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FOOT-ROT DISEASE OF WHEAT— HISTORICAL AND BIBLIOGRAPHIC

BY

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ERRATA

Page 97, line 17, for first *larval* read *pupal.*
Page 112, in legend, for *jonessi* read *jonesii.*
Page 114, in legend, for *or* read *of.*
Page 125, line 4, for *Bonosa* read *Bonasa.*
Page 131, in legend, for *hirundinaceus* read *hirudinaceus.*
Page 138, last line, for *coccoon* read *cocoon.*
Plate XII, explanation page, next to last line, for *acrivora* read *aerivora.*
Plate XIII, explanation page, next to last line, for *White-grubs* read *White-grub.*
Page 293, Figure 5*a* was reversed in printing, and the two items of the legend should change places.
Page 515, second table, for *Pelocoris femorata* read *Pelocoris femoratus.*

ARTICLE IX.—*Foot-rot Disease of Wheat—Historical and Bibliographic.* By F. L. STEVENS.

In April, 1919, a serious wheat disease was noted in Madison and other counties in Illinois; also in several counties in Indiana. Its most constant character is a darkening, and in severe cases a rotting,

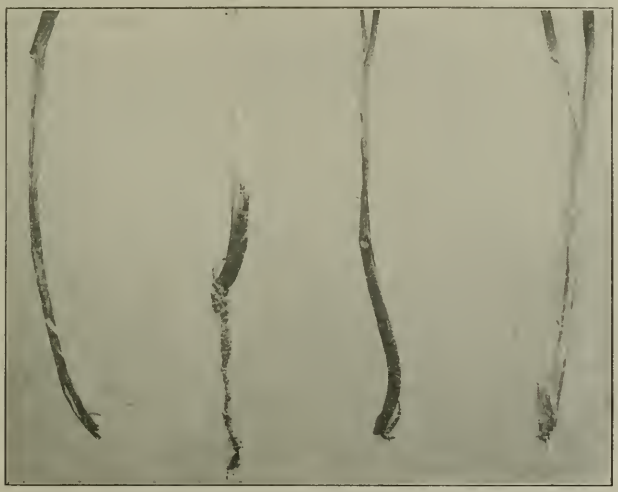

FIG. 1. Wheat plants from Madison County, Illinois, showing typical foot-rot. Three of the plants show the characteristic development of extra shoots.

of the basal portion of the stem.* By various means—telegram, mimeographed letters and circulars, and public notice— the U. S. Department of Agriculture, and its agents, have announced the disease as almost certainly "take-all" (180) (181) (182) (183) (184) (187). Take-all and diseases of similar character—known also as white heads,

* Other characters will be discussed in a later paper.

black-foot, black-stem, stalk disease, foot disease, root disease, foot-rot, wheat-stem killer, straw blight, piétin, pied noir des céréales, mal del piede, mal do pé do trigo, briseur de chaumes, brusone, fogheta, piétin du blé, maladie du pied, Fusskrankheit—occur in Italy, France, Germany, Belgium, Australia, Sweden, Finland, United States, Mexico, England, New South Wales, Holland, Russia, Brazil (?), and Japan, and have been attributed to several different fungi, but most prominently to Ophiobolus.

In connection with a study of the Illinois disease it was necessary to glean as many facts as possible from the literature concerning foot-rot, or take-all, and related diseases, and the large amount of material resulting suggested the utility of putting some of it into permanent form as a convenience to students of the subject. The following chronological account presents facts and opinions selected from important articles cited in the appended bibliography.

Disease of the nature of foot-rot is said by Mangin (158) to have been known in France as early as 1840. In 1823 (1), 1845 (2), 1856 (3), 1863 (4), 1875 (7), 1884 (11), 1887 (14), and 1897 (44) Ophiobolus was noted or collected on cereals, not, however, with reference to its pathogenic relation to the plant. The disease is said to have been noted in South Australia in 1852 (84). In 1864 Parliament appropriated £200 for the study of take-all and other cereal diseases (89), and in 1868 a report of a Commission on Diseases of Cereals was published in Australia (5). In this they say of take-all, "Its ravages are irrespective of climatic influence." In 1870 (6) a fungus was observed in the lesions.

In 1878 (8), in France, the first definite description of piétin was published, the disease being attributed to an excess of moisture and a mild winter. In 1880 (9) the disease was noted in Italy. In 1883 Saccardo (10) mentions Hendersonia as the conidial stage of Ophiobolus. In 1884 the first reference in England occurs under the name "straw blight" (12). Prillieux and Delacroix (16) in 1890 emphasize the importance of a brown mycelium and attribute the disease to *Ophiobolus graminis* Sacc. In 1892 Schribaux (19) noted that early varieties are most susceptible, and tried various control measures. Loverdo (20) reports the disease on Cynodon and Agrostis.

Cobb, in 1892 (22), in a rather extensive article, discusses the disease known as take-all as found in Australia and attributes it to *Cladosporium herbarum*. He advises rotation, drainage, good tillage, burning stubble, seed treatment, and resistant varieties. The disease was also noted as occurring in oats. Frank (23) (24) (25) (26) (27) in 1894 discusses foot-rot in Germany, as does also Hiltner (28) (29). In 1895 Saccardo and Berlese (34) note foot-rot in Italy and attribute it to *Sphaerodcrma damnosum*. Frank in 1895 (30) notes *Leptosphaeria herpotrichoides* on rye and *Ophiobolus herpotrichus* on wheat. The mycelium grows into the roots, which become black and die. No conidial form was observed. In 1897 (43) the disease was noted on wheat, rye, and barley

in France. Prillieux (42) mentions the mycelium in the vessels, also in a brown surface development in flecks. McAlpine in 1898 (46) lists numerous fungi on diseased wheat, among them being *Cladosporium herbarum, Macrosporium graminum* and *M. cerealium*, and *Epicoccum neglectum*. He refers to Dr. Cobb's conclusion and says "It is premature to speak of it [*Cladosporium herbarum*] as the take-all fungus."

In 1898, 1899, and 1902 Mangin (47) (56) (70) contends that Leptosphaeria is the main cause of the disease and that Ophiobolus is secondary, as are also several other fungi which were present. Inoculations with spores in water suspension gave positive results. Frank in 1900 (64) describes *Ophiobolus herpotrichus* as the cause of the disease, while Delacroix (67) in 1901 asserts, on the basis of inoculation experiments, that both Leptosphaeria and Ophiobolus are parasitic, the disease appearing three or four months after inoculation. In 1901 Ophiobolus was first recorded in Australia (68). In 1902 Mangin (70) contends that Leptosphaeria is the primary cause and Ophiobolus of secondary importance.

In 1902 Cordley (75), in Oregon, notes a disease which from the description is indistinguishable from that now in Illinois. In 1904 McAlpine (84) claims to prove that Ophiobolus is the cause of take-all, since wheat planted in plots with diseased stubble became diseased and bore spores of Ophiobolus within fifty-two days. It is to be noted that McAlpine did not employ pure cultures, and it is not clear how he recognized with certainty "the young mycelium of Ophiobolus." In 1906 take-all was noted on barley and other grasses in Australia (89). Kirchner (90) holds that the disease follows weakening of the plant from other causes. Robinson, 1907 (93), notes perithecia in the sheaths, and says that wheat sown in diseased stubble soon becomes sick and in two months may all be dead and covered with perithecia. In 1908 Krüger (95) holds that fungi are not the immediate cause but that the disease is due to weakening of the plant. Richardson, in 1910 (111), in Australia, found upon close examination that the Ophiobolus vegetative mycelium was present in every case. "Swollen roots", he says, "were impregnated with a black sooty incrustation." He also notes the disease on Hordeum, and says that a good stubble-burn gives good crops following. Pridham, 1911 (112) describes the disease as negligible in favorable years, and adds that in all cases of disease there is a blackening of the stalk at the foot. Fron, in 1912 (120), notes the presence of felt-like brown masses and finds Leptosphaeria on all specimens; Ophiobolus, rarely. From infection experiments he concludes that Leptosphaeria is the cause. Eriksson, in 1912 (121), refers to Coniosporium as the conidial stage of the causal fungus. Averna-Sacca (124) writes in Brazil of the disease. Störmer and Kleine in 1912 (129) say the disease can also be caused by Typhula. Voges in 1912 (130) says that fungi are not the primary cause, but that the disease is due to lowering of the vitality of the wheat plant by environmental conditions. Schaffnit in 1912 (131) attributes a foot-rot of rye to *Fusarium nivale*.

Massee, 1912 (127), says that the mycelium forms a thin felt on the stem and sheaths and that a black superficial mycelium is also characteristic. Oats and wheat inoculated when about an inch high with *Ophiobolus graminis* were yellowed and drooping in six weeks, with characteristic mycelial infection. Bromus and Agropyron are also infected. Prunet, 1913 (138), concludes that either *Ophiobolus graminis, O. herpotrichus,* or *Leptosphaeria herpotrichoides* can cause the disease, and says that the name piétin is thus applied to three diseases with the common character of stem-blackening, and that each should be studied separately.

In 1913 Guerrapain and Demolon (139) (140) call particular attention to this disease following a mild winter. Voges, 1913 (143), in a very extensive article, concludes that the Ophiobolus ascospores can give rise to two kinds of mycelium, one of which is *Fusarium rubiginosum* A. & W.; that the Ophiobolus mycelium is not characteristic of foot disease and that the specific cause is not Ophiobolus; and that the disease has various causes, for example frost, the Ophiobolus appearing only after weakening due to other causes. Mangin, 1914 (158), says that both Leptosphaeria and Ophiobolus give a brown or black tint to the stem and roots. The presence of several Fusaria is also noted in connection with this disease. Berthault, 1914 (161), says that *Fusarium rubiginosum* is often present and perhaps causal. Voges, 1914 (162), says that the conidial form is not Fusarium but is Acremonium. Spafford, 1917 (175), suggests the name "wheat stem killer", and says that the disease may be recognized at the base of the stem, which is "covered with a brownish powder or stained brown." He regards this character as important in distinguishing this disease from the results of climatic action due to drying out, in which cases the plant is yellow throughout. He states that if wheat gets a good start, even in infected soil, but little injury follows. In 1917 (176) *Ophiobolus graminis* was reported on rice in Japan. In 1919 Brittlebank (179) lists as hosts, wheat, oats, barley, *Hordeum murinum, Bromus mollis, B. sterilis,* and *Agropyron scabrum.* In 1919 the latest paper available from Australia (178) is less definite as to etiology than are earlier Australian papers.

In the voluminous mass of evidence presented in these articles certain points stand out clear, others are far from clear.

Points of Agreement

1. A serious loss to the wheat crop in many countries arises from a diseased condition of the wheat plant which is aptly called foot-rot, black-foot, or black-stem, or, by the French, piétin, though known by many other names.

2. This disease is characterized by a darkening, blackening, or rotting of the lower stem, usually the first internode above the roots.

3. The disease always occurs in spots in the field.

Beyond these three facts there is practically little or nothing in which there is entire accord.

Points of Disagreement

These may be summarized as follows:

Symptoms.—Many observers describe as an essential symptom of foot-rot the presence of a *brown felt-like mycelial weft* on the diseased stem and adjacent sheath. Some describe it as a black crust. Others fail to find this, or at least do not mention it, while still others definitely assert that it is not an essential symptom.

Some describe the roots as swollen, blackened, or stunted, though most writers mention no root symptoms.

Most writers assert that if land on which the disease occurs is cropped with wheat the following year the disease will again appear, and often on a largely increased area. Some show by experiment that wheat planted in diseased stubble will become diseased; others say that succeeding crops may be healthy, and that the recurrence of the disease is dependent upon various factors, chief among which is the weather.

Etiology.—Most writers on foot-rot say that the causal fungus is *Ophiobolus graminis*; a smaller number that it is *O. herpotrichus.* Some merely report the presence of one or both of these fungi, while other investigators claim to have demonstrated their actual parasitism by inoculations with pure or nearly pure cultures of one or another of these fungi. Other writers claim that *Leptosphaeria herpotrichoides, Typhula graminis,* and *Cladosporium herbarum* are causal agents of foot-rot, while some assert that any one of several of the five fungi mentioned above may be the cause of the disease.

Some hold that these fungi are saprophytes or but weak parasites that can attack the wheat plant only when it is weakened by other causes, chiefly by cold.

Conidial stages of Ophiobolus.—Various claims have been made as to the conidial form of Ophiobolus. Some state that the fungus is usually sterile in its young stages. Some find as the conidial form a Coniosporium, an Acremonium, a Fusarium, or a Hendersonia.

Various prophylactic measures, as burning stubble, rotation, good culture, etc., have been suggested, but they are based on general grounds rather than specific knowledge of this disease, and will not be discussed.

In view of these conflicting observations and conclusions the most reasonable attitude is that of Prunet, Voges, and others, namely, that we have here several distinct diseases due to as many separate causes. Clearly science will be best served by such a conception.

So far as I can judge, the disease now present in Madison county, Illinois, is indistinguishable from that described by Cordley in Oregon, U. S. A., in 1902 (75), the cause of which he did not determine. I am not yet sure what the cause of the Madison county disease really is, but

as to the three points concerning which we have noted universal agreement it is no exception to the rule. I do not find in it the brown felt described by so many as characteristic of Ophiobolus, nor do I find constantly present any of the fungi mentioned above as the cause of foot-rot. Further long and patient investigation must determine which foot-rot, or which of its several types, is now interesting us in Illinois—if indeed it is any one of those yet studied.

The name take-all is linked in the literature with Ophiobolus, and if the disease in Illinois is caused by Ophiobolus this name may be used properly in connection with it, but unless this is the case I prefer to employ the more comprehensive general name, foot-rot.

Until definite knowledge is secured as to the cause of the disease it is impossible to predict its development, or to state whether it will recur in the same fields and spread to others. If it is identical with the Oregon disease which appeared in 1902 and apparently has attracted no attention since then (75), it may here lapse into a similar insignificant position. It should be borne in mind that the winter of 1918-19 was a very exceptional one and of the type that is most favorable to foot-rot in Europe, and that in the absence of such winters the foot-rot may do little harm.*

In our present state of ignorance as to the precise cause of this disease in Illinois it is impossible to give specific advice as to its prevention. A wise course, however, will be to avoid planting wheat for one year or, better, for two years, on lands where the disease occurred this year. Oats may probably be safely substituted. Burning over the stubble after harvest will also be a safe precaution.

Annotated Bibliography

explanatory

The asterisks used in connection with the entries indicate that the articles or books or pertinent passages cited have been carefully read in the original. My acquaintance with those not so marked has been gained through reviews or abstracts. The notes do not indicate the entire content of the articles, but call attention to points most important in connection with the Illinois disease or in the general history of foot-rot. Information given in the preceding pages is not, as a rule, repeated in the notes.

Quite a number of the entries lack the author's name, since they either appeared anonymously or in secretarial or journal reports. Other entries are without title because they so appeared in foot-notes of articles read. It seemed ill-advised to omit them, though I was unable to verify the citations. For the sake of brevity the abbreviation E. S. R. is used to indicate the "Experiment Station Record" published by the U. S.

* Since the above was written, Dr. A. D. Cotton, of the Pathological Laboratory of the Kew Botanic Gardens, has examined the foot-rot in Illinois, and he tells me that the specimens he examined lacked the distinctive characters of take-all as that disease is understood in England.

Department of Agriculture; and Zeit. f. Pfk., for Sorauer's "Zeitschrift für Pflanzenkrankheiten."

ACKNOWLEDGMENTS

I am indebted to Miss C. R. Bennett, of the Library of the U. S. Department of Agriculture, for four titles which I should not have had but for her courtesy; to Mr. P. L. Windsor, Librarian of the University of Illinois, who secured for me very many original articles; and to Mrs. E. Young True for assistance in the preparation of the manuscript.

Fries, E.

*(1) 1823. Systema mycologicum, 2: 504.
Sphaeria herpotricha listed.

Mougeot, A.

(2) 1845. Champignons des Vosges, Épinal, p. 102.

Marchand.

(3) 1856. Sylloge—p. 251.

Tulasne, L. and C.

*(4) 1863. Selecta fungorum carpologia, 2: 255. Paris.
Mentions Ophiobolus under name *Rhaphidophora herpotricha.*

Commission on Diseases of Cereals

(5) 1868. Report on diseases of cereals. Adelaide, S. Austral.

Muęcke, Carl

(6) 1870. The take-all (*Xenodochus cercalium*). Prize essay, published under the authority of the Board of Agriculture of Victoria.
Observed a fungus in the disease lesions. Estimated loss in South Australia at £6,000,000.

Saccardo, P. A.

(7) 1875. Fungi Veniti novi vel critici. Nuovo Giorn. Bot. Ital. Vol. 7.

(8) 1878. Sur l'état de la récolte du blé et sur la maladie du piétin. Bul. des séances de la Soc. Centrale d'Agr. de France, 38: 368.
First adequate description of the disease; "la cause du mal soit généralement attribuée à l'humidité."

Cugini

(9) 1880. Supra una malattía del frumento recentmente composa nella Provincia di Bologna. Giorn. Agr. Ital. 14: No. 13.
Noted the disease as serious near Bologna.

Saccardo, P. A.
*(10) 1883. Sylloge fungorum omnium hucusque cognitorum, 2:352.
Says conidial form of *Ophiobolus herpotrichus* is a Hendersonia.

Brunaud
(11) 1884. Description des Sphaeriacées des environs de Saintes, La Rochelle, p. 213.

Smith, W. G.
*(12) 1884. Diseases of field and garden crops, p. 69.
Describes lesion at base of the stem and fungus present there. No spores known.

Morini
(13) 1886. ———. Nuova Giorn. Bot. Ital. 18:32.
Noted *Ophiobolus herpotrichus*, but regards it as a saprophyte.

Winter, G.
*(14) 1887. Die Pilze Deutschlands, Oesterreichs und der Schweiz. Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz, 1 (Abth. 2): 523, 524.

Pearson, A. N.
*(15) 1888. Blight in wheat. Dept. Agr. Victoria, Bul. 1:38.
Says there is a general consensus of opinion that this is a poverty disease, and that the fungus which causes take-all attacks mainly such crops as are insufficiently nourished.

Prillieux and Delacroix
*(16) 1890. La maladie du pied du blé causée par l'*Ophiobolus graminis* Sacc. Bul. Soc. Myc. de France, 6:110.
Authors note brown mycelium in flecks; perithecia in winter; and mycelium in all browned tissues.

Cugini
(17) 1890. ———. Bol. Staz. Agr. Modena, 9:46.

McAlpine, D.
(18) 1891. ———. Dept. Agr. Victoria, Bul. 14. Cited by McAlpine in (46).

Schribaux, E.
*(19) 1892. Le piétin ou maladie du pied des céréales. Jour. d'Agr. Prat. 2:317–320.
Accepts Ophiobolus as the cause of the disease.

Loverdo, J.
*(20) 1892. Les maladies cryptogamiques des céréales, p. 231, 236.
Reports *Ophiobolus herpotrichus* on Cynodon and Agrostis.

Tepper, J. G. O.
*(21) 1892. "Take-all" and its remedies. Agr. Gaz. N. S. Wales, 3:69–72.
Says that "Take-all is nothing else than starvation of the crop."

Cobb, N. A.

*(22) 1892. Plant diseases and how to prevent them. Agr. Gaz. N. S. Wales, 3: 991–1001.

Notes false theories as to take-all: due to insects, weeds, nematodes, soil deficiency, poor drainage, poor tillage. Characters: occurs in patches; plants in a majority of cases dry up when young; much *Cladosporium herbarum* and *Septoria graminum* present, the latter yellowing the leaf (which later dies) and being fatal when on the sheath of young plants. the former fungus found in nearly all cases of take-all; internal mycelium colorless, conidiophores tufted, usually emerging through stomata; typical spore two-celled and rough.

"I will * * * assign to the *Cladosporium herbarum* the name of take-all, to *Septoria graminum* the appropriate name of dry blight, to the Macrosporium the name of brown blight."

Frank, A. B.

*(23) 1894. Das Umfallen des Roggens. Deut. Landw. Presse, 21 (No. 51): 509.

*(24) 1894. Die diesjährigen neue Getreidepilze. Deut. Landw. Presse, 21 (No. 67): 644–645.

Notes *Leptosphaeria herpotrichoides* on rye as a parasite. It has long been known on stubble as a saprophyte. The base of the stem is browned and weakened. Notes also *Leptosphaeria tritici* and *Ophiobolus herpotrichus* causing a foot-rot, and the latter fungus also killing the roots of winter wheat.

(25) 1894. [A stem disease of wheat.] Deut. Landw. Presse, p. 675.

*(26) 1894. Mitteilungen des Sonderschusses für Pflanzenschutz. Mitt. deut. landw. Ges. 1894 (No. 6): 90, 91; and No. 8: 17. Abs. in E. S. R. 6: 312.

Describes Leptosphaeria on rye and wheat, and Ophiobolus on wheat.

(27) 1894. ———. Deut. Landw. Ztg. 37 (No. 124): 740. Cited by Krüger in (95).

Hiltner, L.

*(28) 1894. Die Fusskrankheit des Getreides. Sächs. Landw. Ztg. No. 33: 397–401.

A hyaline mycelium was present in the roots and in the lower stem, and a dark mycelium on the surface. Hendersonia and Ophiobolus were found.

(29) 1894. ———. Mitt. Pfk. Vers. Stat. Tharand.

Frank, A. B.

*(30) 1895. Über die in Deutschland neu aufgetretenen Getreidepilze. Zeit. f. Pfk. 5: 11, 12.

Mentions *Leptosphaeria herpotrichoides* on rye, *L. tritici* on wheat leaves. *Ophiobolus* (*Raphidospora* [*Raphidophora*]) *herpotrichus* is reported as "now" found in Germany. The mycelium often goes to the roots, which turn black and die.

*(31) 1895. Die neuen deutschen Getreidepilze. Ber. deut. bot. Ges. 13 (No. 2): 61–65. Abs. in E. S. R. 6: 909.
(32) 1895. ———. Jahrb. d. Sondera. f. Pfl. Heft 19: 11, 12.
(33) 1895. ———. Deut. Landw. Ztg. 38 (No. 40): 325. Cited by Krűger in (95).

Saccardo, P. A., and Berlese, A. N.
(34) 1895. Una nuova malattia del frumento. Riv. di Patol. Veg. 4: 56. Abs. in Hedw. 35: (21); in E. S. R. 7: 410: and in Zeit. f. Pfk. 6: 50.
Sphaeroderma damnosum infests bases of sheaths.

Henning, E.
(35) 1895. Agrikulturbotaniska anteckningar från en resa i Tyskland och Danmark är 1894. Med. f. Kon. Landt. Nr. 11, är 1895 (Nr. 29). 72 S. Abs. in Zeit. f. Pfk. 6 (1896): 234–235.

Cuboni, G.
(36) 1896. Notizic sulle malattie della piante coltivate. Bol. d. Not. Agrar. 18 (No. 36): 487–500.

Briosi, G.
(37) 1896. ———. Bol. d. Not. Agrar. 18 (No. 42): 544–548.

Frank, A. B.
(38) 1896. ———. Jahrb. d. Sondera. f. Pflanzenschutz, Heft 26: 9.
(39) 1897. ———. Jahrb. d. Sondera. f. Pflanzenschutz, Heft 29: 14.

Berlese, A. N.
(40) 1897. Nuovi studi sulla malattia del frumento sviluppatasi nel 1895 in Sardegna. Riv. D. Patol. Veg. 5: 88–97. Abs. in Zeit. f. Pfk. 8 (1898): 102.

Solla
*(41) 1897. Notizen über einige in Italien aufgetretene Krankheitserscheinungen. Zeit. f. Pfk. 7: 159–164.

Prillieux
*(42) 1897. Maladies plantes agricoles, 2: 221.
The lower node turns black and dies. The first internode becomes brown, and black specks appear. All browned parts are invaded by a mycelium.

———

*(43) 1897. Sur le pied noir du blé ou piétin des céréales. Bul. Sta. Agron. Laon, p. 63–66. Abs. in E. S. R. 9: 1057.
The first node is attacked, and the plant falls over. Mild, moist weather is favorable to the disease. Seed and chaff are said to spread the disease.

Lindau, G.

*(44) 1897. Die Natürlichen Pflanzenfamilien (Engler and Prantl's), 1 (1 Teil, Abt. 1): 440.

Frank, A. B.

*(45) 1897. Der Weizenhalmtöter (*Ophiobolus herpotrichus* Sacc.). Kampfbuch gegen die Schädlinge unserer Feldfrüchte, p. 67, pl. 3, fig. 8–11.

Describes disease with blackening of the stem-base aud roots.

McAlpine, D.

*(46) 1898. The fungi on the wheat plant in Australia. Agr. Gaz. N. S. Wales, 9: 1009.

"There is no doubt that the fungus [*Cladosporium herbarum*] is found associated with the disease [take-all], as I have never found a case of it without its presence * * * but "until infection experiments have been carried out, it is premature to speak of it as the 'Take-all fungus.'" * * * "This [*O. herbarum*] forms dark-colored blackish-olive patches on both surfaces of the leaf, usually giving it the appearance of being densely spotted." * * * "The conidia are simple or uniseptate * * * occasionally bi- or tri-septate." He lists *Puccinia graminum*, *P. dispersa*, *Ustilago segetum*, *U. bullata*, *Urocystis occulta*, *Septoria glumarum*, *S. graminum*, *Ascochyta graminicola*, *Diplodia olivacea*, *Tilletia tritici*, *Cladosporium herbarum*, *Macrosporium graminum*, *M. cerealium*, *Clavicops purpurcum*, and *Epicoccum neglectum*.

Mangin, L.

*(47) 1898. Sur le piétin ou maladie du pied chez le blé. Compt. Rend. Acad. Sci. Paris, 127 (No. 5): 286–288. Abs. in E. S. R. 10: 650.

Author claims that the parasitism of both Leptosphaeria and Ophiobolus is well established. Ophiobolus is in the lower nodes and on the roots, and is the most important. Other fungi present are saprophytes.

Hollrung, M.

*(48) 1898. Bemerkungen über die im Jahre 1898 zur Kenntniss der Versuchstation für Pflanzenschutz zu Halle a S. gelangten Pflanzenkrankheiten. Jahresber. Vers. Stat. Pflanzenschutz, Halle, 10: 35–64, fig. 3. Abs. in E. S. R. 11: 1057.

*(49) 1898. Das rechtzeitige Pflügen der Stoppeln und sein Einfluss auf gewisse Krankheiten unserer Halmfrüchte. Jahresber. Vers. Stat. Pflanzenschutz, Halle, 10: 29–34. Abs. in E. S. R. 11: 959.

Advises plowing under to control Leptosphaeria and Ophiobolus.

Peglion, V.

*(50) 1898. Il diradamento del grano e dell' avena nell' Agro romange nella Maremma. Stat. Sper. Agrar. Ital. p. 467–484. Abs. in Hollrung's Jahresb. 1:29.

On rye, due to *Ophiobolus herpotrichus* and *O. graminis.*

Frank, A. B.

(51) 1898. ———. Jahrb. d. Sondera. f. Pflanzenschutz, Heft 38:16.

Berlese, A. N.

*(52) 1898. Nuovi studi sulla malattia del frumento sviluppatasi nel 1895 in Sardegna. Bol. di Not. Agrar. Roma, p. 430–437.

A fungus determined as *Sphaeroderma damnosum* was present in foot-rot of grain. This fungus, with its conidial stage, Fusarium, is regarded as a saprophyte which can become a parasite and cause the disease.

Frank, A. B.

(53) 1899. ———. Jahrb. d. Sondera. f. Pflanzenschutz, Heft 50:23.

(54) 1899. Das Auftreten des Weizenhalmtöters auf der Gerste. Deut. Landw. Presse, 26:806, 807. Abs. in Hollrung's Jahresb. 2:45, 227.

Solla

*(55) 1899. In Italien im Jahre 1898 aufgetretene Krankheiten. Zeit. f. Pfk. 9:297–299.

Notes *Ophiobolus graminis.*

Mangin, L.

*(56) 1899. Contribution á l'étude de quelques parasites du blé. Overs K. Danske Vidensk. Selsk. Forhandl. p. 213–272, pl. 3, fig. 17. Abs. in E. S. R. 12:567.

Thinks that Leptosphaeria is the cause of the foot-rot, but it is accompanied by Ophiobolus, Pyrenophora, and other fungi. Claims that cultures prove the Coniosporium to be the conidial form of *Ophiobolus graminis.*

*(57) 1899. Sur le piétin ou maladie du pied du blé. Bul. Soc. Myc. de France, 15:210–237. Abs. in Hollrung's Jahresb. 2:44, 227.

Pyrenophora, Dictyosporium, and Aspergillus are described. Author holds a Leptosphaeria to be the primary cause and the Ophiobolus a secondary cause. Leptosphaeria arises from the superficial mycelium. A Coniosporium belongs to the Ophiobolus. In October, pots of earth were irrigated with water bearing suspension of spores of Leptosphaeria and Ophiobolus. The plants were dead on February 15 from Lepto phaeria. Ophiobolus gave negative results. The roots were black. Leptosphaeria is brown when superficial, hyaline when internal. Attachments were present. Perithecia are free or immersed. Morbid histology is described. Ophioholus forms flecks, superficial, adherent, distinguished by different attachments.

Bussard, L.
(58) 1899. Le piétin et la verse des céréales. Rev. de Vit. 11: 685–687. Abs. in Hollrung's Jahresb. 2: 225.
A general discussion of the various views as to the cause of foot-rot.

d'Almeida, J. V.
(59) 1899–1900. ———. Agr. Contemp. Lisboa, 1899 u. 1900. Abs. in Zeit. f. Pflk. 11 (1901): 237.

Marenghi.
*(60) 1900. Come possiamo difenderci dall' Ofiobolo? Bol. di Ent. Agr. e Pat. Veg. 7: 126. Abs. in Hollrung's Jahresb. 3: 206.

Helms, R.
*(61) 1900. Take-all. Jour. Dept. Agr. W. Austral., Feb., p. 30.
A brief description Cause thought to be a fungus.

Eidam
(62) 1900. Erhebungen über das Lagern des Getreides usw. Zeit. d. Landw. Schlesien, p. 1612. Cited by Krüger in (95).

Frank, A. B.
(63) 1900. ———. Jahrb. d. Sondera. f. Pflanzenschutz, Heft. 60: 34.
*(64) 1900. Der Weizenhalmtöter. Deut. Landw. Presse, 27 (No. 53): 675, pl. 1. Abs. in E. S. R. 12: 261, and in Hollrung's Jahresb. 3: 205.
Discusses *Ophiobolus herpotrichus*, the results of infection at various ages of the wheat plant, and the influence of various cultural methods.

Kühn
(65) 1900. Der Weizenhalmtöter. Ill. Landw. Zeit. 20: 212. Abs. in Hollrung's Jahresb. 3: 31.

Frank, A. B.
(66) 1901. ———. Ber. d. deut. bot. Ges. 19, Heft 29.

Delacroix, D.
*(67) 1901. Sur le piétin des céréales. Bul. Soc. Myc. de France, 17: 136–144, fig. 1, 2. Abs. in Hollrung's Jahresb. 4: 65.
Diseased wheat was replanted in pots. Perithecia were first found in November. Some were of Leptosphaeria, others of Ophiobolus. On some plants both were present. He used sterile soil and seeds in pots and infected them with water holding spores. Three to four months later, traces of disease were present. He concludes that both Ophiobolus and Leptosphaeria can produce the disease. Close sowing increases disease.

Summers, W. L.

*(68) 1901. Wheat-stem killing fungus. Jour. Agr. and Ind. S. Austral. 4: 521.

"There appeared to be a constriction of one or more joints of the plant, and at the base of the stems there were indications, in the form of sooty spores, of a fungus disease. The samples were sent to Mr. D. McAlpine, who states that he finds the wheat attacked by the fungus disease known in Europe as the 'wheat-stem killer' (*Ophiobolus herpotrichus*). This is the first recorded instance of the disease in Australia, though it has probably existed here for some years."

Jungners

(69) 1901. Über die Frostbeschädigung des Getreides im vergangenen Winter und die begleitende Pilzbeschädigung desselben. Zeit. f. Pfk. 11: 343–344.

Mangin, L.

*(70) 1902. Observations sur le piétin du blé. Jour. Agr. Prat. n. ser. 4 (No. 36): 306–308. Abs. in E. S. R. 14: 580, and in Hollrung's Jahresb. 5: 124.

Inoculations were made with watery suspension of spores of Leptosphaeria and Ophiobolus. *L. herpotrichoides* caused disease; Ophiobolus caused disease only rarely, and is secondary.

Nilsson-Ehle

(71) 1902. ———. Sveriges Utsädesförenings Tidskrift, 12: 185–211. Abs. in Hollrung's Jahresb. 5: 116–117.

Remer

(72) 1902. ———. Jahr. d. Schles. Ges. f. vat. Kul. Abs. in Hollrung's Jahresb. 5: 124. (Cf. Zeit. d. Landw. f. Schlesien, 1902, Heft 2; 1903, Heft 23: 723.)

Holds that both Ophiobolus and Leptosphaeria are saprophytes.

Delacroix, G.

*(73) 1902. Maladies des plantes cultivées, p. 8.

Recommends drainage.

McAlpine, D.

*(74) 1902. Take all in wheat. Jour. Dept. Agr. Victoria, 1: 74–80. Abs. in Hollrung's Jahresb. 5: 129.

"The wheat plant makes a start all right, but before the stalk appears the green color fades and the outer leaves become yellow. When the stalk is developed it soon becomes stunted, and never matures the ear. The entire plant soon dies, and this is the case over the affected area. The roots, too, have a very characteristic appearance. They are stunted and deformed at an early stage. * * * The occurrence of the disease in patches is another feature." In many instances the basal portion of the stem was considerably blackened, and on the inner surface of the sheaths the fungus *Ophiobolus*

herpotrichus was found. The roots were often black and dead and covered with black fungous threads. Wheat varieties show but little difference in susceptibility. "Take all largely depends on the nature of the season and the mechanical condition of the soil. * * * If the soil is neither too dry * * * nor so wet as to cake * * * and contains sufficient plant food * * * then the 'Take all' will not appear."

Cordley, A. B.

*(75) 1902. A foot-rot of wheat. Ore. Agr. Exper. Station Rep. p. 66, 67.

Cordley says: "I find that nearly every stalk * * * is infested at the base where it joins the roots, with a fungus disease * * *" It appeared in spots throughout the fields. "The disease is characterized by a blackening of the tissues of the lower part of the stem, particularly at the crown where the roots are given off, and by the stunted, unthrifty appearance * * *" Fungi were present but no spores were found.

In a personal letter dated June 4, 1919, Dean Cordley writes me: "In reply to your letter of May 28, I have made no observations since the 1902 report in regard to the disease in question and have not published anything further along that line."

Peglion, V.

*(76) 1902. Sopra il cosidella brusone del frumento. Staz. Sper. Agr. Ital. 35 (No. 11, 12): 865–886. Abs. in E. S. R. 14: 978, and in Hollrung's Jahresb. 5: 126.

The author believes the disease to be due at times to soil conditions.

Malkoff, K.

(77) 1903. Die schädlichsten Insekten und Pflanzenkrankheiten, welche an den Kulturpflanzen in Bulgarien während des Jahres 1903 geschädigt haben. Abs. in Zeit. f. Pfk. 15 (1905): 52.

Segura, J. C.

(78) 1903. El acame, encamado ó acamado. Bol. Com. de Parasitologia Agr. (Mexico), 2: 62–66. Abs. in Hollrung's Jahresb. 7 (1904): 98.

Stift

(79) 1903. Die im Jahre 1902 beobachteten Schädiger * * * landw. Kulturpflanzen, Oesterreich-ungar. Zeit. f. Landw. Bd. 2.

Marchal

*(80) 1903. Die im Jahre 1902 in Belgien beobachteten Pilzkrankheiten. Zeit. f. Pfk. 13: 216.

Mentions Ophioholus on wheat.

Kornauth, K.

(81) 1903. Pathologische Vorkommnisse en Österreich-ungarn. Abs. in Zeit. f. Pfk. 14 (1904): 353.

Summers, W. L.

*(82) 1903. "Takeall" and "whiteheads" in wheat crops. Jour. Agr. and Ind. S. Austral. 7 (No. 5): 297–299. Abs. in E. S. R. 15: 687.

Advises burning stubble prior to plowing. "There is little doubt that what has often been called 'Takeall' was simply root fail, caused by a dry, hollow seed bed."

Van Hall, C. J. J.

(83) 1903. Notes on the wheat stem disease (*Ophiobolus herpotrichus*). Tijdschr. Plantenziekten, 9: 77–110. Abs. in E. S. R. 16: 571, and in Hollrung's Jahresb. 6: 78.

Notes disease in Holland. Fungus lives in soil. Discusses relation to rotation.

McAlpine, D.

*(84) 1904. Take all and white heads in wheat. Jour. Dept. Agr. Victoria, 2: 709. Abs. in Hollrung's Jahresb. 6: 77.

He says "it [take-all] is now proved through investigation of this branch to be due to a fungus." * * * "True take all * * * had invariably a special fungus at the butt of the stem or on the roots * * * so that the term [take-all] has now a definite meaning and applies to wheat plants which have succumbed to the attacks of this particular fungus." Diseased stubble was placed in sand in pots and wheat planted in the pots with it. "After eighteen days * * * characteristic brownish spots were observed on the young stems. * * * Microscopic examination showed the presence in abundance of the young mycelium of the Ophiobolus. After six weeks many of the plants were dead."

In December, 1900, samples of white head were sent to McAlpine, and he says that he determined the fungus responsible for white heads and take-all.

*(85) 1904. Take all and white heads in wheat. Bul. 9, Dept. Agr. Victoria; Jour. Dept. Agr. Victoria, 1904, p. 410–426.

Ophiobolus is noted on *Bromus steritis* and a sterile mycelium on *Agropyron scabrum*.

Brizi, A.

(86) 1904. Il "mal del piede" del frumonto e l'abbruciamento delle stoppie. Avven. Agric. 12: 147–153.

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(87) 1904. Wheat fungus (*Ophiobolus graminis*). Jour. Bd. Agr. (London) 11: 154, 155. Anonymously cited in Hollrung's Jahresb. 7: 99.

Pòsch-Grinàd, K.

*(88) 1904. Mycopathologisches aus Ungarn. Zeit. f. Pfk. 14: 158.

Mentions Ophiobolus on wheat.

*(89) 1906. Takeall in wheat. Jour. Dept. Agr. S. Austral. 10 (No. 5): 280–283. Abs. in E. S. R. 18: 947.

Thirty per cent. injury is reported in some fields.

Kirchner, O.

*(90) 1906. Die Krankheiten und Beschädigungen unserer landwirtschaftlichen Kulturpflanzen, p. 33–34, 81.

The disease followed weakening of the plant from other causes, as spring frost, poor nutriment, too much water, etc. Ophiobolus is perhaps not a true parasite.

Appel

(91) 1906. Untersuchungen über die Gattung Fusarium. Ber. a. d. Biol. Anst. f. Land. u. Forstw.

Hiltner, L.

(92) 1906. ———. Ber. Kgl. Bayer. Agr. Anst. München, p. 50.

Robinson, G. H.

*(93) 1907. Take all and its control. Jour. Dept. Agr. Victoria, 5 (No. 4): 253–256. Abs. in E. S. R. 19: 151, and in Hollrung's Jahresb. 10: 105.

A dry summer following a wet winter is most favorable to the disease. The butts are quite black and perithecia occur in the sheaths.

(94) 1907. ———. Heft 6? Bericht über die Tätigkeit der Kaiserl. Biologischen Anstalten in Jahre 1907: 11. As cited in Ill. Land. Ztg. 33 (No. 65): 589.

Krüger, F.

*(95) 1908. Untersuchungen über die Fusskrankheit der Getreides. Arb. K. Biol. Anst. f. Land. u. Forstw. 6 (No. 3): 321–351, pl. 1. Abs. in E. S. R. 22: 148, and in Hollrung's Jahresb. 11: 127, 137.

Author holds that while Leptosphaeria and Ophiobolus do cause disease as facultative parasites they are not the immediate cause of the trouble, which arises from weakening of the wheat by rain, frost, etc. Inoculation experiments were made with Leptosphaeria, Dictyosporium, Ophiobolus, Hendersonia, Coniosporium, and Fusarium. *Leptosphaeria herpotrichoides* was found on rye and wheat; *Ophiobolus herpotrichus* on rye, wheat, and barley.

Störmer, K.

*(96) 1908. Die in der Provinz in Sommer 1908 beobachteten Krankheiten aus Getreide. Landw. Wchnschr. Sachsen. 10 (No. 35): 306–309; No. 38: 331, 332; No. 39: 340, 341; No. 40: 347–349. Abs. in E. S. R. 20: 1042.

Author regards the cause of the disease as still in doubt.

Lindau, G.

*(97) 1908. Die pflanzlichen Parasiten. Sorauer's Handbuch d. Pflanzenkrankheiten, 2: 256.

Places Ophiobolus in the Pleosporaceae. *O. graminis* was first known in France; then in Belgium and Saxony. The wheat is normal till bloom-time, when it wilts and dies suddenly. *O. herpotrichus* Sacc. has spores double the length of *O. graminis*. Apparently infection comes at germination. Wet soil and fertilizers favor infection. Early varieties are least resistant. Known also in Italy, Germany, and Holland. Coniosporium is suggested as an imperfect form.

Dombrovski, N.

(98) 1909. [Fungi as a cause of the lodging of cereal crops.] Khozyaïstvo, 1909: 334, 335. Abs. in Zhur. Opuitn. Agron. (Russ. Jour. Expt. Landw.) 10 (No. 4): 558; and in E. S. R. 23: 546.

Shows, as he believes, that *Ophiobolus graminis* is the cause of the lodging, and emphasizes value of drainage to prevent loss.

Farrelly

*(99) 1909. Takeall. Abs. in Jour. Agr. S. Austral. 13: 272.

Massee, G.

*(100) 1910. Diseases of cultivated plants and trees, p. 226–227. Macmillan, N. Y.

Ophiobolus graminis kills plants when young, and produces either "take all" or "whitehead". Description of stages given. The root and stem-base are attacked. A brown superficial mycelium is present on surface of stem and leaf sheaths, forming a weft or felt. Perithecia in winter form on this felt. The disease is also found on Agropyron, Bromus, and oats in Europe, England, and Australia. *O. herpotrichus*, of the same general appearance, is recorded in Italy.

Mortensen, M. L., Rostrop, S., and Ravn, F. K.

(101) 1910. Oversigt over Landbrugsplanternes Sygdomme i 1910, No. 27. Abs. in Zeit. f. Pfk. 22: 358.

Notes foot-rot in Denmark. Chiefly due to Fusarium.

Reynolds, M. H.

*(102) 1910. Some conditions qualifying success in the production of wheat in central and western districts. Dept. Agr. N. S. Wales, Farmers' Bul. 42: 128.

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(103) 1910. ———. Heft 11, Bericht über die Tätigkeit der Kaiser Biologischen Anstalten im Jahre 1910: 19. Cited in Ill. Land. Ztg. 33 (No. 65): 589.

Neldner, Heinrich, et al.

*(104) 1910. Takeall. Editor's note of discussion, Jour. Agr. S. Austral. 13: 537–538.

Lehmann, et al.

*(105) 1910. Takeall in wheat. Note of the discussion, Jour. Agr. S. Austral. 13:544.

Johns

*(106) 1910. Does takeall live in the soil from one year to another? If so, what are the best means of treatment? Jour. Agr. S. Austral. 13:701–702.

*(107) 1910. Takeall. Abs. in Jour. Agr. S. Austral. 14:85.

Pedler, Martin, and Paterson

*(108) 1910. Takeall. Editor's report of the discussion, Jour. Agr. S. Austral. 14:186–187.

Westbrook

*(109) 1910. Takeall. Editor's abstract, with notes of discussion, Jour. Agr. S. Austral. 14:422–423.

Hill

*(110) 1910. Takeall: cause and cure. Jour. Agr. S. Austral. 14:423–424.

Richardson, A. E. V.

*(111) 1910. "Takeall." Jour. Agr. S. Austral. 14:466–471. Abs. in E. S. R. 24:551, and in Hollrung's Jahresb. 13:148.

The crop promised well till October, then the disease became so serious as to reduce the yield to one bushel per acre. Oats near-by were free of disease. Disease occurred in patches. One to two inches of lower stems were blackened with the growth of the fungus. A good stubble-burn gives disease-free crops. Advises to fallow early and to follow with oats.

Pridham, J. T.

*(112) 1911. Field experiments with wheat diseases. Jour. Dept. Agr. Victoria, 9:250–255.

Burning stubble is beneficial. Oats are good in rotation, though a similar disease has been noted in oats and barley. A Helminthosporium was found, but Pridham does not think it responsible for the disease.

Sutton, G. L.

*(113) 1911. Take all. Practical methods for its eradication and control (*Ophiobolus graminis*). Agr. Gaz. N. S. Wales, 22 (No. 2):161–163. Abs. in E. S. R. 25:44.

Advises clean fallowing and rotation.

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*(114)) 1911. Samples of growing crops and takeall. Jour. Agr. S. Austral. 14:809–810.

Lowrie, Richardson, et al.

*(115) 1911. Takeall. Abstract of discussion, Jour. Agr. S. Austral. 14:884.

Nicholls, R., et al.
*(116) 1911. Takeall. Abstract of discussion, Jour. Agr. S. Austral. 14: 899.

Correll
*(117) 1911. Takeall. Abs. in Jour. Agr. S. Austral. 14: 902.

Fogarty
*(118) 1911. Takeall. Abs in Jour. Agr. S. Austral. 14: 995.

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*(119) 1911–12. L'Ofioboio o mal del piede del frumento. Ann. d'Uffio. Agr. Prov. Bologna, 18: 194–197. Abs. in E. S. R. 30: 349.
Brief account of this disease; attributed to *Ophiobolus graminis* and *O. herpotrichus*.

Fron, G.
*(120) 1912. Contribution à l'étude de la maladie "Pied noir des céréales" ou "Maladie du Piétin". Ann. Sci. Agron. 4 (ser. 1, No. 1): 3–29, fig. 3. Abs. in Internat. Inst. Agr. (Rome), Bur. Agr. Intel. and Plant diseases, 3 (No. 4): 1054–1056; in E. S. R. 27: 747; and in Hollrung's Jahresb. 15: 149.
Sterile wheat was easily infected with Leptosphaeria.

Eriksson, J.
*(121) 1912. Fungoid diseases of agricultural plants. London.
Black cover on the lowest joint. Roots black for most of their length. Conidia (Coniosporium) small, ovate, one-celled.

Bruck, W. F.
*(122) 1912. Plant diseases, p. 47.
Ophiobolus herpotrichus on wheat; *Leptosphaeria herpotrichoides* on rye.

Mangin, L.
*(123) 1912. Le piétin ou maladie du pied noir du blé. Jour. Agr. Prat. n. ser. 24 (No. 32): 174–176, fig. 3. Abs. in E. S. R. 27: 748, and in Hollrung's Jahresb. 15: 135, 151.
Ophiobolus and Leptosphaeria present. Mycelium brown, sterile. The Leptosphaeria is the most important.

Averna-Sacca, R.
*(124) 1912. Relatorio do gabinete de pathologia vegetal. Bol. Agr. 13 (No. 3): 235–236, fig. 6. São Paulo. Abs. in E. S. R. 29: 243.
Describes foot-rot but does not definitely state that it occurs in Brazil.

Bureau of Microbiology

*(125) 1912. "Take all" in wheat. Agr. Gaz. N. S. Wales, 23 (No. 11): 934–936. Abs. in E. S. R. 28: 646.

Mycelium abundant in the leaf sheaths. Plant dies from below upwards. No spores.

Hiltner, L.

*(126) 1912. Eine Voraussage! Im heurigen Jahr wird die sogenannte Fusskrankheit des Getreides in Stärkerem Masse auftreten. Prak. Blatter f. Pflanzenbau und Pflanzenschutz München, 10: 37–45. Abs. in Hollrung's Jahresb. 15: 150.

Claims that unripe seed or seed-wheat grown in an abnormally dry season produced very susceptible plants, and that infection is seed-borne.

Massee, G.

*(127) 1912. White heads or take all of wheat and oats. Bul. Misc. Inform. Roy. Bot. Gard. Kew, 10: 435–439, fig. 1; Jour. Bd. Agr. 19 (No. 12): 1020–1025, pl. 1. 1913. Abs. in E. S. R. 28: 646.

Two or three inches of straw at base blackened as though charred. Roots woolly, owing to root hairs. *Ophiobolus graminis* is readily recognized by the dark color of its mycelium, which forms a thin felt on the stem and leaf sheaths. Says the disease is well known in Italy, France, Germany, Belgium, Australia, and the United States. In hanging drop the colored mycelium gives rise to a hyaline mycelium.

Peglion, Vittoria

*(128) 1912. Intorno al mal del piede del frumento. Casale. Stab. tip. ditta C. Cassone. 60 p.

Störmer, K., and Kleine, R.

*(129) 1912. Über das auswintern des Weizens und das auftreten der Fusskrankheit. Illus. Landw. Ztg. 32 (No. 38): 360–361. Abs. in E. S. R. 28: 52, and in Hollrung's Jahresb. 15: 135, 153.

Ophiobolus herpotrichus and *Typhula graminum* caused disease following severe cold; the latter noted heretofore only in Sweden and Denmark.

Voges, E.

*(130) 1912. Zur Fusskrankheit des Getreides. Deut. Landw. Presse, 39 (No. 71): 815, 816, fig. 4; No. 72: 823, 824, fig. 3. Abs. in E. S. R. 28: 445.

Concludes that fungi are *not* the primary cause of foot-rot, but that it is due to lowering of vitality by cold or drouth.

Schaffnit, E.

*(131) 1912. Der Schneeschimmel und die übrigen durch *Fusarium nivale* Ces. hervorgerufenen Krankheitserscheinungen des Getreides. Landw. Jahrb. 43: 521–648. Abs. in Hollrung's Jahresb. 15: 137–140, 55.

Discusses extensively a disease attributed to *Fusarium nivale*, one phase of which is a foot-rot.

(132) 1912. Beiträge zur Biologie der Getreidefusarien. Jahrb. d. Ver. ang. Bot.

Rasquin, Max

*(133) 1912. Le piétin des céréales. Jour. Soc. Agr. Brabant and Hainaut, 58: 421–422. Oct. 11, 1912.

Summarizes earlier literature.

Bredemann, G.

(134) 1912. Das diesjährige starke Auftreten der Fusskrankheit und der Schwärze des Getreides in unseren Bezirk. Amt. d. Land. f. Reg. Cassel, 16: 412. Abs. in Hollrung's Jahresb. 15: 148.

Ivett, J.

*(135) 1912. Takeall and how to control it. Jour. Agr. S. Austral. 16: 84–85.

Reuter, E.

(136) 1912. Ett uppträdande af halmdödaren (Ophiobolus) i Finland. Med. af Soc. Fau. et Fl. Fennica, 38: 65. Abs. in Hollrung's Jahresb. 15: 152.

Depole, R., and Voglino, E.

(137) 1912. [Foot-rot of grains.] Coltivatore, 58 (No. 18): 567–572, fig. 2. Abs. in E. S. R. 27: 748.

Prunet, A.

*(138) 1913. Sur les champignons qui causent en France le piétin des céréales. Compt. Rend. Acad. Sci. Paris, 157 (No. 22): 1079–1081. Abs. in E. S. R. 30: 648.

This disease is of importance in parts of Italy.

Guerrapain, A., and Demolon, A.

*(139) 1913. Enquête et observations sur la maladie du piétin des céréales. Jour. Agr. Prat. 137: 566–567, 627–630.

Discusses climatic influences, calling particular attention to increase of this disease following a mild winter, to geographic distribution, to time and density of seeding, to varietal resistance, to fertilizers, and to the use of copper sulfate. It occurs on rye and winter barley. Abnormal winter temperatures favor the disease.

*(140) 1913. Enquête sur la maladie du piétin. Betterave, 23 (No. 597): 386–388, fig. 1; No. 598: 402–405; 24 (No. 599): 7, 8. Abs. in E. S. R. 30: 747.

Either high winter temperatures or excessive growth of the wheat favors development of the disease.

Eriksson, J.

*(141) 1913. Die Pilzkrankheiten der Kulturpflanzen, p. 138–140. (Cf. No. 121.)

Great Britain Board of Agriculture

*(142) 1913. "White heads" or "take-all" of wheat and oats. (*Ophiobolus graminis* Sacc.) Jour. Gt. Brit. Bd. Agr. 19:1020–1025. Reprinted with slight changes and abridgment as Leaflet 273 (July, 1913) by Gt. Britain Bd. Agr. and Fisheries, 1 fig. Abs. in E. S. R. 30:148.

Voges, E.

*(143) 1913. *Ophiobolus herpotrichus* und die Fusskrankheit des Getreides. Ztschr. f. Gärungsphysiol. 3 (No. 1):43–83, fig. 5. Abs. in E. S. R. 31:542.

The fungus appears as a felty layer over the host, and in dampness develops *Fusarium rubiginosum* A. & W. Ascospores give two kinds of mycelium: (1) a dark thick-walled one; (2) a hyaline thin one. The second gives the Fusarium. No. 1 put on cooked wheat gives Fusarium; and on raw wheat, the usual dark mycelium. The mycelium of Ophiobolus, *Cladosporium herbarum*, or *Mucor racemosus* may be present. The Fusarium form is most dangerous.

*(144) 1913. Die Schneeschimmel. Deut. Landw. Presse, 40 (No. 19):229–231, fig. 3. Abs. in E. S. R. 29:244.

Thinks Fusarium is the conidial form of *Ophiobolus herpotrichus*.

*(145) 1913. Die Witterung und die Fusskrankheit des Getreides. Deut. Landw. Presse. 40 (No. 83):993, 994, fig. 3. Abs. in E. S. R. 30:541.

Indicates that fungi other than Ophiobolus may cause foot-rot, and that Ophiobolus and Leptosphaeria are not the primary cause of the disease. The conidial form of Ophiobolus is given as Acremonium.

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*(146) 1913. Takeall. Abs. in Jour. Agr. S. Austral. 16:1430.

*(147) 1913. Wheat diseases. Abstract of discussion at Annual Conference meeting, Jour. Agr. S. Austral. 17:178–180.

Trowbridge, J., et al.

*(148) 1913. Takeall. Abs. in Jour. Agr. S. Austral. 17:206–207.

McCormack, L.

*(149) 1913. Takeall. Abs. in Jour. Agr. S. Austral. 17:247.

Hartmann, A.

*(150) 1913. Takeall. Extract in Jour. Agr. S. Austral. 17:249–250.

*(151) 1913. Takeall. Extract in Jour. Agr. S. Austral. 17:551.

Gray, J.

*(152) 1913. Takeall and oats. Extract in Jour. Agr. S. Austral. 17: 631–633.

Stebler, F. G.

(153) 1913. [Plant protection.] Land. Jahr. Schw. 27:18 Abs. in E. S. R. 29: 150.

Notes presence of foot disease due to Ophiobolus.

Reuther

(154) 1913. [Foot disease of wheat.] Deut. Landw. Presse, 40: 780. Abs. in E. S. R. 30: 243.

*(155) 1913. Beobachtungen über die Fusskrankheit des Weigens. Ill. Land. Ztg. 33: 589.

Notes on *Ophiobolus herpotrichus*, on *Hordeum murinum*, *Bromus sterilis*, *Festuca bromoides*, and *Triticum repens*. Foot-rot is worst when frost injury occurs in fields that are infected with foot-rot fungi.

Robert, E.

*(156) 1913. Quelques mots encore sur le piétin du blé. Jour. Agr. Prat. 137: 715–716.

Mentions five conditions of maximum disease and deduces five recommendations as to practice.

Boijeau, A.

*(157) 1914. Le piétin du blé. Prog. Agr. et Vit. 61: 241–247. Abs. in E. S. R. 31: 51.

Author discusses the influence of environment and variety on prevalence of foot-rot.

Mangin, L.

*(158) 1914. La question du piétin. Jour. Agr. Prat. n. ser. 27 (No. 8): 236–239, 267–269. Abs. in E. S. R. 31: 147.

Fusarium nivale, *F. hibernan*, *F. minimum*, *Nectria graminicola*, and *Calonectria nivalis* are discussed. Infection is said to be by either soil or seed. In piétin the stems are black; the grain is weak and lodges. Secondary fungi are Septoria, Sphaerella, Helminthosporium, Cladosporium, Leptosphaeria, etc.

Foëx, E.

(159) 1914. [Stalk disease of wheat.] Bul. Soc. Path. Veg. France, 1 (No. 1): 26–30, pl. 1. Abs. in E. S. R. 37: 248.

Ophiobolus graminis is said to work at the base of the stalk; *Leptosphaeria herpotrichoides* higher on the stem. *Cercosporella herpotrichoides*, perhaps a conidial form of Leptosphaeria, is also said to cause a weakening of cereal stems.

Hollrung, M.

*(160) 1914. Die Mittel zur Bekämpfung der Pflanzenkrankheiten, p. 292.

Emphasizes drainage, quoting Dombrovski—(98) of this list.

Berthault, P.
*(161) 1914. Contribution à l'étude du piétin des céréales pendant l'année 1913. Rev. Gen. Bot. 25: 29–34. Abs. in E. S. R. 32: 641.

Voges, E.
*(162) 1914. [The conidial form of *Ophiobolus herpotrichus*.] Centralbl. Bakt. [etc.]. Abt. 2, Bd. 42 (No. 1–4): 49–64, fig. 9. Abs. in E. S. R. 32: 843.
Finds *Hendersonia herpotricha*, Ascochyta, Septoria, Mucor, Leptosphaeria, Cladosporium, and *Alternaria tenuis* associated with Ophiobolus.

Ross, H.
*(163) 1915. Wheat culture. Dept. Agr. N. S. Wales, Farmers' Bul. 101.

Goldsworthy, W. R.
*(164) 1915. Takeall. Extract in Jour. Agr. S. Austral. 18: 921.

Journal of Agriculture of S. Australia
*(165) 1915. "Take-all". Jour. Agr. S. Austral. 18: 966.

Perkins, Arthur J.
*(166) 1915. What the man on the land wants to know. Jour. Agr. S. Austral. 18: 1072–1080.
Replies to a series of questions.

Darnell-Smith, G. P., and Mackinnon, E.
*(167) 1915. Fungous diseases of wheat. Dept. Agr. N. S. Wales, Farmers' Bul. 102: 3–31, fig. 28. Abs. in E. S. R. 34: 845.
Notes the disease on barley, barley-grass, and Bromus. It occurs on oats in England and N. S. Wales.

Capus, J.
*(168) 1915. Action de l'acide sulfurique sur le "piétin" du blé. Compt. Rend. Acad. Agr. France, 1: 228–231. Abs. in E. S. R. 34: 244.
Describes accurately three phases in the development of the disease which he considers due to Leptosphaeria. Reports beneficial effect of sulfuric acid.

(169) 1915. Action de l'acide sulfurique sur le piétin du blé. La Vie Agricole et Rurale, No. 4.
Possibly identical with *(168).

Moretlini, A.
*(170) 1915. L'impiego dell' acido sulforico per combattere le erbe infeste nel frumento. Staz. Sper. Agr. Ital. 48: 693–716. Abs. in E. S. R. 36: 534.

Biffen, R. H.
*(171) 1915. ———. Jour. Roy. Agr. Soc. Eng. 76: 309.
Leptosphaeria culmifruga produces brittleness of stems.

(172) 1916. ———. Jour. Roy. Agr. Soc. Eng. 77: 218–220. Abs. in E. S. R. 39: 452.

Darnell-Smith, G. P.
*(173) 1916. Green vitriol (ferrous sulfate) as a preventive of take-all. Agr. Gaz. N. S. Wales, 27 (No. 2): 134. Abs. in E. S. R. 35: 750.
Recommended fifty pounds per acre.

Spafford, W. J.
*(174) 1916. "Bunt" and "Take-all". Jour. Agr. S. Austral. 19: 953–961.
*(175) 1917. Some diseases of wheat crops and their treatments. Jour. Agr. S. Austral. 20: 537–548. Abs. in E. S. R. 38: 48.
Finds on the roots many dark brown threads. A plate mycelium between sheath and stem is continuous with the root mycelium. This peels off in flakes when dry. Also between sheath and stem a brown band passes upward. Perithecia occur on roots or sheaths. Infection is mainly from the soil. Prevention: burn stubble, kill weeds, use oats. Oats are but little susceptible. Mechanical condition of the soil is very important.

Tanaka, I. T.
*(176) 1917. New Japanese fungi. Notes and translations. Mycologia 9 (No. 3): 167–172. Abs. in E. S. R. 38: 648.
Ophiochaeta graminis causes diseases on rice.

Godfrey, G. H.
*(177) 1918. *Sclerotium rolfsii* on wheat. Phytopathology, 8 (No. 2): 64–66, fig. 1. Abs. in E. S. R. 39: No. 9.
Small brown lesions occurred on the crown.

Pridham, J. T.
*(178) 1919. Take-all, the wheat-growers' worst enemy. Agr. Gaz. N. S. Wales, 30: 77–79.
"Whether the disease is caused by the fungus *Ophiobolus herpotrichus*, by *Cladosporium herbarum*, by *Fusarium rubiginosum*, or by *Mucor racemosus*, the result is much the same on the wheat plant." * * * "The roots are rotten."

Brittlebank, C. C.
*(179) 1919. Green manurial crops and "take all". Victoria Jour. Agr. 17: 171–174.
Says that McAlpine (84) clearly showed that the disease is due to *Ophiobolus graminis*.

Johnson, A. G.

*(180) 1919. New wheat disease. Extension Messenger for Apr. 30, 1919, 2 (No. 18): 2.

In telegram to J. B. Haberkorn, says that "disease in wheat * * * is almost certainly the serious Australian disease known as take-all, not previously found in America."

Haskell, R. J.

*(181) 1919. Take-all and flag smut: two serious wheat diseases new to the United States. Plant Disease Surv. U. S. Dept. Agr. (A leaflet, without number or date.)

"Take-all, known for many years in Australia and Europe, and flag smut, common in Australia, India, and Japan, have recently been discovered in the United States in the very center of the winter wheat area." * * * "This examination showed the discase to be very similar to the take-all of Australia and Europe, and [it] is probably identical with it."

Lyman, G. R.

*(182) 1919. "Take all" of wheat in this country. Circular letter bearing date of May 1, 1919.

"A serious wheat disease which appears to be the same as the Australian 'Take all' (Ophiobolus) has made its appearance in southern Illinois." * * * "It appears, therefore, that we now have 'take all' in this country."

Johnson, A. G.

*(183) 1919. [As reported at the St. Louis Conference (May 12, 1919) on Take-all and Flag Smut of Wheat.]

"* * * After careful study he decided that the trouble was the Australian 'take-all' disease. Dr. N. A. Cobb, of the U. S. Department of Agriculture, who has seen this disease in Australia, was consulted and stated that the behavior of the disease as described in Illinois agreed perfectly with conditions in Australia. It therefore seemed practically certain that the trouble in Illinois was the Australian 'take-all.'" * * * "Approximate number of acres affected, 802."

Lyman, G. R.

*(184) 1919. Plans for survey of "take-all" and "flag smut" of wheat. Circular letter, dated May 23, 1919.

"In addition to the Madison county area in Illinois, take-all has been found in Porter, Laporte, Tippecanoe, and Jasper counties, Indiana."

Onondaga County Farm Bureau News [N. Y.]

*(185) 1919. New wheat diseases. Onondaga Co. Farm Bur. News, June, 1919.

"Two new wheat diseases, known as 'take-all' and 'flag smut', which have caused serious loss in Australia, have recently been found in Illinois and Indiana."

Bulletin of the American Steel and Wire Co.

*(186) 1919. [Popular description of take-all.] See said Bulletin for June, 1919.

Federal Horticultural Board

*(187) 1919. Notice of public hearing of proposed European quarantine on account of the flag smut and take-all diseases of grains and the wheat nematode or eelworm disease. Mimeographed notice issued June 18, 1919, by U. S. Dept. Agr., Fed. Hort. Bd.

The Secretary of Agriculture is said to have information that "take-all (*Ophiobolus graminis*)" has been "determined as existing * * * in Indiana and Illinois."

U. S. Department of Agriculture

*(188) 1919. Quarantine on account of flag smut and take-all diseases. Notice of Quarantine No. 39 (with regulations). 6 pp.