is flowing through a one-inch pipe at the rate of 15 gallons per minute it causes a friction loss of about eight pounds pressure for every 100 feet of pipe. The same rate of flow through a two-inch pipe causes a friction loss of less than half a pound pressure for every 100 feet of pipe. If you have a sprinkler that is operating poorly on a one-inch pipe, replace the line with 1¼-inch pipe, and the friction loss will be only one-fourth as much.

The carrying capacity of pipes is in the same ratio as their diameters squared. For example, a two-inch pipe will carry four times as much as a one-inch pipe, and only one-fourth as much as a four-inch pipe. Therefore, a main pipe line serving six greens where the sprinklers might all be running at one time, should have six times the capacity of each branch line serving a sprinkler. Expressed in diameters the main should be about 2½ times the size of the branches.

The two preceding paragraphs outline the most important principles involved in laying out pipe lines to deliver water effectively at the greens. To make more definite suggestions that will be of practical benefit depends on certain actual conditions, such as the number of gallons per minute used by a sprinkler. Conditions vary so much that no attempt will be made here to say what is an average condition, nor should any suggestions given here be taken to apply to all conditions. But certain definite suggestions can be made, based on assumed conditions, that will be of benefit if applied with an understanding of the two preceding paragraphs. The advisability of installing two outlets at each green should be considered particularly when the greens are large or it is important to minimize the time spent in watering.

Assume a golf course of 18 greens, not more than half of which will be watered at one time, and that each has one sprinkler using 15 gallons per minute. Assume also that the supply at the source is of sufficient volume and pressure.

The branches, or laterals, serving individual sprinklers should be 1¼-inch pipe, unless the line is more than 100 feet long, in which case it should be 1½-inch pipe.

A 2-inch line should not be required to serve more than two 1¼-inch branches, but a 2½-inch line can serve three.

A main line serving four or five branches should be 3-inch pipe, except that if it is 2,000 feet long it should be the next size larger.

The main supply pipe may be 4-inch and will be sufficient for watering half the course at one time.

The Brown-Patch Disease of Turf: Its Nature and Control

By John Monteith, Jr.

With the increased attention given to development of better turf grasses and the demand for pure strains of the finer types on putting greens to replace mixtures of coarser grasses and clover, the damage caused by the brown-patch disease of turf in many sections of the country has become increasingly important. The disease has undoubtedly occurred throughout the country for many years, but formerly was overlooked or disregarded since there has always been a tendency to assume that grasses "naturally die out" to a certain extent during the summer months. Therefore little or no attention was given to these browned areas, for from previous experience it was known that just as "naturally" these scars would, in time, become green again, due frequently to an invasion of clover or another grass. Now that a single variety is desired to give a better putting surface, this grass alone must replace that injured by brown-patch, and methods have to be devised to check the disease and to aid the grass in its recovery. Many of the devices now used for control are well founded and under certain conditions beneficial, but many others are evidently based on little more than superstition or hearsay—about on a par with the old method of "bleeding" to control human diseases. It is apparent that the nature of the difficulty is widely misunderstood. As a result, the methods of combating it are largely ineffective. It is the purpose of this discussion to try to indicate how the disease works and to point out a few of the factors influencing its development with the hope that ultimately more intelligent methods may be used to control it.

Brown-patch has been known to occur on the fescues, redtop, Rhode Island bent, creeping bent, velvet bent, seaside bent, the ryegrasses, *Poa annua*, and *Poa trivialis*, but so far not on Bermuda grass or Kentucky bluegrass.

From the nature of the disease and the variety of circumstances under which it works, it is not expected that any single treatment will be found to prevent and cure all cases of brown-patch. Frequently some one announces a method which is claimed to forever settle the problem. As is to be expected, such a claim does not stand long, for while one method may be effective under certain conditions on one course it may be of little value when applied under the entirely different conditions found on another course. We can hope for adequate control only by recognizing the various factors which influence the disease and making due allowance for them when utilizing the various remedies which have been devised.

Injuries Confused With Brown-Patch

Before any general discussion of the disease itself is attempted, it may be well to point out various types of grass injury which are often confused with brown-patch. There are many unfavorable soil

conditions which at times cause turf to die or become discolored in patches; as, for instance, the following: too shallow soil where there is a large rock just beneath the surface; improper preparation of the soil before planting; poor drainage; an improperly sloped surface producing pockets where water collects readily and "drowns" the grass. There are also various insects which feed on the roots or leaves of grass, and these may weaken or even kill turf in irregular patches. Grass is often injured by chemicals, such as drops of oil from machinery and excessive use of copper in the form of Bordeaux mixture, and by fertilizers or composts improperly used. Any of these injuries, although confused by many persons, are usually readily distinguished from brown-patch by a careful observer. The discussion here given does not apply to the injuries mentioned above, but is limited to the diseases commonly referred to as "brown-patch."

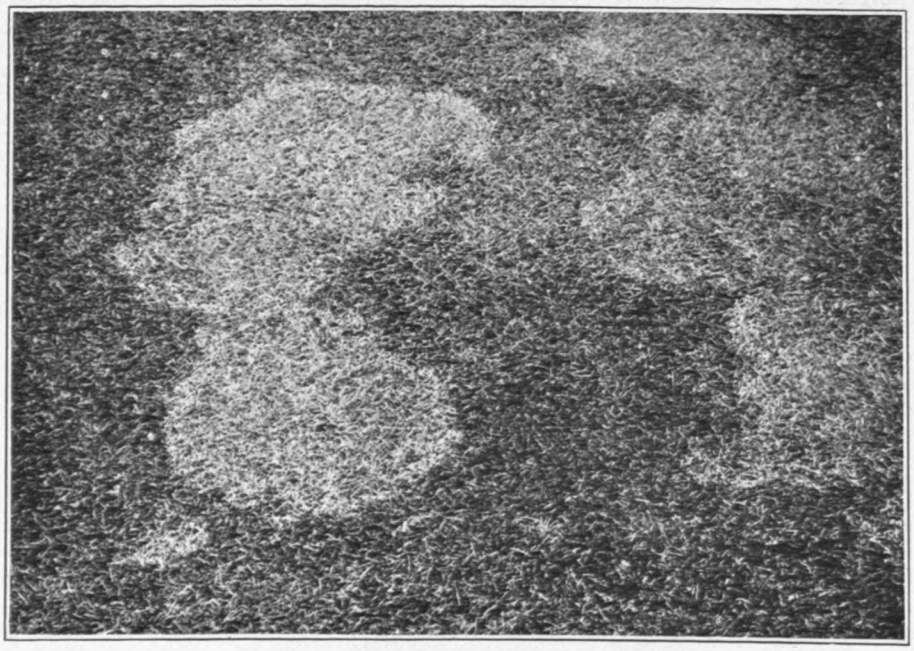

Fig. 1. Large brown-patch. This photograph was taken at the Arlington Turf Garden on the same day as that shown in Fig. 2. The brown, diseased turf appears light in the photograph contrasted with the dark color of the healthy green grass. The conspicuous area at left center was formed by two patches spreading outward until they joined. Each of these two patches was more than a foot in diameter.

Symptoms of the Diseases

There are two well-recognized types of brown-patch, but their differences are still often much confused. Large brown-patch is more prevalent in the southern section of the bent-grass area. It appears suddenly as large discolored areas which may be several feet across and which apparently develop overnight (Fig. 1). In the morning, before the grass is dry, the affected blades have a blackened appearance, as if scalded, and around the borders of the patch a fine cobweb-like growth may be seen spreading over the grass. As

soon as the sun is high enough to dry the green this so-called "cobweb" growth disappears and the discolored grass shrivels and dies, giving the patch the brown color from which it is named. In mild attacks a large percentage of blades escape injury and show up green throughout the browned area. The stems and runners are not killed except in very severe cases, and as a result the patch soon recovers its green color if conditions are made favorable.

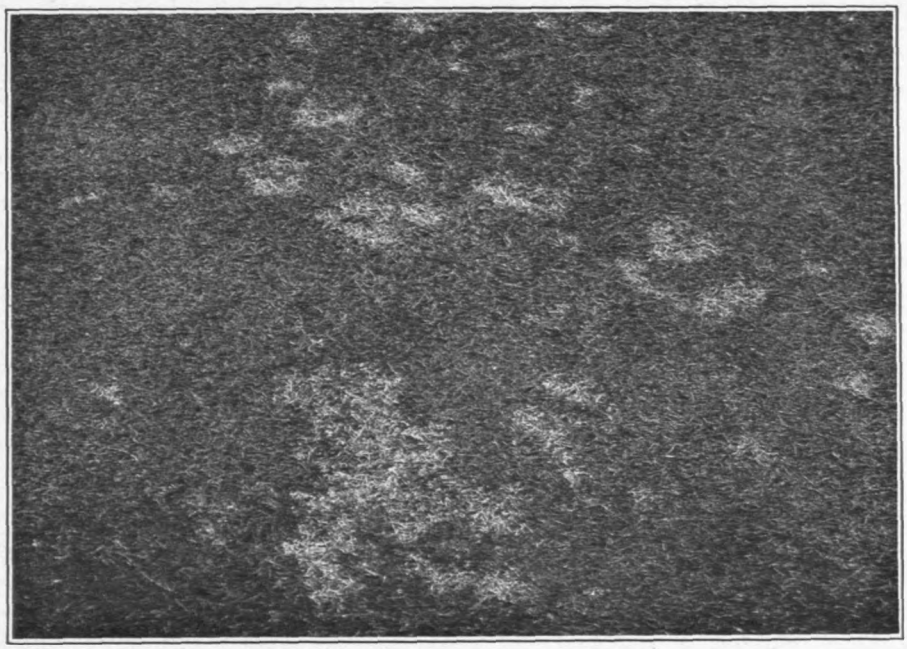

Fig. 2. Small brown-patch or "dollar spot." Notice the numerous definite spots an inch or two in diameter, contrasted with the spreading character of large brown-patch shown in Fig. 1. Figs. 1 and 2 are photographed at approximately the same magnification.

Small patch is generally limited to about the size of a silver dollar, from which it has been commonly referred to as "dollar spot." Like the large patch, it appears suddenly, and overnight the turf may develop a conspicuous "moth-eaten" appearance (Fig. 2) caused by numerous small browned spots. With this type the grass is usually killed to the ground; none of the blades escape; and the dead grass has a lighter, more bleached appearance than is found in the large patch. In certain cases several patches of the small type may develop so close together that they coalesce and give the appearance of the large patch. Similarly, under certain conditions, large brown-patch may start to develop and be checked before it spreads more than an inch or so in diameter. In such cases one may easily be mistaken for the other, although in instances where they both occur at the same time, as illustrated in Figs. 1 and 2, they are readily distinguished.

So-Called "Causes" of Brown-Patch

Brown-patch has been attributed to a large number of causes; some have no connection with the trouble, while many, although in themselves not the cause, have a direct bearing on its development.

The "weather" is always a convenient alibi for failure of any crop, and, as might be expected, has been most blamed for brown-patch. Under this designation have been included high temperature, excessive rain, heavy dews, high humidity, and cloudy periods. Some of these weather conditions, as will be shown later, no doubt exert a marked influence on the development of the disease, but none of them alone can cause this particular type of injury. Soil conditions of various kinds are frequently blamed, especially excessive soil moisture due to poor drainage. Spiders are sometimes supposed to produce the patches by forming webs which kill the grass. This idea came, no doubt, from confusing harmless cobwebs with the fine colorless threads of the fungus which is actually the cause of the disease. Various fertilizers and composts are often supposed to cause brown-patch. There are numerous other theories which have been presented and passed on from one greenkeeper to another with very little substantial evidence to support them. The fact that some of these so-called "causes" actually do exert a secondary influence by favoring growth of the fungus producing the disease may explain much of the confusion which has obscured the actual source of injury.

The Disease Caused by a Fungus

Brown-patch is produced by a fungus which penetrates and kills the grass leaves. For the benefit of those who are not familiar with plant diseases produced by fungi, a brief explanation will be given to enable them to better understand brown-patch and the various factors influencing its development and control.

A fungus is one of the lower forms of plant life, which does not possess the green coloring material found in the common higher plants. Since this green coloring material enables plants to utilize sunlight in the manufacture of certain foods, fungi are unable to manufacture these foods and must therefore depend on other plant or animal tissue for their supply. They are most commonly referred to as molds or mildews, and are found on all kinds of organic matter in moist places, particularly in the shade. A common example of a fungus is the edible mushroom. Commercial mushroom beds are prepared in dark, damp cellars where fungous "spawn" is planted in beds of stable manure. From this "spawn" is developed a growth of very fine cobweb-like threads (mycelium) which ramifies through the manure and serves much the same purpose as the roots and branches of our higher plants. After some weeks' growth of this mycelium, the fungus develops fruiting bodies, commonly referred to as mushrooms. If one leaves a mature mushroom in a damp place on a piece of paper, he will find after a few hours that there is a dark dust-like deposit on the paper. This powder comes from the gills on the under side of the mushroom cap, and consists of millions of very small "spores," which serve as seeds to distribute and propagate the fungus.

As in the case of the higher plants, there are thousands of species of fungi. A few of these, like some of the mushrooms and toadstools, can be readily distinguished, but in a large majority of cases their differences can be determined only by use of a microscope. Many fungi are decidedly limited in their distribution and food requirements. Some forms, such as the mushroom fungus, depend entirely on dead organic matter for their food, while others may penetrate

living organisms, where they are able to feed and ultimately destroy the invaded tissue. It is this latter type which produces disease in plants. The most familiar of these are the various rusts, smuts, mildews, blights, and similar diseases which have been known for many years. They are caused by various fungi which are, as a rule, very closely limited as to the plant they may attack. Unless one is mindful of the presence of these many distinct fungi, he is apt to mistake a harmless one for a dangerous one, and vice versa. As an example of this confusion, some greenkeepers have observed a fungus (mold) growing over their compost pile and, thinking it was the same as that causing brown-patch, have hesitated to use the compost lest they thereby infect the turf. The fungus, or perhaps many fungi, which they observed on the compost pile, were no doubt the usual ones causing decay and entirely incapable of injuring any living plant. This was pointed out in an article in THE BULLETIN for May, 1926, page 119.

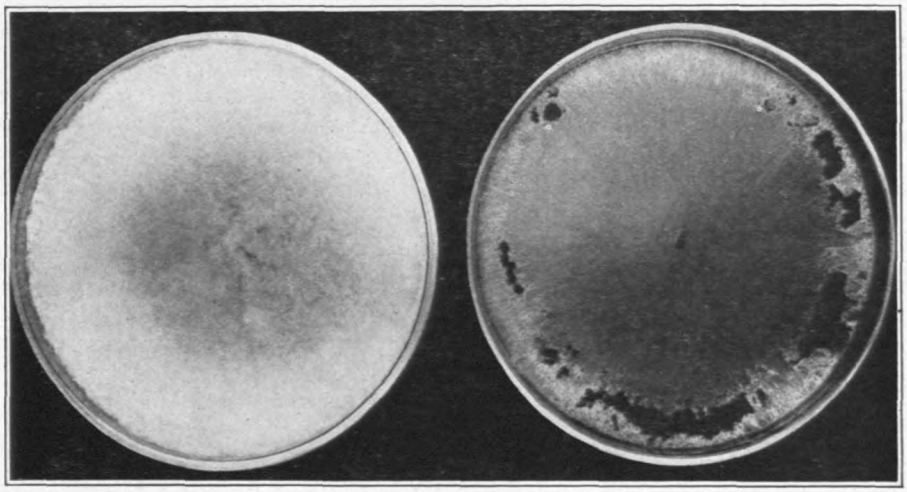

Fig. 3. Pure cultures of the fungi causing small (left) and large brown-patch (right). These circular glass dishes contain a thin layer of sterilized food material over which the fungus (mold) has been allowed to grow. Notice the "fluffy" growth of the small brown-patch fungus on the left compared with the more spreading habit of growth shown by the fine threads (mycelium) of the large brown-patch fungus in the other dish. The black masses shown near the edge of the plate on the right are "sclerotia" (see Fig. 4).

Experimental Proof of the Cause

When a fungus attacks a plant, it is possible to examine, under a microscope, a section of the part affected and see the threads of mycelium growing through it. It is usually possible to isolate this fungus from the diseased plant and grow it in culture free from the plant. These cultures are obtained by preparing a gelatin-like material (culture medium) containing certain foods needed by the fungus, sterilizing it in a covered glass tube or plate, and placing on it a section of the diseased plant. The fungus causing the disease then grows out from the plant tissue on to the culture medium. Pieces of this fungus may then be transferred to other tubes or glass plates containing sterilized medium and allowed to develop there

quite free from any other living organism. Such a growth is shown in Fig. 3 and is referred to as a "pure culture."

Pure cultures of fungi may be kept alive for many years simply by transferring them occasionally to new tubes of culture media. This makes it possible to study them independent of the host plant and obtain much information which helps in understanding their behavior under a variety of conditions. Fig. 4 shows an enlargement of the fungus causing large brown-patch as it grows in pure culture on sterilized artificial medium.

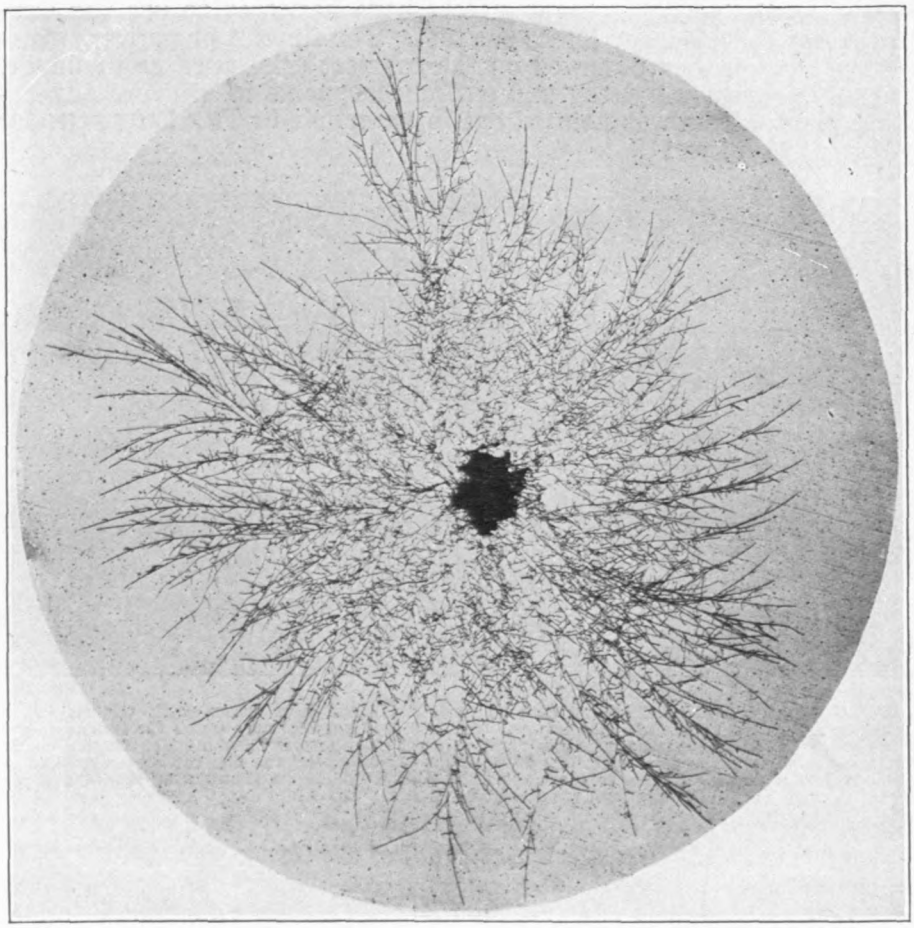

Fig. 4. Large brown-patch fungus growing on culture medium (magnified 10 times the actual size). This shows the fine thread-like mycelium growing out from the black sclerotium in the center. Sclerotia (see Fig. 3) serve to perpetuate the fungus through periods of drought or other unfavorable weather conditions which are likely to kill the delicate mycelium. Like seeds of higher plants, they send out new shoots as soon as conditions are again favorable.

Pieces of the fungus from a pure culture put on a plant will, under favorable conditions, attack the plant and produce the same disease symptoms found originally. Such a process is called "artificial inoculation" and is used to prove that the fungus isolated is actually the cause of the disease. The artificially inoculated plant

is examined for the disease, the organism is again isolated from an infected part, and is then compared with the original isolation. This method of isolation, artificial inoculation and reisolation of the organism, is used in both animal and plant pathology to test the disease-producing possibilities of an organism. A result of this process is illustrated in Fig. 5 which shows a box of grass inoculated with both the large and small types of brown-patch.

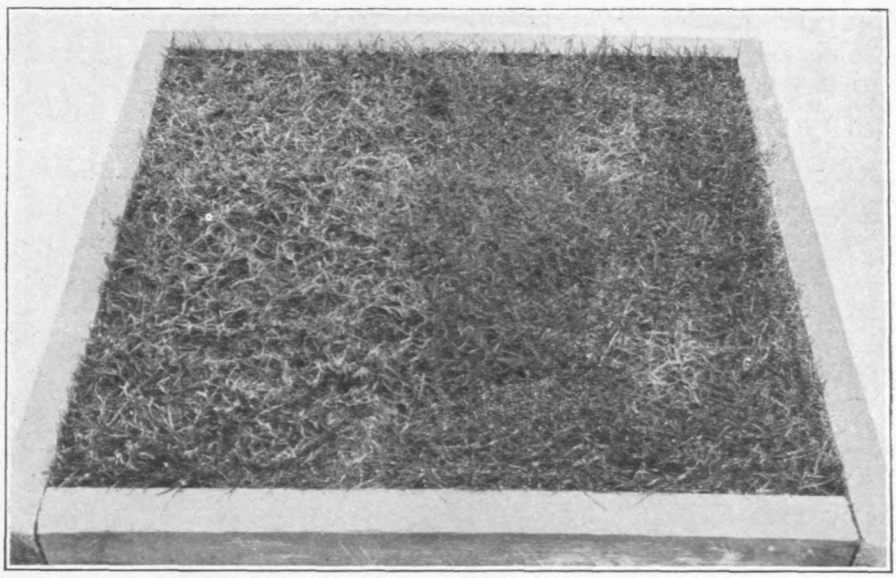

Fig. 5. Creeping bent artificially inoculated with the brown-patch fungi in greenhouse experimental work. .Pieces of small brown-patch fungus were taken from a dish, such as that shown in Fig. 3, and placed on the above box of grass in two places at the right. Similar pieces of large brown-patch fungus were placed in corresponding positions at the left, after which the box was placed in a moist enclosure where "dew" settled on the grass. The pieces of fungus placed on the turf immediately started growth and infected the grass blades. When the large brown-patch fungus, spreading from the two inoculated points on the left, had covered half the turf, the box was removed to a drier atmosphere. As soon as the dew evaporated the affected grass blades shrivelled and turned brown, as shown by the light areas in the picture. .These inoculations were made at the same time. Note, however, the limited development in the case of "dollar spot" contrasted with the extended area affected by large brown-patch. Compare this with the disease as it occurs naturally (see Figs. 1 and 2).

The Disease as Influenced by Environment

Since a fungus is a plant, it is influenced by certain environmental factors much the same as are the higher plants. It is well known that certain plants, such as corn, grow best at comparatively high temperatures, whereas others, such as many of our early spring plants, are unable to grow during the hot summer period. Fungi show a similar response to temperature. The organism causing large brown-patch grows best at fairly high temperatures, as shown in Fig. 6, and therefore this disease becomes serious only in periods of hot weather.

In the same way, some plants require plenty of moisture, while others survive with very little water. As a rule, fungi require plenty of moisture, and because their mycelium is so delicate they are usually extremely sensitive to drying out or to strong sunlight. For this reason molds or mildews are most common in moist, shaded

places; and this, in the case of brown-patch, accounts for the severity of an attack during periods of cloudy weather and heavy dews.

Acidity of the soil has a direct influence on the growth of many fungi. This is illustrated in Fig. 7, which shows its effect on the growth of the large brown-patch fungus on artificial medium. It would be well to compare this figure with the table given in the article by H. L. Westover on the "Effects of Certain Fertilizers on Soil Acidity, Quality of Turf, and Weed Control" on page 269 of the December, 1925, number of THE BULLETIN. In his table Mr. Westover gives the effect on acidity of the soil produced by various fertilizers as indicated by pH measurement of acidity, which is the same measurement as that used in the cultures shown in Fig. 7.

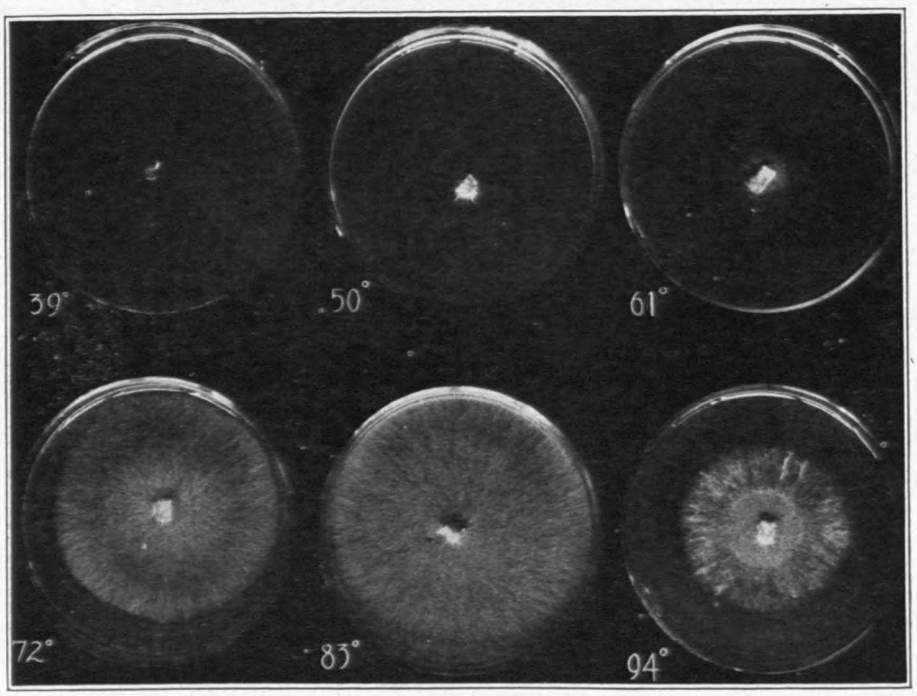

Fig. 6. The effect of temperature on growth of the large brown-patch fungus. In each of these glass dishes was placed an equal amount of food (culture medium) for the fungus. A piece of material on which the fungus was growing was then placed in the center of the dish, after which each was kept constantly at the temperatures indicated (Fahrenheit). Notice that no growth occurred at 39° and very little at 50° and 61°. The most rapid growth was at 83°. In applying this to field conditions it should be remembered that the fungus usually develops during the night; so these temperatures are to be considered in terms of night averages rather than maximum day temperatures.

Fungi, like green plants, are influenced by the food materials available; for that reason, brown-patch may be affected by the kind and amount of certain fertilizers used on greens. This relationship in the development of turf diseases has not been thoroughly studied as yet. There are many other conditions of soil and environment which may exert some influence on the growth of fungi; but thus far these are not understood in the case of brown-patch.

All these factors not only exert a direct influence on the development of the fungus, but also have a bearing on the development of

the host plant. For example, a high temperature is favorable to the development of the fungus and at the same time less favorable to grass of the bent or fescue type. Such a condition which weakens the grass and stimulates the fungus naturally increases the likelihood of a disease attack. On the other hand, the fungus requires

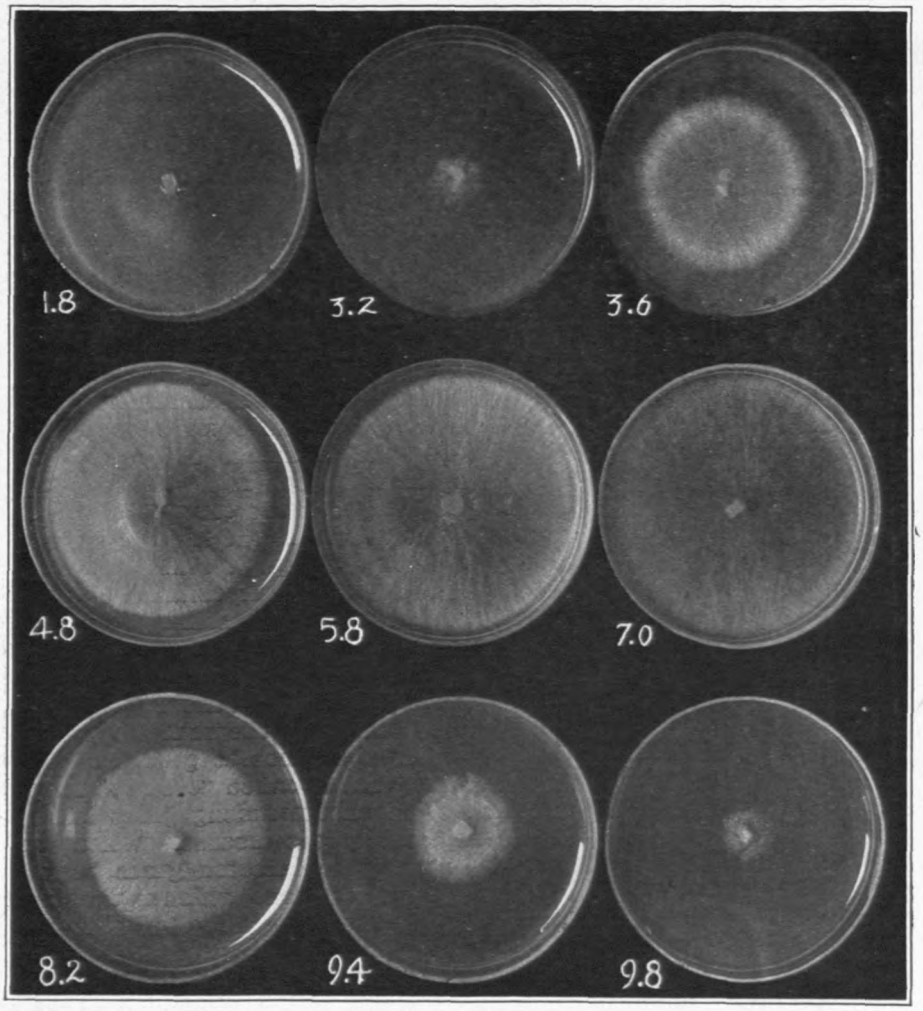

Fig. 7. Showing the effect of acidity on the growth of large brown-patch fungus. These nine dishes all had equal amounts of the same culture medium, were started at the same time, and grown under identical conditions; the only difference being that of acidity, indicated by the pH figures beneath the dishes. A pH of 7.0 (right on center row) is neutral. The greater the acidity the smaller the figure below 7.0; those above 7.0 are alkaline. Notice that the most rapid growth was on the slightly acid or neutral plates. Adding lime to acid soil tends to bring the reaction up toward 7.0 but does not raise it above that point.

much more moisture than does grass; so even if the temperature is favorable to the fungus and unfavorable to the grass, the disease may not appear, due to insufficient moisture for the fungus. In a similar way many other factors may balance one against another to influence the occurrence or severity of an attack of brown-patch. For this reason no hard and fast rule can be laid down as to when to ex-

pect an attack nor how to completely prevent one. It is not difficult to see that hot weather, heavy dews, cloudy weather, or other weather conditions which have been regarded as the "cause" of brown-patch, do not in themselves actually cause the disease, although they unquestionably have a decided influence on the real source of the disease—the fungus. When these factors are well understood and analyzed there will no doubt be devised some method for greens management that will greatly reduce the prevalence and severity of brown-patch.

To fully understand the disease it is essential that one get the conception of two separate plants, the grass and the fungus, each affected by a great many conditions which when balanced in certain ways give the fungus a decided advantage and permit the disease to develop, whereas at other times the balance is thrown in favor of the grass and the fungus is practically harmless.

Development of the Disease

Under conditions favorable for the development of the disease, the fungus grows up over the grass blades and spreads rapidly from one blade to another. The fine thread-like mycelium grows over the surface of the leaf until it reaches one of the pores, through which the grass "breathes." When it reaches one of these pores (stomata) the mycelium enlarges somewhat and fine branches of the fungus push through the opening into the leaf. When it has thus penetrated the grass it grows through and between the cells which make up the leaf tissue. This invasion is illustrated in the drawing shown in Fig. 8. The fungus absorbs food from these grass cells and grows rapidly until the blade is filled with the parasitic mycelium. At this stage the grass blade has a scalded, darkened appearance, but may show no sign of shrivelling. A blade in this condition does not last long, however, and as soon as the sun strikes it and the dew has evaporated it shrivels and turns brown. Most of the blades over a large area may be affected; and in this way the familiar brown patches are produced. It is a common experience to go out on the greens before the dew has dried, during the so-called "cobweb" stage of attack, and find a fine network of mycelium among grass blades that show the first blackened symptoms of the disease. When the dew disappears this mycelium vanishes, the infected grass begins to shrivel, and finally there is the brown, dead area which is the final symptom of the disease.

Two Types of Brown-Patch

Large brown-patch is caused by a strain of the fungus which has been known for many years as a serious disease of potatoes. Dr. C. V. Piper several years ago identified it with this potato fungus, known scientifically as *Rhizoctonia solani.* The threads of its mycelium are at first colorless, but gradually develop a light brown color and at times grow together in compact knotted masses, forming dark brown or black mats which are known as "sclerotia." These are shown in pure culture in Fig. 3. The mycelium grows very rapidly over the surface of the soil or turf, and under favorable conditions may soon cover a large area, in which it kills a high percentage of the leaves. In most cases it skips a number of blades, so that there is a scattering of green within the browned area. Ordi-

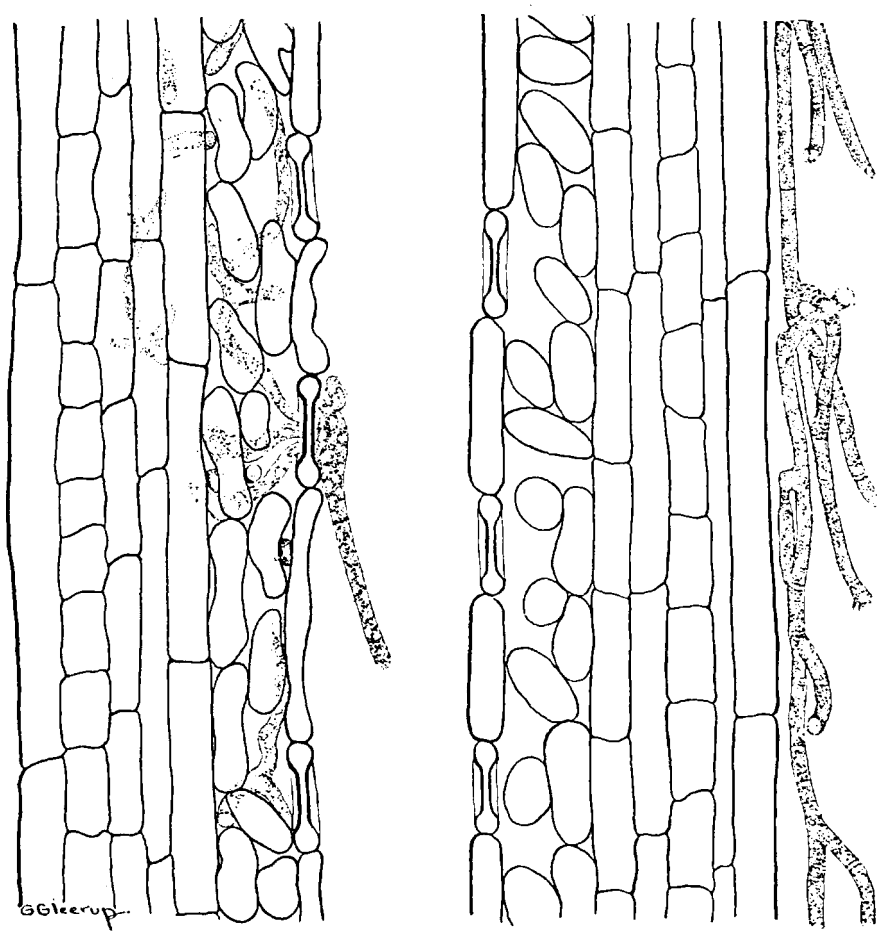

Fig. 8. Sketch showing the large brown-patch fungus growing on grass (magnified 375 time). This drawing was made, with the aid of a microscope, from very thin sections cut lengthwise through leaves of grass over which the fungus was growing. The cells making up the grass blade are simply outlined, whereas the tubular thread-like mycelium of the fungus is represented as dark stippled strands in the drawing. On the right is shown a healthy grass blade with the fungus still entirely on the outside. In the case of the blade at the left the fungus has penetrated through one of the "pores" in the epidermis (skin) and has spread among the cells of the leaf. By comparing the individual cells of this leaf with those of the healthy blade at the right it will be seen that some cells of the former are beginning to collapse; especially noticeable is the case of the cell just above the point where the fungus entered the leaf. After a leaf is thus invaded by the fungus, the cells gradually break down, causing the leaf to shrivel and turn brown. When the fungus has penetrated a blade as here shown, no control measure is known which will restore that leaf. Methods for control are based on checking the development of the fungus and following this by stimulating the grass to replace injured leaves with new ones. As the sections are magnified about 375 times, the actual size of each of the sections represented was approximately 1/250 of an inch thick and 1/88 of an inch long.

narily it attacks only the leaves and does not injure the stems or the buds on these stems, although in severe cases even these may be attacked and the turf is then "killed out" in the affected patches. Fortunately, however, the stems usually escape injury and are therefore left to produce new leaves to replace those killed by the fungus. This makes it possible to treat the green after an attack, and by stimulating a rapid growth the scar can be quickly obliterated by new blades shooting up from the uninjured buds along the stem.

Small brown-patch is due to a distinctly different species of Rhizoctonia. This fungus has a white mycelium with a much more "fluffy" growth. It does not produce the same type of hard, black sclerotia as does the one described above. It is shown in Fig. 3 in pure culture compared with the one causing large brown-patch. The area affected by this small brown-patch fungus is limited, but the injury, although it covers only a small piece of turf, is severe. Usually every blade in the patch and frequently even the buds and stems are killed. Fortunately this more severe injury is restricted in area, and the spot is ordinarily not more than an inch or two across, as shown in Fig. 2. The killed leaves have a more bleached appearance than do those affected in large brown-patch.

Control of Brown-Patch

Readers of this article will of course be interested chiefly in a discussion of the disease from the standpoint of control. Control methods, if they are to be made effective over any considerable range of conditions, must naturally be based on some understanding of the cause of injury and factors affecting its development. Many greenkeepers think they have solved the whole problem of brown-patch because their greens have been comparatively free from the trouble. As a matter of fact they may have had little to do with preventing the disease, for conditions on their particular course may be naturally unfavorable for the disease whereas conditions on a near-by course may be extremely favorable. Also a certain method of treatment may actually prevent the disease in one case, but due to other conditions it may be much less effective on another course.

Control measures may be classified into three groups, which are, in the order of importance, cultural methods, resistant varieties, and chemicals.

Cultural Methods

Under cultural principles will be included the various details involved in the construction and maintenance of greens. As far as known, no single practice can be advocated which will completely control this disease. However, it is obvious that certain modifications in construction and management of putting greens will decidedly lessen the severity of attacks by brown-patch. These modifications are based on considerations of the various factors involved in creating conditions as favorable as possible for the growth of grass and as unfavorable as possible for the growth of the fungus parasitic on the grass.

It is self-evident that the first consideration should be given to creating proper soil conditions in building the green, for no subsequent treatment will quite compensate for original deficiencies in construction. This is not meant to imply that the most expensive plan is the best, for in many cases much better soil conditions are produced by the simple processes of plowing and pulverizing the soil than by some of the most expensive methods used in certain freak schemes for green construction. From the standpoint of brown-patch control, one of the most important soil conditions to be considered is that of drainage. Since grass is weakened and the activities of the fungus increased by excessive water it is apparent that poor drainage will increase the severity of the disease. Judged from

any standpoint, a green should be well drained; but this again does not necessarily mean an expensive drainage system, for many greens are located where there is adequate natural drainage. It is often assumed that because a green is located on high ground the soil is well drained. This is not always the case, for poorly drained greens are sometimes found even on a hillside. By careful observation after watering or during rainy weather, it is usually not difficult to discover defective drainage. Another flaw in the construction which often encourages brown-patch is the disregard for adequate air circulation. As pointed out previously, the fungus is usually encouraged by heavy dew, especially when it falls early and lasts late into the morning. Many greens are so situated that the prevailing winds do not have access to the grass, and as a result dew has every opportunity to settle early in the evening and remain there until the sun dries the grass late the following morning. Frequently a breeze comes up during the night, which effectively removes dew from exposed greens, whereas sheltered greens remain wet. These latter are usually most subject to brown-patch. Often this difficulty can not be remedied owing to the contour of the land; but in a large number of cases a few channels cut through the confining underbrush would provide adequate ventilation whenever there was any air movement. In this connection reference is invited to the article, "Air Pockets and Brown-Patch," on page 180 of THE BULLETIN for August, 1925.

Another construction flaw which is occasionally found is that of slope as affecting temperature. The temperature influence on development of the disease is one which can be rarely modified. In some cases, however, it is worth consideration, especially if other factors are unfavorable. A slope toward the west which gets the full force of the afternoon sun would naturally retain more heat during the night, the time when brown-patch develops. Such faulty construction is well demonstrated on a green near Washington, D. C. The course is well managed and little bothered with brown-patch except for this one green with a southwest pitch located on a hillside where it is banked with a heavy growth of trees and thick underbrush both above and below it. Since the slope was rather steep, it was naturally assumed that drainage need not be considered. As a matter of fact, considerable water drains out from the wooded slope above on to the green and keeps it entirely too wet much of the time. The heavy growth of trees and underbrush at each end establishes a pocket of "dead air," and consequently dew settles there many times when nearby greens are perfectly dry due to air currents. The pitch toward the southwest insures full utilization of the heat of the sun, and as a result when night comes that green has a big reserve of heat, an abundance of moisture, and no air circulation to help reduce either. Thus ideal conditions have been created for the fungus and miserable conditions for the grass. In this particular case the green could be moved a few yards back without materially affecting the play, a few channels might be cut through the underbrush which would in no way detract from the beauty of the course, and drainage could easily be provided for the water running from the woods above, and thereby an environment would be created which, although perhaps not ideal, certainly would enormously decrease the injury from brown-patch.

Provided proper attention has been paid to construction, there are several points which should be considered in managing greens to reduce brown-patch injury. Chief of these is the proper use of water. Greens should not receive too much water, especially during periods recognized by most greenkeepers as "brown-patch weather." It is especially important that heavy watering should not be done late in the day if there is a possibility that the night will be warm and quiet, for under such circumstances conditions would be ideal for the development of the disease throughout the night. It is this consideration which no doubt contributes to the success of early morning watering in the cases where it has proved successful in controlling the disease. By avoiding the practice of afternoon or evening watering and adopting the morning watering plan, the grass remains dry later in the night and the fungus is thereby given a shorter time to develop. Early morning watering also has the advantage of washing the dew from the grass blades, making the turf dry more rapidly. The use of bamboo poles, rubber hose, or similar devices to sweep the dew from grass early in the morning hastens drying of the turf and under certain conditions may be of value in checking the disease. It is apparent that a general recommendation of early morning watering to control brown-patch may be overdone, for there are times when the greens already have too much water in them, so that further watering would tend to increase the injury. In such cases the dew would no doubt be more wisely removed by some process of sweeping as above mentioned.

Another matter to be considered is that of fertilizing. Grass should be kept in a good healthy condition, which, however, does not necessarily mean a rank growth. Mowing should not be checked in case of a severe attack of the disease, but extra care should be taken to remove all the clippings from the green.

Resistant Varieties

The method of controlling brown-patch which appears to hold the most promise is that of the development of strains which are able to resist attacks of the disease. At present there are two strains of creeping bent which are outstanding in this quality. These are the well known "Washington" and "Metropolitan" strains. It should be understood that they are not *immune* to brown-patch, nor is it likely that any strain under every condition will prove wholly immune. They do, however, show a decided resistance when grown under favorable conditions. These strains, especially the "Washington," have in the last few years provoked a great deal of discussion and have perhaps received more abuse and praise than any other strains of grass used for putting greens. Much of this has been caused by over-enthusiastic claims and exaggerated expectations. It should be remembered that all strains of bent are new as compared with our other cultivated plants. It would certainly be remarkable if, in the short history of bent strains, a *perfect* grass had been developed. Nevertheless those two have sufficient merit to justify their use even without the stamp of "perfection." In the course of the next decade it is probable that many better strains of bent will be developed in different localities. Indeed it would be surprising to find a single strain which would prove best for every soil type and climatic condition throughout the country. It is more likely that

one strain will prove the favorite in sections such as St. Louis, for instance, while another strain will be found best for clubs in New England. There are some strains now on the market which are advertised as "immune to brown-patch." Such a claim may possibly in time be substantiated, but as a rule it is either a deliberate attempt at deception or is based on total ignorance of the disease. To claim that a strain is "immune" to brown-patch simply because on the few courses where used it has never had the disease is about as safe as to claim that a man is "immune" to pneumonia because of the convincing fact that he has never been known to have it. Such strains

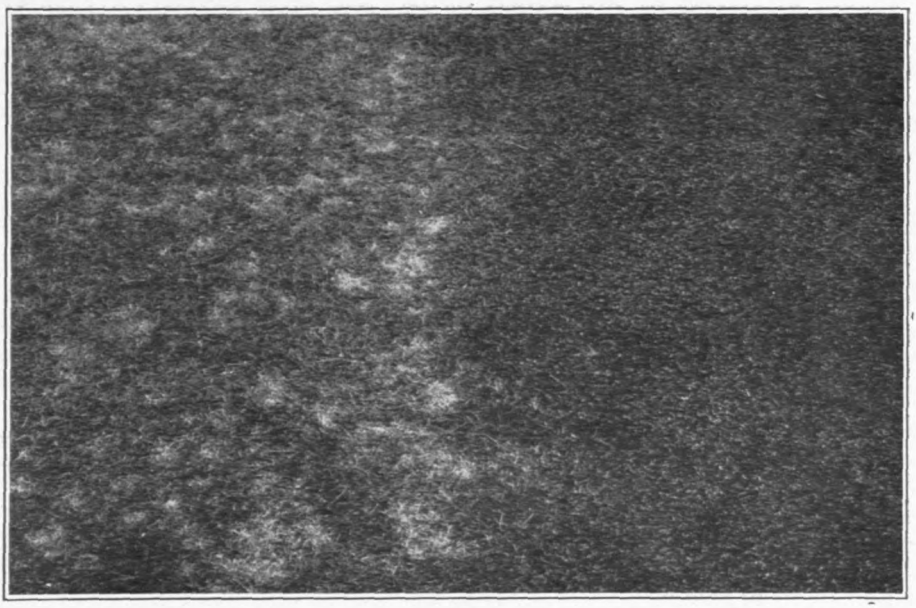

Fig. 9. Photograph showing difference in resistance of strains of creeping bent to small brown-patch. On the right is the Metropolitan strain, which is highly resistant, and at the time the photograph was taken it was entirely free from the disease. On the left, immediately adjoining, is a very susceptible strain badly spotted with brown-patch. Both plots were planted at the same time and have received identical treatment since planting. The economy of the use of resistant strains is obvious.

must prove their worth through at least three seasons, and in tests beside other grasses where brown-patch is prevalent, before they may be wisely branded "immune." Until other strains have been developed and adequately tested, the Washington and Metropolitan head the list of strains resistant to brown-patch. The resistance of the Metropolitan strain is shown in Fig. 9.

Chemicals

There are times when, due to climatic conditions over which we have no control, brown-patch will develop in spite of all precautions such as those indicated above. On such occasions certain chemicals may be used to kill the fungus or at least to check its spread over the turf. Numerous fungicides which are used against plant diseases in several fields of agriculture have been tested for control of brown-

patch. One of the most common groups of spray used against fruit diseases is that containing some form of sulfur. This group has, so far, not been satisfactory against turf diseases, due to the tendency of sulfur to injure grass. Another group of sprays is based on some form of copper compound. The most common of this group is Bordeaux mixture, either in the liquid or powder form. This mixture has proved effective in controlling the large brown-patch but is of little or no value when used against the small patch. There is also danger of an accumulation of copper in the soil, which, after excessive applications, appears toxic to grass and may produce an injury as serious as the disease itself. The most effective groups of chemicals so far tested are those composed of some combination of mercury. These results have been reported in detail in previous articles in THE BULLETIN and have been summarized in the October, 1925, number, page 219. From these tests it appears that mercury in several organic or inorganic forms is efficacious in checking the disease. The period of protection varies considerably, apparently due to some soil or climatic conditions which we so far do not understand. Some cases have been reported where the protection afforded turf lasts only a couple of days, while in others it has lasted several weeks. During the period of midsummer, when the disease is worst, these compounds, unfortunately, give their shortest period of protection. Other chemicals have been tested but have proved of little value or have not been tested under sufficiently varying conditions to justify any general conclusions.

While much has been learned about brown-patch and methods of control within the last few years, there is still much to be done. The experimental work will be continued during the summer chiefly along lines leading to control, and will be reported in THE BULLETIN as soon as results with any treatment are sufficiently promising to justify any general trials.

New Member Clubs of the Green Section

Stoughton Country Club, Stoughton, Wis.; Huron Hills Golf Club, Ann Arbor, Mich.; Granville Inn and Golf Course, Granville, Ohio; Shamokin Valley Country Club, Shamokin, Pa.; Black Hawk Hills Country Club, Rock Island, Ill.; Great Chebeaque Golf Club, Boston, Mass.; Hillcrest Country Club, Kansas City, Mo.; Oyster Harbor Country Club, Osterville, Mass.; Corning Country Club, Corning, N. Y.; Opequon Golf Club, Martinsburg, W. Va.; Haverhill Country Club, Haverhill, Mass.; Cedar Rapids Country Club, Cedar Rapids, Iowa; McMinnville Golf and Country Club, McMinnville, Oreg.; Skaneateles Country Club, Skaneateles, N. Y.; Mr. R. S. Burlingame, Syracuse, N. Y.; Meadow Brook Country Club, New Haven, Conn.; Picatinny Arsenal Golf Club, Dover, N. J.; Forest Lake Country Club, Pontiac, Mich.; Superior Golf Club, Minneapolis, Minn.; Seneca Falls Country Club, Seneca Falls, N. Y.; Orinda Country Club, Berkeley, Calif.; Nippersink Lodge Assn., Genoa City, Wis.; Mission Hills Country Club, Kansas City, Mo.; Dublin Road Golf Club, Columbus, Ohio; Bloomington Country Club, Bloomington, Ill.; Scenic Highlands Golf Club, Babson Park, Fla.; Country Club of Geneseo, Geneseo, N. Y.

Rhode Island Bent As a Putting Green Turf

By C. A. Tregillus, Green Section, Royal Canadian Golf Association

The popularity of creeping bent as a putting green turf has spread with remarkable rapidity. Its ability to produce with proper care, a close, dense turf capable of throttling the inroads of weeds and withstanding the severe conditions of play and climate commends it to golfers and greenkeepers far and wide. The use of creeping bent has become very general throughout the northern part of North America. We have it on putting greens over Canada to a northerly latitude close to the 60th parallel. It is essentially at home in the northern climates and so adapts itself particularly well to Canadian courses.

However, simple as it is to produce a vegetated turf of creeping bent on the new green, the transforming of an established turf to creeping bent either seriously disrupts the course during the playing season or takes so long that a year or more must elapse before a solid bent turf is assured.* For this reason attention has reverted within the past couple of years to the use of Rhode Island bent as a quick renovator of greens composed of grasses ill suited to this purpose. Rhode Island bent grass being reproduced from seed permits of changing the turf over from fescue and coarser grasses at a minimum of time, labor and inconvenience. The supplies of German bent imported by America prior to the Great War contained a high percentage of Rhode Island bent together with creeping bent and velvet-bent. Greens sown with this seed formed a beautifully fine sward but lacked uniformity of color and texture due to the individuality of species and of varieties within the species; the creeping and velvet-bent showing great diversity in this respect. Of recent years, German bent, now known commercially as South German mixed bent, has so depreciated in quality that the writer can find no trace of this year's importations into Canada for resale.

The Rhode Island bent, when separated from the other species, does not show such peculiarity among the individual plants and so can be depended upon to present a turf of fairly uniform color and texture. This grass, a native of the North American Atlantic seaboard section, including the New England states and Canada, has long been recognized as a premier turf former but its use has been limited of late years due in a large measure to difficulty in obtaining seed of a worth-while quality. However, it appears that seed is now coming on the market both in Canada and the United States of America from those sections just referred to, of such purity that it can be depended upon to produce a fine, even, permanent putting green.

Rhode Island bent differs considerably from creeping bent. It is upright in habit of growth, as against the creeping, which sends out the long creeping stems. Its inclination to root at the joints of the stem is very slight indeed, hardly noticeable, but nevertheless, it will knit up very closely.

We have in Canada many greens sown exclusively to this grass. The earliest were seeded with seed from the New England states and later ones with seed from Canadian sources. As a vigorous grower,

* In Canada no greens have as yet been converted to creeping bent by the method described on page 223 of THE BULLETIN for October, 1925.—EDITORS.

it leaves but little to be desired. It comes on early in the spring and holds up well during the season. On the smaller courses where maintenance expenditure is cut down to a fine figure, it can be depended upon to make a very fair green with a minimum of attention. As seems the inclination of all bent grasses, it is aggressive, crowding out the coarse grasses and weeds, and further, having an upright habit of growing, can be permitted extra length of leaves with no further hazard than a slower green. This fact is of value where greens are not cut as frequently as ideal conditions demand and topdressed but two or three times through the season at most. Under these circumstances, the Rhode Island bent has done particularly well. Further, the fact that greens have been changed over to bent from fescue and coarser grasses with no further delay than that of reseeding on top of the old turf, has done much to increase its use in the Dominion.

While Rhode Island bent as a putting green turf has proven itself on inland situations, it is particularly at home under maritime conditions. This fact was particularly impressed upon the writer when visiting the golfing sections of the eastern Canadian provinces. Most courses in those districts are overrun with the native grass, largely Rhode Island bent. A problem that concerned the Green Committees was that greens made by merely cutting and rolling the native turf proved much better than those carefully seeded to, supposedly, superior imported grass. The use of native grass of any species, provided it makes the kind of turf required for putting green conditions is, of course, much to be preferred to seed or grass imported at an expense and risk of damaging the vitality of the material.

Bent seed, as compared with the coarser species, is very fine, running up as high, so analysts tell us, as four or five million seeds per pound, and carrying a high percentage capable of germination. The difficulty of securing good seed of bent is largely due to the extreme fineness of the seed, making it difficult to separate the good seed from chaff and inert matter. Furthermore, it is impossible for anyone other than the expert analyst with a microscope to separate the finer bent from redtop; and so the possibility of this coarser grass being present in greater or smaller proportions can be readily understood. While we have yet no means of commercially separating the bent seed from redtop seed and most likely never will, yet when the two grasses are growing side by side the difference is quite apparent, both in color of flowerhead and the height of the flowering stalk. Keeping this in mind, it is a simple matter to estimate the percentage purity of the bent by inspecting the field prior to harvest. This inspection is necessary when growing the Rhode Island bent seed in sections where redtop has been introduced.

We have in commerce Rhode Island bent seed from New Zealand under the name of Colonial bent. Tradition says that this was introduced into New Zealand by Scotch-Canadian settlers who sailed from Nova Scotia a hundred years ago, taking with them mattresses stuffed with the wild grass which, on arrival at their new home, were emptied out and the seed germinating, it spread rapidly. It is the same species and if the story be true, presents rather an interesting twist in the development of this phase of the seed industry.

QUESTIONS AND ANSWERS

All questions sent to the Green Section will be answered in a letter to the writer as promptly as possible. The more interesting of these questions, with concise answers, will appear in this column each month. If your experience leads you to disagree with any answer given in this column, it is your privilege and duty to write to the Green Section.

While most of the answers are of general application, please bear in mind that each recommendation is intended specifically for the locality designated at the end of the question.

1. The effect of long-continued close mowing and topdressing.—Is there any danger of shortening the life of turf by subjecting it to the continual close clipping and topdressing recommended for keeping creeping bent turf in true putting green condition? (Ohio.)

ANSWER.—The plots of Washington and Metropolitan bent turf at the Arlington Turf Garden that are now in their eighth year have been cut very close practically every weekday and topdressed about once a month during the growing season through their duration to date, and they are apparently as good now as the one-, two-, and three-year old turf. Close clipping is necessary to keep any kind of turf in good putting green condition, and the frequent topdressing with proper materials, if properly applied, will in no way impair the durability of any turf but will be found very helpful, both for keeping the grass vigorous and healthy, and for keeping the surface of the green true.

2. Close cutting of newly planted bent greens.—I recently noticed a recommendation for cutting creeping bent in the early stages of turf development in which it is stated that the grass should be cut at first with an ordinary lawn mower, and after the first topdressing it should be cut with the mower set at three-quarters of an inch and gradually lowered until the proper height for the finished putting surface is reached. This is apparently contrary to former advice to cut it to a putting green length from the beginning. Which method should we follow? (Michigan.)

ANSWER.—Cut close from the beginning and you will find that a true putting surface and a good dense turf will develop quicker and with less labor.

3. Neither Washington nor Metropolitan strain should produce fluffy turf.—We have been informed that the Washington strain of creeping bent grows upright and produces a fluffy turf, and that the Metropolitan strain clings closely to the ground and does not make fluffy turf. Is this correct? (Illinois.)

ANSWER.—Both the Washington and Metropolitan strains of creeping bent cling very closely to the ground when growing naturally, but the nodes are very close together, and when they are grown under turf conditions they produce a dense growth of foliage which stands upright owing to the fact that the leaves are so closely crowded. Neither of these strains produces a fluffy turf when kept properly cut and topdressed. The quality of turf produced by these two strains is practically identical except in color. The Washington is a bright apple-green, and the Metropolitan a light blue-green.

4. Truing putting green surfaces.—Our greens are not true and we wish to know what weight roller you would advise us to use on the greens in order to make them true. (Minnesota.)

ANSWER.—In the rolling of greens in the spring the idea is to roll just heavily enough that footprints, particularly heelprints, will not be left in the turf. Rolling more heavily than this is not desirable and is in most cases harmful. The weight of roller desirable to bring about these results will depend on the character of the soil and the denseness of the turf. A heavy clay soil will stand much less rolling than a light soil. This is a matter which is however easily determined. The weight of roller most commonly used is from 175 to 225 pounds. The weight can readily be altered to suit conditions when a water-ballast roller is used. We believe however that you will get better results in truing the surfaces of your greens by topdressing the greens perhaps several times until you get the desired trueness of surface. If your soil is heavy, topdress with sandy loam; if medium, topdress with ordinary good loam or compost.

5. Effect on soil of continued use of corrosive sublimate in earthworm control.—Some of our neighboring courses are still buying the worm eradicator advised by seed houses and paying $120 for the amount used in one application for the 18 holes. Counting labor of hauling and mixing the sand required with the corrosive sublimate which we use for the same purpose, I think our applications cost less than $40 for one application on 18 holes. We are advised, however, that frequent applications of corrosive sublimate will produce a permanent injury to the greens. Please let us have an answer about this. Also, would it not pay to worm the ground on the approach to the green for a distance of, say, 20 yards; especially where the ground is very favorable for worms? Can anything be put under a green to prevent the worms coming through? (Ontario.)

ANSWER.—Corrosive sublimate is the best thing we have found for getting rid of earthworms on putting greens. Its method of use is fully detailed in THE BULLETIN for May, 1924 (page 115). Of course, it is possible to use it in such large quantities that it will scorch the grass, but we have thus far not noted any injury from its continued use. We have been using it on a certain area for eight years and have not the slightest indication of any evil effect from it. We think it will pay you well to worm your approaches, as it is not very expensive when corrosive sublimate is used. We have found nothing that can be put under greens to prevent the occurrence of earthworms and at the same time grow grass satisfactorily. Furthermore, we do not approve of putting layers of cinders or any other material of such a nature under putting greens.

6. Animal charcoal as a fertilizer.—We are sending you a specimen of animal charcoal, which is a by-product of a local industrial concern. We are inclined to believe that it has good fertilizing or mechanical properties, or possibly both, so that we might use it to advantage on our greens and fairways. We can obtain it delivered on the job very cheap. Would you advise our using this material as a fertilizer? (West Virginia.)

ANSWER.—Charcoal, on account of the English tradition, is still favored by some greenkeepers. In our experience we have been unable to see any results whatever from the use of any form of charcoal. Animal charcoal would have some advantage over vegetable charcoal, inasmuch as it carries some phosphorus. We think you can rest assured the material would do no harm, but we doubt if there is any particular benefit to be derived from its use. It would have to be very cheap, in our judgment, to justify its use.

7. Disadvantage of spring and summer planting.—About the first of June we will be ready to plant with creeping bent stolons a green which we have had to change. Do you think that time would be too late in the season for success? (Pennsylvania.)

ANSWER.—Bent stolons can be planted at any time of the year, but if they are planted in spring or summer they are certain to be damaged badly by the growth of weeds. The best time to plant greens in your locality is between August 15 and September 1.

8. Sand-binding grasses; salt-resistant grasses.—Can you suggest any grass which will grow in salty sand, especially for the purpose of binding the sand to prevent its blowing? (New York.)

ANSWER.—Of turf-forming grasses, the two having the best chance of succeeding under the conditions you mention are seaside bent and red fescue. Seaside bent is best established by planting the stolons, but the red fescue would have to be seeded. The best tall grass for holding blowing or drifting sand is beach grass (or marram grass), which would have to be started by setting out the roots. This however is a tufted grass, and not a turf-former. Seaside bent and beach grass can be obtained at many places along the New England coast, especially the coast of Massachusetts. The latter grass also occurs extensively on the shores of Long Island.

9. Value and use of guano as a fertilizer.—Kindly give us your recommendations as to the use of guano as a fertilizer, its value and how it should be applied. (Pennsylvania.)

ANSWER.—Guano is used in mixed fertilizers, chiefly in the South. There is no question regarding its efficiency. We have conducted no experiments with its use on putting greens, but are inclined to think that the most economical and at the same time most effective method of using it on putting greens would be to mix it with good top soil in the proportion of 10 to 15 percent of guano to the soil.

10. Comparison of rotted compost with mushroom soil.—Which would you consider the better for topdressing fairways, compost which has been in the pile for over a year, or mushroom soil just taken from the beds? (Pennsylvania.)

ANSWER.—We consider good compost made by rotting manure in soil of equal value to mushroom soil. In fact, they are one and the same thing. Mushroom soil is a compost of horse manure and clay or clay loam of a year's standing in a mushroom cellar.

Meditations of a Peripatetic Golfer

A green planted by the vegetative method where so little care is taken to keep the surface even that the first mowing will result in scalping a quarter of it and leaving another quarter uncut!

If anything can make a green look worse than brown-patch it's a poorly adjusted mower.

A word to the wise: Crab-grass has sprouted and brown-patch is with us again.

Nitrogen leaches out of the soil rapidly, and without it turf can not be vigorous, but there are many who see no need for frequent applications of nitrogenous fertilizer in topdressing.

Weed your greens by hand, use ammonium sulfate regularly, and less hand weeding will be necessary next year.

How few absolutely uninteresting dog-leg holes there are after all!

Unless the greenkeeper knows the area of each of his greens his applications of topdressing, fertilizers, and chemicals are nothing but guesswork.

Soil should contain air and water in about equal proportion. When a cup stands full of water long after the sprinkler has been stopped, "Stand back, give him air."

An extra bed-knife is very handy to have around. So is a regrinding crank and some emery dust.

Cheap construction generally means expensive maintenance.