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CAUSED BY HELMINTHOSPORIUM VAGANS**

BY

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(Contribution from Bureau of Plant Industry)

Reprinted from **JOURNAL OF AGRICULTURAL RESEARCH**

Vol. 40, No. 5 : : : : Washington, D. C., March 1, 1930

(Pages 447-456)



PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE
WITH THE COOPERATION OF THE ASSOCIATION OF
LAND-GRANT COLLEGES AND UNIVERSITIES

U. S. GOVERNMENT PRINTING OFFICE : 1930

LEAF SPOT AND FOOT ROT OF KENTUCKY BLUEGRASS CAUSED BY HELMINTHOSPORIUM VAGANS^{1 2}

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INTRODUCTION

In an abstract³ published in 1922 the writer reported the widespread occurrence on Kentucky bluegrass (*Poa pratensis* L.) of a leaf spot caused by a species of *Helminthosporium*. Often, especially in moist situations, the lesions had been found on the leaf sheaths at the base of the plants as well as on the blades, giving rise to a condition comparable to foot rot of wheat. A brief account of the parasite, containing a discussion of its distribution and its pathological effects in addition to its description under the name *Helminthosporium vagans* Drechs., was included the following year in a paper⁴ dealing with various forms parasitic on grasses. Except for a report by Gardner⁵ stating that leaf spot of June grass due to *H. vagans* was prevalent at La Fayette, Ind., during May, 1923, the literature seems to offer no information concerning the disease in which the parasite involved was referred to by the binomial mentioned. However, Monteith⁶ reported that the leaf-spot disease of bluegrass had been destructive in fairways of golf courses in New Jersey and Pennsylvania during the early part of June, 1924. Although in the text the causal fungus was not cited by name, its identity was indicated in the statement that it was "closely related to those causing stripe, net blotch, spot blotch, and similar serious diseases of various grain crops." In a second paper⁷ by the same writer extensive browning of bluegrass caused by the same leaf spot was noted as having occurred during May of the following year on some golf courses in the vicinity of Washington, D. C., and on the plots at the Arlington Experiment Farm, Rosslyn, Va. While the illustrations of severely affected leaves accompanying the text of the latter account appear altogether characteristic of those attributable to *H. vagans*, it may not be amiss to add that specimens of the diseased grass that formed the basis of Monteith's two reports had been submitted to the present writer for examination and the cause of the trouble had been determined as the parasite under consideration by microscopic inspection of the conidiphores and conidia present on the better developed lesions.

At the time the description of *Helminthosporium vagans* was drawn up⁸ the writer's observations were limited to the development of the fungus on Kentucky bluegrass growing in fields or in lawns cut only

¹ Received for publication Oct. 12, 1929; issued March, 1930.

² A popular summary of this paper appeared in the following publication: DRECHSLER, C. LEAF SPOT AND FOOT ROT OF BLUEGRASS. Bul. Green Sect. U. S. Golf Assoc. 9: 120-123, illus. 1929.

³ DRECHSLER, C. A NEW LEAF SPOT OF KENTUCKY BLUEGRASS CAUSED BY AN UNDESCRIBED SPECIES OF HELMINTHOSPORIUM. (Abstract.) Phytopathology 12: 35. 1922.

⁴ DRECHSLER, C. SOME GRAMINICOLOUS SPECIES OF HELMINTHOSPORIUM: I. Jour. Agr. Research 24: 641-740, illus. 1923.

⁵ GARDNER, M. W. INDIANA PLANT DISEASES, 1923. Ind. Acad. Sci. Proc. (1924) 34: 297-313, illus. 1925.

⁶ MONTEITH, J., JR. THE LEAF-SPOT DISEASE OF BLUEGRASS. Bul. Green. Sect. U. S. Golf Assoc. 4: 172-173. 1924.

⁷ MONTEITH, J., JR. LEAF SPOT OF BLUEGRASS. Bul. Green Sect. U. S. Golf Assoc. 5: 198-199, illus. 1925.

⁸ DRECHSLER, C. Op. cit., p. 687. (See footnote 4.)

at moderate intervals and then not excessively close. Although some material collected in Brooklyn, N. Y., in August, 1920, showed leaves that had withered as a consequence of infection, no instances of the killing of plants down to the ground had come to light. While, therefore, it was apparent that "under certain conditions of moisture and of temperature such as would favor a multiplication of foliar lesions and accentuate the foot-rot symptoms the damage may not be altogether unappreciable," the sparse scattering of lesions ordinarily displayed was held to mark the parasite as one of minor destructiveness. Later observations made, especially in fairways of golf courses, where more rigorous cutting is practiced, dictate a modification of this view. As the outward expression of the disease and its relation to the causal fungus still seem far from being generally recognized even among students dealing with troubles affecting the grasses, it may not be inappropriate to amplify the somewhat inadequate account previously submitted.

EFFECT OF THE PARASITE ON THE HOST

LEAF SPOT

In the earlier paper the foliar lesions were described as being of the spot-blotch type, appearing as areas of bluish-black coloration, diminishing in intensity about the margin. Such lesions are indeed found in all representative lots of material, but where conditions have been favorable for the development of the trouble they are outnumbered by morbid regions mostly of larger dimensions. The central areas of these regions are bleached to a straw color, leaving the bluish-black or dark-brown discoloration restricted to a marginal zone of varying width. As the lesions of the latter category, which manifestly conform to the eyespot type, bear conidiophores and conidia in the central bleached parts, the presumption follows that they represent the more advanced stages in the development of the spot-blotch lesions. The correctness of this presumption was proved when cultures obviously belonging to the same identical fungus were obtained on agar plates planted with excised spot-blotch lesions, with excised peripheral portions of eyespot lesions, and with bits of agar media from dilution plates each containing a single conidium from an eyespot lesion after germination. Indeed, the obvious transition of one type of lesion into another, exhibited in a collection of leaves like that shown in Figure 1, A-M, provided visible evidence scarcely less conclusive than the more formal proof by comparison of fungus cultures isolated from them.

A feature frequently noticeable in leaves of *Poa pratensis* affected with leaf spot is a symmetrical development or symmetrical pairing of lesions relative to the midrib. Manifestly, such arrangement is traceable to infection at an early stage in the growth of the leaf while the latter is still tightly folded, the fungus mycelium then permeating the double thickness of folded blade regardless of anatomical relationships. With the unfolding of the leaf the infected mass is naturally separated into corresponding halves. The symmetrical or paired disposition was thus more frequent than usual following the early severe outbreak of the disease in April, 1929, as is evident in Figure 1, which represents leaves collected in the District of Columbia, April 30, from a stand that had been allowed to grow up unmolested and was heading out at the time.

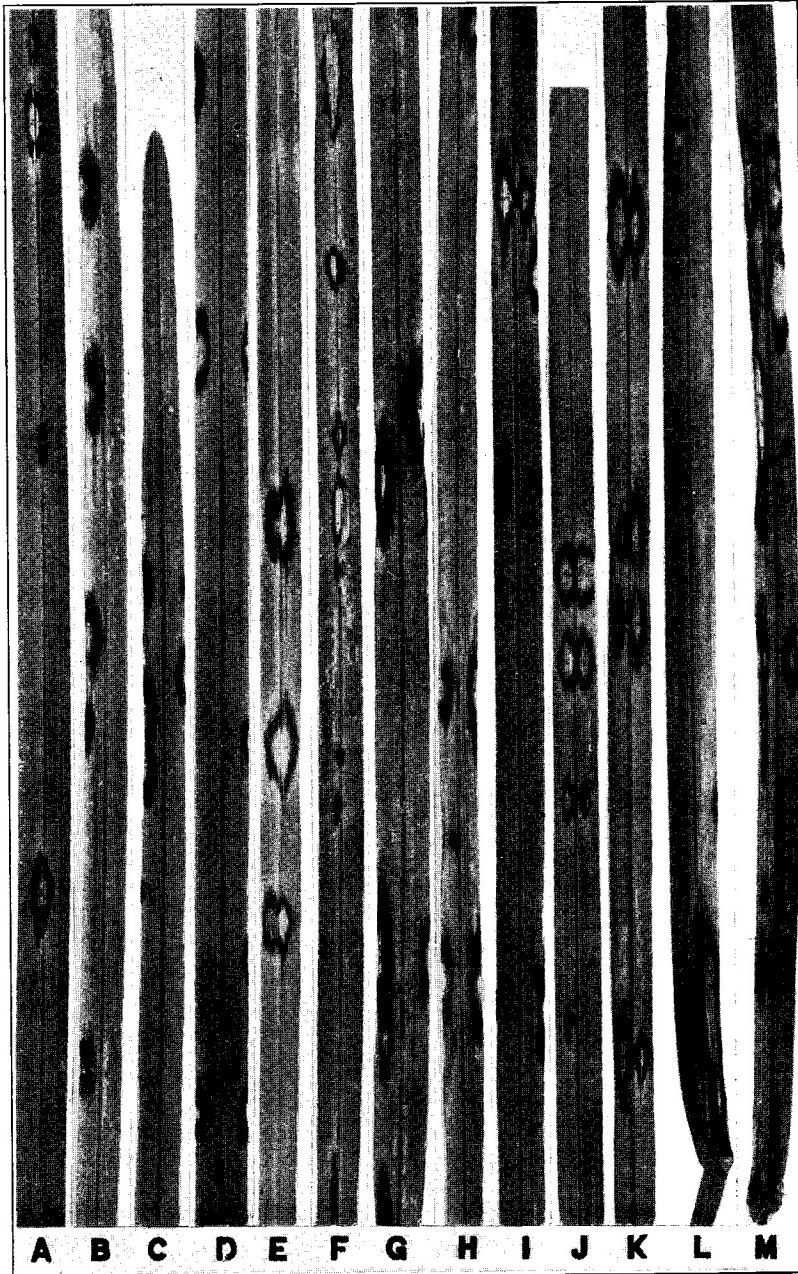


FIGURE 1.—A-M, Leaves of *Poa pratensis* affected with leaf-spot lesions due to *Helminthosporium vagans*. Collected April 30, 1929, in the District of Columbia, in a stand that had not been subjected to cutting. × 2

FOOT ROT

Even in bluegrass plants left to grow to full size, leaf-spot lesions occur at the bases as well as in other parts of the leaf blades. (Fig. 1, L and M.) As the leaves are relatively broad under such conditions, a single lesion rarely occupies the entire width, so that the organ as a whole remains alive. In lawns cut close and at frequent intervals a much more delicate habit of growth is imposed on the host. A half dozen leaves greatly reduced in size are crowded into an almost rosettelike arrangement. Lesions of only moderate width may extend entirely across the basal part of the blade, thus bringing about its eventual death. (Fig. 2.) A more serious situation results when infection spreads to the closely imbricated delicate leaf sheaths that make up the upper portion of the central axis of the plant. All of the foliar organs, including the very young structures enveloped within, are invaded by the fungus, with the result that the miniature plant is effectually destroyed. (Fig. 3.) In April, 1929, the fairways in the public golf courses in the District of Columbia showed numerous gray or brownish patches in which such destruction was so general that the turf survived only in scattering plants and isolated stools.

That the severe manifestation of the disease in the fairways was caused not only by the prevalence of the parasite, but also by the excessively close cutting to which the grass was subjected, became evident from the fact that the same host in the rough near by, treated less rigorously, appeared in relatively good condition. To be sure, the foliage bore an abundance of lesions, and more than a few leaves were cut off by injuries at the base of the blade, but only occasional plants were killed entirely, and the general appearance of the turf was not noticeably impaired. Undoubtedly, close cutting operates to the disadvantage of the host, not only by imposing a delicate habit of growth especially subject to serious injury by the parasite, but also by entailing an excessive removal of foliage and a consequent loss in capacity for renewed growth. Owing to its generally erect foliar habit, bluegrass is shorn of its leaves in far more rigorous measure than are turf grasses of a more nearly prostrate leaf habit, like creeping bent (*Agrostis stolonifera* L. var. *compacta* Hartm.). The recommendation made by Monteith that when leaf spot is prevalent on Kentucky bluegrass in golf courses the blades of the mower be raised as high as circumstances will permit appears, therefore, to be thoroughly sound.

THE PARASITE

CULTURAL CHARACTERISTICS

As has been suggested previously, *Helminthosporium vagans* can be isolated without difficulty by excising bits of infected host tissue and, after surface sterilization, planting them on a suitable medium like maize-meal agar. Conidia may also be successfully utilized, in spite of the somewhat slow rate of mycelial extension characteristic of the fungus and the greater difficulty incurred thereby from the presence of contaminating bacteria. In cultural characteristics the fungus presents nothing striking enough to set it apart from congeneric types. Zonation involving both aerial and submerged mycelium is not uncommon (fig. 4, A), the darker submerged growth being composed of dark-brown filaments consisting of unusually strongly inflated segments. The tendency toward the formation of densely ramifying

systems, referred to in the earlier account, is emphasized by its growth on Dox agar⁹ illustrated in Figure 4, B, and would seem to be associated with retarded growth. That the quantity and the coloration of aerial mycelium is subject to considerable variation not readily traced



FIGURE 2.—A stool consisting of three plants of *Poa pratensis* vigorously attacked by *Helminthosporium vagans*. Many of the leaves are already killed, and those still green bear lesions varying in extent. Photographed from material collected April 30, 1929, in the District of Columbia from a golf course that had been subjected to excessively rigorous cutting. $\times 3$

to any specific cause is shown in Figure 4, C, *a* and *b*, representing two growths obtained in parallel potato-dextrose agar plate cultures. In tube cultures, owing apparently to the moister conditions, flesh-colored columnar structures somewhat resembling those formed by *H. teres* Sacc. and *H. avenae* Eidam frequently make their appearance.

⁹ Distilled water, 1,000 c. c.; magnesium sulphate, 5 gm.; dipotassium phosphate, 1 gm.; potassium chloride, 0.5 gm.; ferrous sulphate, 0.01 gm.; sodium nitrate, 2 gm.; dextrose, 5 gm.; agar, 15 gm.

MORPHOLOGY AND TAXONOMY

Although in artificial culture *Helminthosporium vagans* generally remains sterile, occasionally a moderate number of conidiophores and conidia are produced. In some instances the sporophores are represented by the terminal portions of aerial hyphae differentiated somewhat from the vegetative parts by a slightly greater diameter, a



FIGURE 3.—A plant of *Poa pratensis* severely attacked by *Helminthosporium vagans*. The three remaining green leaves are so severely affected at the closely arranged sheaths as to leave no doubt as to their early destruction. Photographed from material collected April 30, 1929, in the District of Columbia, from a golf course that had been subjected to excessively rigorous cutting. $\times 3$

thicker wall, and a deeper coloration. More frequently, however, they are present as lateral branches on the longer aerial filaments, modified in the same manner as the terminal conidiophores, the deeper coloration and greater thickness of wall usually extending a short distance into one or both arms of the parent hypha. (Fig. 5, A-H.) These lateral sporophores ordinarily show a range in length from approximately 25μ (fig. 5, C) to over 100μ (fig. 5, G), and a range in

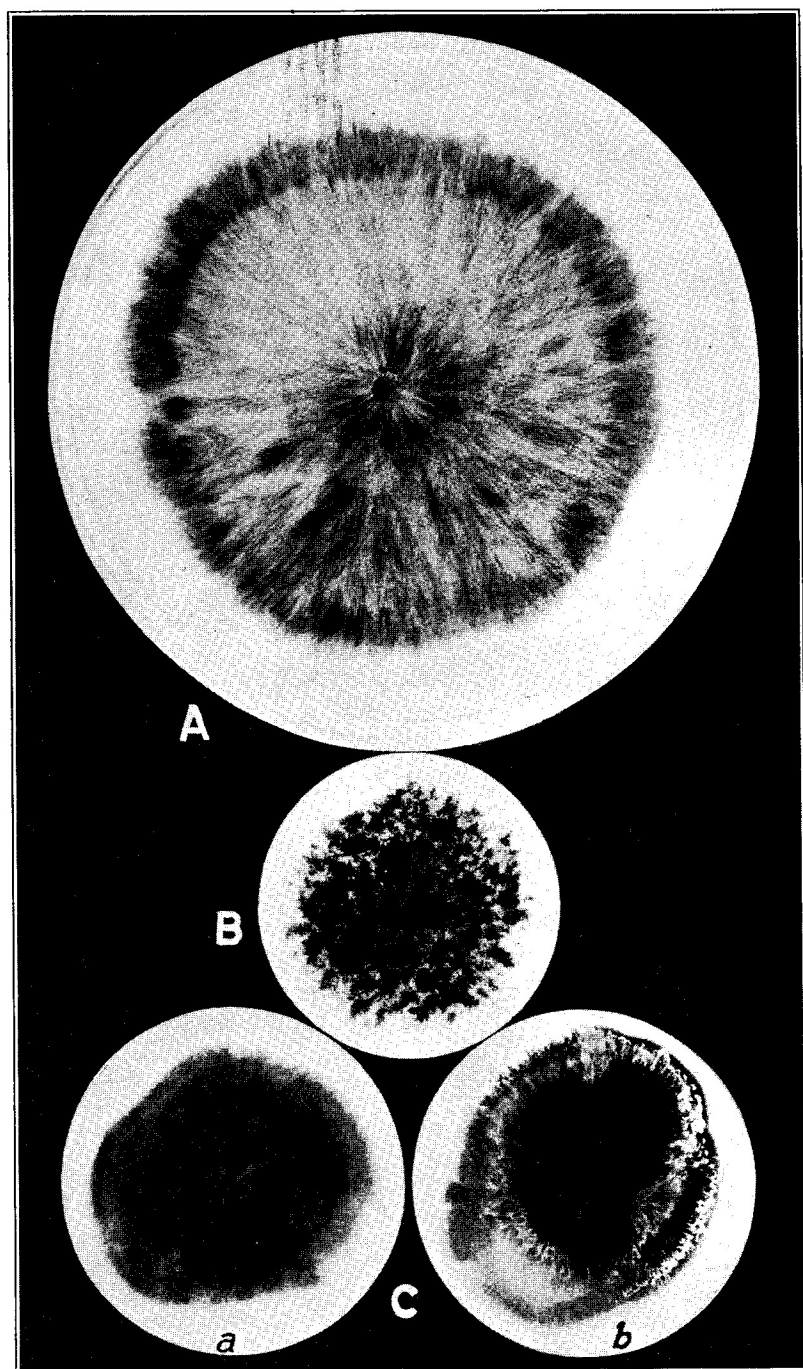


FIGURE 4.—Growth of *Helminthosporium vagans* in plate culture 12 days after planting: A, Maize-meal agar; B, Dox agar; C, potato-dextrose agar. The ready variability of the fungus with respect to the appearance of the aerial mycelium is shown in C, *a* and *b*, representing parallel cultures of the same age and on the same substratum. $\times 1$

number of septa from one (fig. 5, C, and H, *a*) to five (fig. 5, G). Most conidiophores give rise to only one conidium (fig. 5, A–E), but instances in which continued development results in the production of a second spore are not rare (fig. 5, F, *a, b*, and G, *a, b*). The lateral sporophores are usually inserted on the parent filament at rather long intervals, though cases of more closely approximated origins occur. (Fig. 5, H, *a* and *b*.) The conidia produced in culture on artificial media resemble in general shape those found in nature. With respect to coloration they are generally somewhat darker, because of a larger proportion of olivaceous individuals than yellowish or brownish ones. Especially marked, however, is their inferiority in size and number of septa, as is evident by a comparison of the conidia shown in Figure 5, A–H, with those shown in Figure 5, I–S, the latter having been drawn at the same magnification from field material. Such inferiority, to be sure, is generally characteristic of most of the species of *Helminthosporium* parasitic on grasses that can be induced to sporulate at all in artificial culture.

In this connection attention is directed to certain of the more extreme expressions of morphological features pertaining to conidia produced under natural conditions. The conidium represented in Figure 5, L, for example, exhibits 12 septa, 2 in excess of the number allowed for in the original diagnosis. The one shown in Figure 5, J, was found to measure 137μ in length, while the spores represented in Figure 5, P and S, measured 25μ in diameter—magnitudes also somewhat in excess of those previously submitted. In order that undue importance may not be assigned to such extreme values, it may not be amiss to include here a brief summary of measurements of lengths and diameters made on 200 living conidia selected at random in mounts of material scraped from Kentucky bluegrass leaves collected on a golf course in the District of Columbia on May 1, 1929. The 200 measurements of spore lengths fall into classes covering range intervals of 5μ , as follows: 31–35 μ , 3; 36–40 μ , 3; 41–45 μ , 4; 46–50 μ , 6; 51–55 μ , 3; 56–60 μ , 4; 61–65 μ , 14; 66–70 μ , 13; 71–75 μ , 21; 76–80 μ , 18; 81–85 μ , 25; 86–90 μ , 26; 91–95 μ , 17; 96–100 μ , 13; 101–105 μ , 11; 106–110 μ , 7; 111–115 μ , 2; 116–120 μ , 5; 121–125 μ , 2; 126–130 μ , 1; 131–135 μ , 0; 136–140 μ , 2. The corresponding 200 measurements of spore diameters are referable to the different values found, as follows: 11 μ , 1; 12 μ , 1; 13 μ , 1; 14 μ , 1; 15 μ , 4; 16 μ , 5; 17 μ , 25; 18 μ , 40; 19 μ , 41; 20 μ , 38; 21 μ , 19; 22 μ , 10; 23 μ , 8; 24 μ , 3; 25 μ , 3. Counts of cross walls made on the same 200 individual conidia are distributable as follows: 2 septa, 3; 3 septa, 8; 4 septa, 21; 5 septa, 34; 6 septa, 39; 7 septa, 46; 8 septa, 28; 9 septa, 14; 10 septa, 4; 11 septa, 1; 12 septa, 2. Computations from the three sets of values for the 200 spores gave 82.7μ as the average length of the conidium, 19.1μ as the average diameter, and 6.3 as the average number of septa. The conidium shown in Figure 5, I, thus represents a moderately close approximation to the average values determined from field material, though comparing more than favorably with the largest individual spores produced in artificial culture.

While conidia of members of genus *Helminthosporium* do not regularly exhibit septa other than transverse cross walls, oblique and even longitudinal partitions occur rather sparingly in most species. Such departures from the usual morphological trend are present also in conidia of *Helminthosporium vagans*. Oblique partitions are not

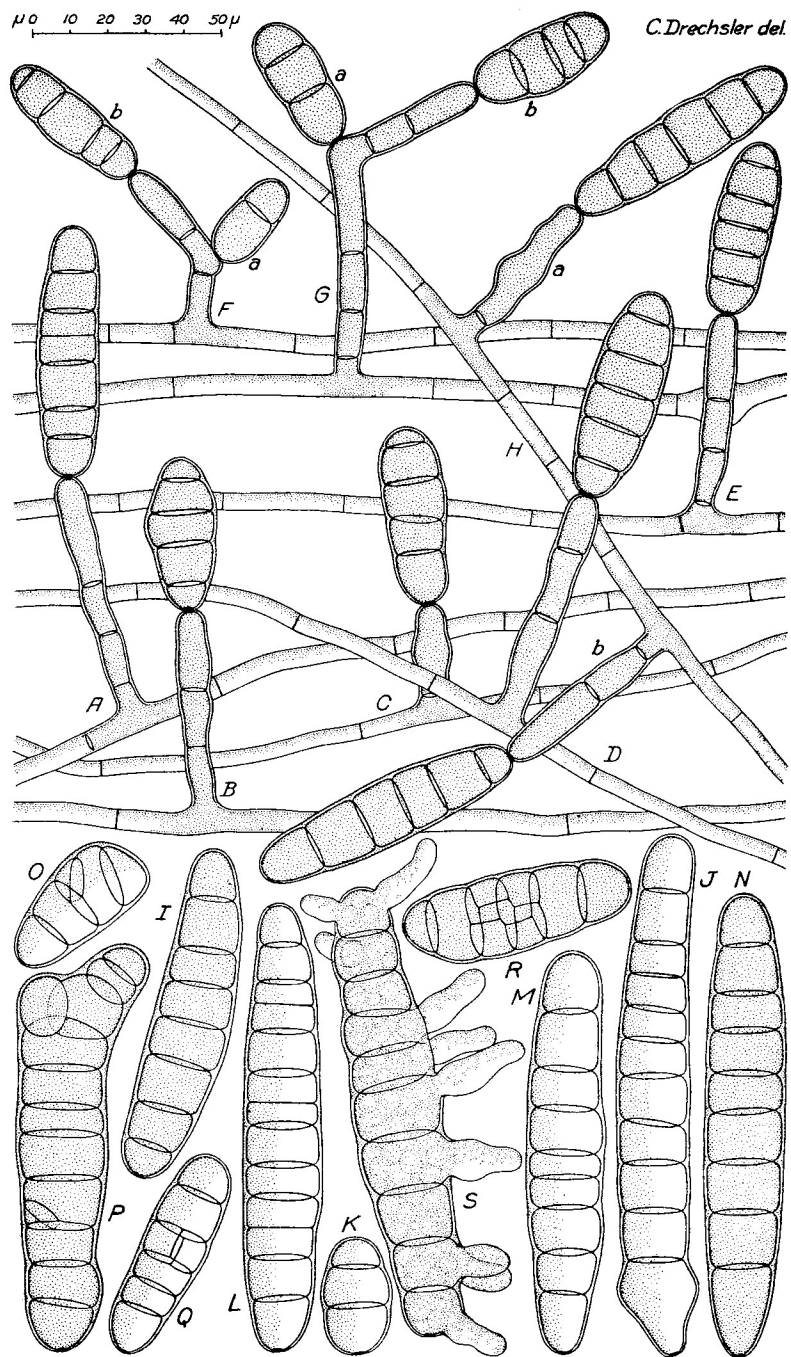


FIGURE 5.—A-H, Portions of aerial filaments of *Helminthosporium vagans* bearing conidiophores with one or two conidia. Drawn from material produced in a 30-day-old maize-meal agar plate culture. $\times 500$. I-S, Conidia of *H. vagans* from affected leaves of *Poa pratensis* collected in Washington, D. C., May 1, 1929. Note the germination of S by the production of germ tubes from intermediate as well as from end segments. $\times 500$

infrequently associated with marked curvature in the axis of the spore, though in many instances their presence, like that of longitudinal septa for the most part, is independent of any unusual external feature. The occurrence of one or two septa of the latter type, especially in conidia of the smaller dimensions, brings about a striking resemblance to ascospores of certain species of *Pyrenophora* having a *Helminthosporium* stage parasitic on grasses. The resemblance is of interest especially because the germination of the conidia by the production of germ hyphae indiscriminately from the intermediate as well as from the end segments (fig. 5, S) indicates that *H. vagans* is indeed to be regarded as belonging to that series of forms achieving their sexual stage in the ascigerous genus mentioned, or in the very closely related, if not identical, genus *Pleospora* Fries. That the muriformly septate bodies in question were actually conidia rather than ascospores was sufficiently apparent in that they were regularly provided at one of the ends with a scar entirely like the basal scar invariably present in the more regularly partitioned conidia of the leaf-spot fungus, and marking the point of their former attachment to the conidiophore.

Owing to the exceptionally early appearance of the leaf spot on Kentucky bluegrass in 1929, with the resulting occurrence of the causal parasite in quantity on new growth while the withered remains of growth of the previous season were still intact, opportunity for the discovery of an ascigerous stage of *Helminthosporium vagans* might well be considered as having been favored in at least one respect. Some effort was therefore made to detect perithecia that might plausibly represent a phase in the life history of the parasite. However, no perithecial form occurring in a relationship suggesting an ontogenetic connection was found in any of the decaying material examined.

SUMMARY

Helminthosporium vagans, previously set forth as a relatively innocuous parasite on *Poa pratensis*, has at various times during several seasons been found to cause conspicuous damage, especially in the fairways of golf courses. The most destructive effects occur apparently when the grass has been subjected to close cutting. The delicate habit of growth encouraged thereby results in plants with the upper axial part consisting mostly of imbricated leaf sheaths of such small proportions as to be subject to direct destruction through the development of foot-rot lesions. The excessive reduction of functional leaves resulting from close clipping because of the erect foliar habit of the grass evidently reduces the capacity for renewed growth. The few field observations made by the writer confirm the validity of the recommendation of less drastic mowing as preventive and remedy.

In pure culture the fungus occasionally produces conidia resembling the smaller ones produced under natural conditions, the conidiophores being represented by noticeably differentiated terminal prolongations or lateral branches of aerial filaments. The germination of the conidia by germ tubes arising from middle as well as from end segments indicates close affinity of the fungus with the series of graminicolous congeners achieving their ascigerous phase in the genus *Pyrenophora*, although no sexual stage of any kind has yet been found associated with it.

