

ADVISORY COMMITTEE

W. A. ALEXANDER, Chicago, Ill.
 EBERHARD ANHEUSER, St. Louis, Mo.
 A. C. U. BERRY, Portland, Oreg.
 N. S. CAMPBELL, Providence, R. I.
 WM. C. FOWNES, JR., Pittsburgh, Pa.
 F. H. HILLMAN, Washington, D. C.
 THOS. P. HINMAN, Atlanta, Ga.
 FREDERIC C. HOOD, Watertown, Mass.
 K. F. KELLERMAN, Washington, D. C.
 NORMAN MACBETH, Los Angeles, Calif.
 E. J. MARSHALL, Toledo, Ohio.

W. L. PFEFFER, St. Louis, Mo.
 GEORGE V. ROTAN, Houston, Tex.
 SHERRILL SHERMAN, Utica, N. Y.
 FREDERICK SNARE, Havana, Cuba.
 JAMES D. STANDISH, JR., Detroit, Mich.
 CHARLES E. VAN NEST, Minneapolis, Minn.
 W. R. WALTON, Washington, D. C.
 ALAN D. WILSON, Philadelphia, Pa.
 M. H. WILSON, JR., Cleveland, Ohio.
 FRANK L. WOODWARD, Denver, Colo.

Snow-Mold

By Arnold S. Dahl

University of Wisconsin .

In the northern tier of states and in Canada, where golf courses are covered with snow for long periods in winter and early spring a disease of grass has become increasingly noticeable. This disease, known as snow-mold, causes great damage, particularly to putting greens. It is caused by a fungous organism which remains in the soil in a dormant state during most of the year and attacks the grass when conditions are favorable for its growth. Because of its great havoc in some sections an intensive study of the disease has been undertaken. The purpose of this study is to determine the cause of and the conditions which are favorable to the development of the disease and to devise control measures.

Although snow-mold has been known in this country only a few years it has been recognized in Europe for over a century. There it has been reported as occurring on fields of grain in the Scandinavian countries, and in Germany and Austria. In some years, when conditions have been favorable, great losses have been reported in those countries. Frequently whole fields of grain have been completely wiped out. The organism attacks all the winter grains, but judging from most of the reports rye is apparently the most susceptible. Barley and wheat, though not as susceptible as rye, likewise suffer at times from the disease. Snow-mold has also been reported on lawns in Europe, but only in a few cases. Considering its widespread distribution on golf courses in the United States it is peculiar that snow-mold has never been reported on fields of grain. Last spring, when the snow was melting, an attempt was made to find plants of grain injured by the organism. A survey was made of several fields of rye in various sections, but in no case were injured plants found nor could the organism be detected in the fields examined. It is hoped that a more complete survey can be made to determine whether or not the disease is present on winter grains in this country. Snow-mold causes great damage to putting greens in the United States, particularly in Minnesota, Wisconsin, and Michigan, and has been reported as serious in several regions of Canada.

The disease is noticeable as soon as the snow melts in the spring. When the snow has disappeared, dead areas are found in the turf. These places are sometimes covered with an aerial growth, or mycelium, of the snow-mold fungus. When exposed to the sun this growth takes on a pinkish color, so that whole patches may have a pinkish cast. At times this aerial growth is so abundant that the grass leaves are matted together and form a thick layer over the affected area. When this happens, the grass underneath is usually

killed outright. Other patches may not have an abundant aerial growth nor a pinkish color; instead they are a dirty gray, being thus easily distinguished from areas where the grass has been killed by other causes and which are light brown in color. Patches not having an abundant growth of mycelium are frequently not entirely killed but will slowly recover. Apparently the organism attacks the leaves first, and if conditions continue favorable it will then invade the stems and roots. The relation between the parasite and the host has not been worked out as yet, so that little is known as to what parts of the plants are involved.

The organism causing snow-mold was isolated at Madison, Wis., in February, 1927, by Dr. John Monteith, Jr. Experimenting in a greenhouse, he found that the organism which he had isolated from infected turf on a golf course would cause the disease in grass artificially inoculated in the manner customary in studying plant diseases. Last winter the organism was again isolated at Madison, from local diseased turf and from material received from Grand Rapids, Mich., and Minneapolis, Minn. Pure, or artificial, cultures of the organism were produced, and from a study of these the identity of the organism was found to be *Fusarium nivale* (the Latin word *nivale* meaning "pertaining to snow"). The genus *Fusarium* contains a large number of species in addition to *F. nivale*, some causing diseases in plants and others remaining harmless in the soil. Most of the *Fusaria* develop best at high temperatures, but in this respect *Fusarium nivale* is an exception to the rule, growing well at any ordinary soil temperature but attacking grass only at very low temperatures. In the greenhouse experiments successful inoculations with *Fusarium nivale* were made at temperatures ranging from 32 to 39 degrees Fahrenheit. At these low temperatures spores are formed, either in salmon-colored masses of millions of spores, or singly on the mycelium. The organism was found, in the greenhouse, to cause disease in rye, barley, wheat, oats, fescue, creeping bent, and Kentucky bluegrass.

Snow-mold has been studied carefully by European scientists for many years but notwithstanding there is as yet very little known of its life history. It is known, however, that, particularly in Europe, it causes snow-mold during the late winter and early spring, while in late spring it may cause a disease known as foot-rot, in which the crown of the plant is attacked. Late in the season it causes a head-blight of grains. In the United States it has been reported as causing foot-rot and head-blight. It is probable that on golf courses, and particularly on putting greens, it remains in a dormant state during most of the year, attacking the plants only under such temperature and moisture conditions as prevail when the snow is melting. Spores are produced in large numbers on infected plants, becoming visible at times as slimy, salmon-colored masses. These spores are usually carried from one place to another by means of water, and as a result of this an area on a green which is washed by much surface water may be very badly damaged or entirely killed from numerous infections. Often spores are formed early on mounds near a green, later to be washed down onto the green where they cause secondary infections.

It has been observed in Europe that when snow falls before the ground is frozen the damage from snow-mold is very serious. From the limited observations made in the United States on putting greens

this would seem to hold true here also. When snow falls on ground that is not frozen and remains throughout the winter, the frost does not penetrate the ground to any marked extent, and under this condition apparently the fungus can become active during a thaw at any time of the winter. In sections where snow does not lie on the greens all winter and thaws are frequent, the patches of snow-mold may be seen as early as December. Under such conditions it would seem that snow is not necessary for the development of the fungus. It is, however, evident that low temperature and much moisture are necessary. During thawing weather large snow banks create ideal conditions for the development of the disease, and under these circumstances serious losses occur.

Although a great deal of work has not been done to determine the difference in susceptibility of the various grasses, none of the grasses tested have proved to be immune. Fescue appears to be highly susceptible, while creeping bent is much less so. Kentucky bluegrass is more resistant than fescue but not as resistant as some strains of creeping bent.

The Control of Snow-Mold

By John Monteith, Jr., and Arnold S. Dahl

In the April, 1927, issue of THE BULLETIN a report was given of some preliminary experimental work for the control of snow-mold on putting greens. The results of those first trials were so promising that further experiments were arranged in the fall of 1927 to determine whether the same treatment would prove effective in different sections of the country. During the last season the disease was not as prevalent as usual on several courses where experimental plots were placed, and since the untreated areas on those courses were not severely damaged the freedom from disease in the treated areas could not be regarded as altogether conclusive. However, some such tests in Detroit, Chicago, Minneapolis, and Madison, Wis., gave results which indicated that the corrosive sublimate and calomel treatments would check light attacks. These will not be discussed in detail, for they merely substantiate the results already reported in the April issue of last year.

During the past winter many northern courses were severely damaged by a late freeze, and the injury was so extensive that it was difficult to tell how much might have been due to snow-mold. On several courses, however, it was possible to distinguish the snow-mold damage, and some interesting reports of tests with fungicides were received. These results, taken collectively, serve greatly to advance our knowledge of the problem of the control of snow-mold.

On the course of the Grand'Mere Golf Club, Grand'Mere, Quebec, snow-mold is regarded as an important annual problem, necessitating extensive patching in the spring. The chairman of the green committee, Mr. E. B. Wardle, conducted some tests with different rates of application of corrosive sublimate, as suggested in THE BULLETIN. Reviewing his results of the past season, he writes: "The treatment of our greens has resulted in very considerably diminishing the damage caused by snow-mold. Only one green, No. 9, was badly affected, although we followed up the snow as closely as possible with brooms,