Studies on Fusarium-Blight of Cereals in Japan. I.

On the Physiological Specialization of *Gibberella saubinetii* (Mont.) Sacc. in the Pathogenecity to Wheat Seedlings.

By

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Contents.

I. Introduction.

The Fusarium-blight of wheat and barley caused by *Gibberella saubinetii* (Mont.) Sacc. is a very prevalent disease everywhere in Japan, and is one of the most serious menace to wheat industry in our country. The occurrence of this disease is very severe, if rainy weather continues during the flowering and ripening period of wheat and barley. Therefore the damage caused by the present disease has been erroneously assumed to be the injury by the rain fall. Accordingly the losses caused by this Fusarium-blight of wheat and barley have been underestimated for a long time in Japan, although they were serious in some parts of this country, and attained to an enormous sum. In 1933, the disease was very severe in all the parts of Japan. In some districts the losses reached to more than 60% of the estimated sum of the crops, and even the seed wheat for the following season was hardly secured.

The Fusarium-blight attacks the ears as well as the seedlings during the course of germination, and reduces the germination percentage greatly. Not only during the germination, but also the germinated seedlings are subject of the attack.

In some instances the blighted grains of wheat, barley and oats were seriously poisonous to the human bodies and also to the domestic animals, so that the grains could not be as their food.

Therefore the investigations of the Fusarium-blight and the establishment of the suitable measures for its control are of urgent need. The writers set about their investigation on this disease with the co-operation of the Department of Agriculture and Forestry, Imperial Government of Japan. Among many members of the form-genus Fusarium attacking cultivated plants, and even in the present species, the physiological specialization has been proved to exist. Therefore it seems advisable to begin the investigation by studying the physiological specialization of the causal fungus, especially as to the pathogenecity, and then to use the strongly virulent strains for the further investigations.

For this reason, the writers set about their investigation on this Fusarium-blight, regarding to the physiological specialization of the causal fungus, *Gibberella saubinetii* (Mont.) Sacc.

This paper presents a part of the experimental results on this problem and serves as an introductory report of the writers' studies in the Fusarium-blight of cereals in Japan.

The writers' acknowledgments are due to Messrs. A. Manabe, S. Mori, J. Takeuchi, and U. Bokura of the Department of Agriculture and Forestry, and to Dr. M. Kondō, Director of the Ōhara Institute.

II. Name of the Causal Fungus and the Historical Review.

The Fusarium-blight of wheat and barley under consideration is caused by an ascomycete, *Gibberella saubinetii* (Mont.) Sacc. The fungus was described in France by J. F. C. Montagne (1856) and was named as *Gibbera saubinetii* Mont. In 1879, the fungus was transferred by Saccardo (Michelia, 1 : 513) to the genus Gibberella by the name *Gibberella saubinetii* (Mont.) Sacc.

The conidial stage of *Gibberella saubinetii* had been called by the name *Fusarium roseum* Link, until the perfect stage of the Fusarium was ascertained. In 1910, Appel and Wollenweber found mature perithecia of *Gibberella saubinetii* (Mont.) Sacc., in a culture of a Fusarium on boiled straw. As *Fusarium roseum* Link had been a name given to a group of species, they gave a new name of *Fusarium rostratum* Appl. et Wr. to their fungus. Wollenweber (1917) had then found that *Fusarium rostratum* is one and the same with *Fusarium graminearum* Schwabe (1898). Since then the name has been used to the conidial stage of the ascomycete, *Gibberella saubinetii* (Mont.) Sacc.

As the Fusarium-blight of cereals is very prevalent all over the world and causes frequently severe losses, it was studied by many authors, and the papers regarding to this disease are very numerous. The investigations of Wollenweber (1913, 1922), Atanasoff (1920), Hopkins (1922), Dickson and his fellows (1923, 1932, 1933), Bennett (1930, 1931, 1932), Tu (1930), Tanja (1933), etc. may be considered as more important ones.

In Japan this fungus was described by I. Miyake (1910), K. Hara (1910, 1930) and S. Ito (1912) on rice, wheat and oats, respectively. K. Sawada (1919) reported the fungus occurrence on barley and wheat in Formosa. M. Kasai (1923) and C. Miyake (1924) described it on rice and horse-bean, respectively. Lately, Y. Tochinai (1933) discussed the poisonous effects of the blight-diseased grains to the cattles. U. Bokura (1933) reviewed the occurrence of the disease in Japan and summarized the results of experiments of various local agricultural experiment stations, regarding the control measure of this disease.

The present writers reported the results of their investigations on the physiological specialization of this fungus, at the general meeting of the Japanese Society of Agricultural Science held in Tokyo in April, 1934.

III. Fungus Strains Studied.

The fungus strains studied were isolated chiefly by the writers from the diseased ears of wheat and barley, which were sent to them from various local agricultural experiment stations and the agricultural schools and colleges. The writers wish at this place to express their hearty thanks to those gentlemen, who sent the diseased materials to them.

The numbers of the strains, the names of the host plants and the parts, from which the strains were isolated, the localities and dates of the collection and the name of the collectors, are here given. The strains without the description of the localities and the names of collectors mean that they were isolated from the specimens collected in or near Kurasiki by the writers themselves ; and those without the isolated parts of plants show that they were isolated from blighted ears. The strains studied are as follows :

No. 523 is *Gibberella saubinetii* (Mont.) Sacc., isolated from a conidial mass developed on a blighted ear of wheat, collected at Yosioka, Kurasiki, on June 1, 1932. Nos. 540—546, wheat, Bakuroiti, Kurasiki, 13/VI, 1932. No. 547, wheat, Nisinaka-Sinden, Kurasiki, 13/VI, 1932. Nos. 548—551, wheat, Sasaoki, Kurasiki, 13/VI, 1932. No. 552, wheat, Ootayama, Kurasiki, 13/VI, 1932. Nos. 553—554, wheat, Sinden, Kurasiki, 13/VI, 1932. No. 555, wheat, Hunagura, Kurasiki, 13/VI, 1932. No. 556, wheat, Syôwamatidôri, Kurasiki, 13/VI, 1932. No. 557, wheat, Masu, Kurasiki, 14/VI, 1932. No. 558, wheat, Hamanotyaya, Kurasiki, 14/VI, 1932. No. 559, wheat, Sugô, Tukubo-gun, Pref. Okayama, 14/VI, 1932. No. 564, wheat (Nôrin No. 1), Tottori Agricultural Experiment Station, by T. Hitomi, 23/VI, 1932. No. 565, wheat (Nôrin No. 2), ditto. No. 566, wheat (Nôrin No. 4), ditto. No. 567,

wheat (Esima No. 1), ditto. No. 568, wheat (Saitama No. 18), ditto. No. 778, wheat (Kinai No. 158), Kagosima Imperial College of Agric. and Forestry, by T. Naitô, 10/V, 1933. No. 779, wheat (Esima-sinriki), ditto. No. 780, wheat (Sintyûtyô), ditto. No. 781, wheat (Sakigake No. 1), ditto. No. 782, wheat (Igatikugo), ditto. No. 783, barley (Oni-hadaka), ditto. No. 784, wheat (Aka-sinriki), ditto. No. 785, barley (Takasita), ditto. No. 786, barley (Simabara), ditto. No. 787, barley (Kamaore), ditto. No. 788, barley (Hizahati), ditto. No. 789, barley (Kôbai No. 1), ditto. No. 790, barley (Ko-tinko), ditto. No. 832, wheat (Igatikugo-oregon × Kinai-3-nen No. 42), Saga Agric. Exper. Station, by A. Maeda, 13/IV, 1933. No. 833, isolated from asocospores in perithecium produced on wheat (Igatikugo-oregon × Kinai-3-nen No. 42), ditto. No. 836, barley, at Itabasi, Pref. Ibaragi, by E. Kurosawa, 17/V, 1933. No. 837, *Panicum Crus Galli* L., ear, ditto, 15/V, 1933. No. 838, *Miscanthus sinensis* Anders. ear, ditto. No. 839, *Zea Mays* L. ear, ditto. No. 840, barley, ditto, 19/VI, 1933. No. 853, wheat, ditto. No. 854, wheat, Osikabe, Sôzya, Kibi-gun, Pref. Okayama, 22/V, 1933. No. 855, wheat, Bakuroiti, Kurasiki, 22/V, 1933. No. 856, barley (Wase-hadaka), Saga Agric. Exper. Station, by A. Maeda, 20/V, 1933. No. 857, barley (Golden melon), ditto. No. 858, wheat (Saikai No. 6), ditto, 22/V, 1933. No. 859, wheat (Nôrin No. 5), ditto, 20/V, 1933. No. 860, wheat (Esima-sinriki), ditto. No. 861, barley (Mikuri-hadaka), ditto. No. 862, barley (Hizahati), ditto. No. 863, barley (Kobin No. 7), ditto. No. 864, barley (Kobin-katagi), ditto. No. 865, wheat (Kônosu No. 25), Kyûsyû Wheat Breeding Station of the Imperial Agric. Exper. Station, by H. Hukano, 22/V, 1933. No. 866, wheat (Kônosu No. 26), ditto. No. 867, wheat (Iga-tikugo), ditto. No. 868, wheat (Pusa No. 12), ditto. No. 869, wheat (Esima-sinriki), ditto. No. 870, wheat, Aiti Agric. Exper. Station, by K. Kuwaduka, 25/V, 1933. No. 871, barley, ditto, 24/V, 1933. No. 872, wheat (Saikai No. 31), Ooita Agric. Exper. Station, by K. Konno, 27/V, 1933. No. 873, wheat (Sirobôzu), ditto. No. 874, wheat (Akabôzu), ditto. No. 875, wheat (Iga-tikugo), ditto. No. 876, wheat (Kinai No. 189), ditto. No. 877, barley (Tatuho), ditto. No. 878, barley (Bôzu-mugi), ditto. No. 879, barley (Kairyô-Ooita), ditto. No. 880, barley (Ooita-hizahati No. 85), ditto. No. 881, barley (Kobin-hadaka No. 8), ditto. No. 882, barley (Hadaka, Ooita-nedi No. 15), ditto. No. 883, horse-bean (*Vicia Faba* L.) stem, Hatihama, Kozima-gun, Pref. Okayama, 28/V, 1933. No. 884, barley, Miyazaki Imperial College of Agric. and Forestry, by I. Hino, 31/V, 1933. No. 885, barley (Kedaka-rokkaku), Hukui Agric. Exper. Station, by T. Matsuura, 2/VI, 1933. No. 886, wheat (Tôhoku No. 17), ditto. No. 887, barley (Siro-bunbu), Kumamoto Agric. Exper. Station, by Y. Kiba, 2/VI, 1933. No. 888, wheat (Sintyûtyô), ditto, 29/V, 1933. No. 889, barley (Simabara), ditto. No. 890, wheat (Kumamoto No. 1), ditto. No. 891, wheat (Wase No. 1), ditto. No. 892, wheat (Esima-sinriki), ditto. No. 893, wheat (Saitama No. 27), ditto. No. 894, wheat, Naka, Inaba-gun, Pref. Gihu, by M. Hiura, 29/V, 1933. No. 895, barley (Ooita-nedi), Ooita Agric. Exper. Station, by K. Konno, 1/VI, 1933. No. 896, wheat (Ooita-igatikugo), ditto, 5/VI, 1933. No. 897, wheat (Wase-kiso), Sioya, Hikawa-gun, Pref. Simane, by K. Yokogi, 6/VI, 1933. No. 899, barley, Ooyama, Itano-gun, Pref. Tokusima, by T. Aoyagi, 9/VI, 1933. No. 900, wheat (To-

kusima-tikuma No. 29), Tokusima Agric. Exper. Station, ditto. No. 901, barley (Tinko No. 1), ditto. No. 902, barley (Harima), Ehime Agric. Exper. Station, by H. Mitsuhasi, 9/VI, 1933. No. 903, wheat (Gôsyû No. 3), ditto. No. 904, wheat, Yosikata, Iwami-gun, Pref. Tottori, by Y. Uemura, 5/VI, 1933. No. 905, wheat, Inaba, Iwami-gun, Pref. Tottori, by N. Hiratuka, 5/VI, 1933. No. 906, wheat, Omokage, Iwami-gun, Pref. Tottori, by Y. Uemura, 8/VI, 1933. No. 907, wheat (Hatakeda), Tottori Imper. College of Agric, by Y. Uemura, 12/VI, 1933. No. 908, wheat (Sintyûtyô), ditto. No. 909, wheat (Wase-komugi), ditto. No. 910, wheat (Nitta-wase), ditto. No. 911, wheat (Bô-tin), ditto. No. 912, barley (Nara Karyô No. 1), ditto. No. 913, barley (Miho), ditto. No. 914, barley (Ei-gata), ditto. No. 915, barley (Yamaguti-hadaka), ditto. No. 916, barley (Sin-tinko), ditto. No. 917, barley (Esima-sinriki), Nara Agric. Exper. Station, by Z. Murata, 14/VI, 1933. No. 918, wheat (Nôrin-gô), Toyama Agric. Exper. Station, by S. Iwayama, 14/VI, 1933. No. 919, wheat, Yamaguti Agric. Exper. Station, by Z. Okada, 14/VI, 1933. No. 920, wheat, Hide-mati, Turemi-gun, Pref. Ooita, by A. Ideta, 1/VI, 1933. No. 921, wheat (Kantô No. 2), Tottori Agric. Exper. Station, by T. Hitomi, 16/VI, 1933. No. 922, wheat (Nôrin No. 1), ditto. No. 923, wheat (Igatikugo×Tyabo), ditto. No. 924, wheat (Tôkai No. 10), ditto. No. 925, wheat (Kantô No. 6), ditto. No. 926, wheat (Tyûgoku No. 12), ditto. No. 927, wheat (Tôhoku No. 4), ditto. No. 928, wheat (Tyûgoku No. 9), ditto. No. 934, wheat (Nôrin No. 6), ditto. No. 935, wheat (Kantô No. 9), ditto. No. 936, barley, Tyôsen Agric. Exper. Station, Suigen, Tyôsen, by T. Nose, 9/VI, 1933. No. 937, wheat (Tukinosima), Western Branch Station of Tyôsen Agric. Exper. Station, Syariin, Tyôsen, by E. Hirata, 7/VII, 1933.

IV. Methods of Experiments and the Results.

In the present investigation, the pathogenecity of *Gibberella saubinetii*, the causal fungus of the Fusarium-blight, to wheat seedlings was examined by the methods given in the writers' previous paper on the pathogenecity of *Gibberella Fujikuroi*, the rice-"Bakanae"-fungus, to the rice seedlings (Nisikado etc. 1933). Triplicate inoculation-experiments were carried out.

Experiment I.

In the first inoculation-experiment, above stated 124 strains of *Gibberella saubinetii* were grown on boiled rind of water-melon. When they had developed copious conidia, they were used for the inoculation-experiments on wheat. The wheat grains used were "Hatakeda" variety, harvested in the experimental fields of this Institute in 1932. They were disinfected superficially with a mixture of alcohol (50%), and corrosive sublimate (0.1%) for 2 or 3 minutes, and then they were rinsed thoroughly with sterilized water. About 70 grains, thus disinfected, were put into a sterilized Petri dish, to which a piece of the fungus

cultures grown on the boiled rind of water-melon was added. The Petri dishes were then shaken to cover the seed surface thoroughly with the conidia of the fungus strains to be tested.

On October 2, 1933, the first inoculation-experiment was started and sixty-four wheat grains, inoculated as above were sown in sand in two flower pots, for each of the fungus strains. The pots used were 14 cm. in diameter, 17 cm. high, filled with sand and autoclaved at 20 pounds pressure for two to four hours beforehand. The 0.1 per cent KNOP's solution was added to each of the pots as uniformly as possible. After sowing, the pots were kept in the net-house in the daytime and in the glass-house at night. When the wheat seedlings in the control grew and attained the height of about 15 cm., the results were studied. The number of the germinated grains and that of the diseased seedlings after germination were examined. From these data secured, the percentage of the germinated grains and of the healthy seedlings were computed. The results of Experiment I, examined on October 18, 1933, are given in the columns 2—5 in Table I.

Table I.

Results of Inoculation-Experiments of Various Strains of *Gibberella saubinetii* (Mont.) Sacc. to Wheat Seeds.

	Date of inocultion and sowing.	Date of examination.
Experiment I.	October 2, 1933	October 18, 1933
Experiment II.	October 23, 1933	November 16, 1933
Experiment III.	November 18, 1933	December 28, 1933

Fungus strains studied	Experiment I				Experiment II				Expriment III			
	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings
No. 523	45	6	70.2	60.9	53	11	82.8	65.5	42	0	65.8	65.8
40	47	19	73.4	43.8	25	21	39.1	6.2	32	10	50.0	34.4
41	45	12	70.3	51.5	45	20	70.3	39.5	23	21	35.9	3.3
42	43	6	67.2	57.8	37	20	57.8	26.6	30	12	46.9	28.3
43	39	20	60.9	29.7	38	9	59.4	45.6	47	2	73.4	70.3
44	43	0	67.2	67.2	49	5	76.6	68.8	50	2	78.1	75.0
45	45	3	70.3	65.6	43	5	67.2	59.4	50	3	78.1	73.4
47	50	1	78.2	76.6	41	3	64.0	59.4	13	8	20.3	7.8
48	46	3	71.9	67.2	55	7	85.9	75.0	22	8	34.4	21.9
49	49	0	76.6	76.6	54	4	84.4	78.2	50	2	78.1	75.0
550	42	10	65.6	50.0	49	7	76.6	65.6	46	4	71.8	65.6
51	42	9	65.6	51.5	50	6	78.2	68.7	45	1	70.3	68.8
52	42	0	65.6	65.6	50	2	78.2	75.0	52	0	81.2	81.2
53	56	1	87.5	86.0	51	4	79.7	73.4	45	3	70.3	65.6
54	42	0	65.6	65.6	52	5	81.2	73.4	48	3	78.5	70.3

Table I. (Continued.)

Fungus strains studied	Experiment I				Experiment II				Experiment III			
	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings
No. 555	41	20	64.1	32.8	14	14	21.9	0	26	13	40.6	20.3
56	41	2	64.1	60.9	48	2	75.0	71.8	50	0	78.1	78.1
57	35	5	54.7	46.9	40	4	62.5	56.2	44	8	68.8	56.3
58	34	24	53.1	15.6	23	23	35.9	0	31	22	48.4	14.1
59	37	21	57.8	25.0	49	25	76.6	37.5	13	11	20.3	3.3
64	42	2	65.6	62.5	52	7	81.2	70.4	53	1	82.8	81.2
65	44	0	68.7	68.7	48	5	75.0	67.2	58	2	90.6	87.5
66	47	3	73.4	68.7	47	14	73.4	51.6	35	11	54.7	37.5
67	37	4	57.8	51.5	48	2	75.0	71.9	51	0	79.7	79.7
68	51	3	79.7	81.3	48	5	75.0	67.2	46	18	71.8	43.8
778	46	8	71.9	59.4	41	5	64.0	56.2	39	2	60.9	57.8
79	45	9	70.3	56.3	43	8	67.2	54.7	45	2	70.3	67.2
80	29	26	45.3	4.7	24	21	37.5	4.7	17	16	26.6	1.6
81	43	26	67.2	26.6	42	4	65.6	12.5	16	7	25.0	14.1
82	36	14	56.2	34.4	21	18	32.6	4.7	9	9	14.1	0
83	40	16	62.5	37.5	43	12	67.2	48.4	39	21	60.9	28.3
84	40	26	62.5	21.9	34	29	53.1	7 8	16	12	25.0	6.3
85	32	16	50.0	25.0	27	18	42.4	14.1	12	7	18.3	7.8
86	41	12	64.1	45.3	26	25	40.6	1.6	9	9	14.1	0
87	47	3	73.4	68.7	48	1	75.0	73.4	47	0	73.4	73.4
788	38	24	59.4	21.9	45	22	70.3	35.9	15	12	78.1	4.7
89	47	2	73.4	70.3	45	1	70.3	68.7	50	3	78.1	73.4
90	34	31	53.1	4.7	40	27	62.5	20.3	18	13	28.1	7.8
832	46	0	71.9	71.9	45	12	70.3	51.6	33	9	51.6	37.5
33	46	0	71.9	71.9	55	0	86.0	86.0	55	2	86.0	82.8
36	35	12	54.7	35.9	42	21	65.6	32.8	17	11	26.6	9.4
37	40	12	62.5	43.8	42	12	65.6	46.9	37	5	57.8	50.0
38	54	0	84.4	84.4	49	0	76.6	76.6	49	0	76.6	76.6
39	53	0	82.8	82.8	54	0	84.4	84.4	51	3	79.7	75.0
40	23	16	35.9	11.0	27	23	42.4	6.3	35	16	54.7	29.7
853	46	9	71.9	57.8	45	7	70.3	59.4	50	17	78.1	51.6
54	46	0	71.9	71.9	54	3	84.4	79.7	52	4	81.2	75.0
55	45	4	70.3	64.1	49	13	76.6	56.2	26	12	40.6	21.9
56	32	8	50.0	37.5	45	20	70.3	39.1	45	16	70.3	45.3
57	40	16	62.5	37.5	37	23	57.8	21.9	33	24	51.6	14.1
58	31	26	48.4	7.9	19	15	29.7	6.3	13	8	20.3	7.8
59	40	19	62.5	32.8	25	23	39.1	3.1	19	15	29.7	6.3
60	45	0	70.3	70.3	52	2	81.2	78.2	55	5	86.0	78.1

Table I. (Continued.)

Fungus strains studied	Experiment I				Experiment II				Experiment III			
	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings
No. 861	52	5	81.2	73.4	46	5	71.8	64.1	17	8	26.6	14.1
62	45	1	70.3	68.7	40	13	62.5	42.2	33	13	51.6	32.8
63	39	8	60.9	49.2	35	26	54.6	14.1	29	23	45.3	9.4
64	50	0	78.2	79.4	52	0	81.2	81.2	50	1	78.1	76.6
65	39	15	60.9	37.5	39	34	60.9	7.8	40	17	62.5	35.9
66	40	4	62.5	56.3	42	11	65.6	48.4	20	9	31.3	17.2
67	43	36	67.2	11.0	34	17	53.1	26.6	26	7	40.6	29.7
68	22	1	34.4	32.8	44	20	68.7	37.5	5	5	7.8	0
69	47	15	73.4	50.0	25	15	39.1	15.6	11	10	17.2	1.6
70	50	0	78.2	78.2	53	4	82.8	76.6	37	6	57.8	48.4
871	49	0	76.6	76.6	49	1	76.6	75.0	46	3	71.8	67.2
72	39	14	60.9	39.0	33	25	51.6	12.5	35	27	54.7	12.5
73	54	1	84.4	82.8	48	0	75.0	0	56	2	87.5	84.4
74	43	15	67.2	43.8	30	24	46.9	9.4	15	9	23.4	9.4
75	37	9	57.8	43.8	35	27	54.6	12.5	39	21	60.9	28.3
76	37	9	57.8	43.8	31	21	48.4	15.6	37	14	57.8	35.9
77	53	4	82.8	76.6	48	14	75.0	53.1	32	10	50.0	34.4
78	41	9	64.1	50.0	43	21	67.2	34.4	27	5	42.2	34.4
79	41	32	64.1	14.1	25	25	39.1	0	16	13	25.0	4.7
80	44	19	68.7	39.0	45	21	70.3	37.5	26	5	40.6	32.6
881	40	20	62.5	31.3	34	33	53.1	1.6	9	8	14.1	1.6
82	35	31	54.7	6.3	17	17	26.6	0	41	17	64.0	37.5
83	45	3	70.3	65.6	51	1	79.7	78.2	48	0	75.0	75.0
84	32	22	50.0	15.6	42	21	65.6	32.8	24	14	37.5	15.6
85	44	0	68.7	68.7	38	0	59.4	59.4	50	3	78.1	73.4
86	56	1	87.5	85.9	47	12	73.4	54.7	45	3	70.3	65.6
87	35	19	54.7	25.0	9	8	14.1	1.6	24	20	37.5	6.3
88	21	20	32.8	1.6	7	7	10.9	0	28	15	43.8	20.3
89	18	13	28.3	7.9	14	14	21.9	0	45	2	70.3	67.2
90	47	2	73.4	70.3	26	4	40.6	34.4	38	3	59.4	54.7
891	15	15	23.4	0	36	29	56.3	10.9	35	16	54.7	29.7
92	47	28	73.4	29.7	36	18	56.3	28.1	39	8	60.9	48.4
93	18	13	28.3	7.9	19	14	29.7	7.8	27	24	42.2	4.7
94	42	27	65.6	23.4	39	15	60.9	37.5	52	4	81.3	75.0
95	1	1	1.6	0	20	15	31.5	7.8	8	1	12.5	10.9
96	42	21	65.6	32.8	19	18	29.7	1.6	13	5	20.3	12.5
97	40	4	62.5	56.3	30	29	46.9	1.6	30	10	46.9	31.2
99	52	2	81.3	78.2	44	6	68.7	59.4	47	2	73.4	70.3

Table I. (Continued.)

Fungus strains studied	Experiment I				Experiment II				Experiment III			
	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings	No. of germinated seeds	No. of diseased seedlings	Percentage of germination	Percentage of healthy seedlings
No. 900	43	24	67.2	29.7	40	32	62.5	12.5	36	7	56.3	45.3
1	50	3	78.2	73.4	33	27	51.6	9.4	47	12	73.4	54.7
2	4	3	6.3	1.6	9	9	14.1	0	15	15	23.4	0
3	30	19	46.9	17.2	26	25	40.6	1.6	24	16	37.5	12.5
4	28	19	43.8	14.1	36	18	56.3	28.1	44	8	68.7	56.3
5	50	7	78.2	67.2	44	1	68.7	67.2	43	3	67.2	62.5
6	46	12	71.9	53.2	42	3	65.6	60.9	42	4	65.6	59.4
7	37	21	57.8	25.0	19	15	29.7	6.2	21	18	32.8	4.7
8	8	7	12.5	1.6	23	22	35.9	1.6	22	16	34.4	9.4
9	35	23	54.7	18.8	22	19	34.4	4.7	47	16	73.4	48.4
910	46	6	71.9	62.5	35	15	54.6	31.2	45	3	70.3	65.6
11	14	10	21.9	6.3	43	15	67.2	43.7	32	11	50.0	32.6
12	41	22	64.1	29.7	35	23	54.6	18.8	37	16	57.8	32.6
13	22	20	34.4	3.1	11	10	17.2	1.6	17	7	26.6	15.6
14	5	3	7.8	3.1	21	21	32.8	0	16	12	25.0	6.3
15	40	27	62.5	20.3	33	26	51.6	10.9	30	14	46.9	25.0
16	47	26	73.4	32.3	15	14	23.4	1.6	14	14	21.9	0
17	41	17	64.1	37.5	33	33	51.6	0	28	18	43.8	15.6
18	46	17	71.9	45.3	38	12	59.4	40.6	36	8	56.3	43.8
19	18	13	28.3	7.8	38	18	59.4	31.3	23	10	36.0	20.3
920	26	22	40.6	6.3	27	26	42.2	1.6	7	7	10.9	0
21	41	1	64.1	62.5	48	3	75.0	70.4	52	1	81 3	79.7
22	48	19	75.0	45.3	38	21	59.4	26.6	34	11	53.2	35.9
23	10	3	15.6	10.0	36	6	56.3	46.9	17	12	26.6	7.8
24	40	20	62.5	31.2	35	23	54.6	18.8	34	6	53.2	43.8
25	8	6	12.5	3.1	36	27	56.3	14.1	51	12	81.3	60.9
26	39	10	60.9	45.3	49	11	76.6	59.4	35	4	54.7	48.4
27	6	5	8.4	1.6	9	9	14.1	0	24	8	37.5	25.0
28	13	13	20.3	0	35	31	54.6	6.3	26	3	40.6	35.9
34	43	1	67.2	65.6	40	13	62.5	42.2	39	7	60.9	50.0
935	49	16	76.6	51.5	40	24	62.5	25.0	41	4	64.0	57.8
36	42	16	65.6	40.6	36	23	56.3	20.3	36	16	56.3	31.2
37	51	0	79.7	79.7	53	0	82.8	82.8	49	9	76.6	62.5
Control	47	0	73.4	73.4	49	0	76.6	76.6	138 : 192	7	71.8	68.2

According to the figures given in columns 2 to 5, Table I, there exists a large difference between the germination percentage of the wheat inoculated with the fungus strains and that of the control uninoculated wheat. Among the total

64 grains sown, only 20 or less grains germinated in those inoculated with the following strains: Nos. 889, 891, 893, 895, 902, 908, 911, 914, 919, 923, 925, 927 and No. 928.

The percentage of the healthy seedlings of the uninoculated control wheat was 73.4%, meanwhile it was only less than 10% in those inoculated with the following 19 strains: Nos. 790, 858, 882, 838, 839, 891, 893, 895, 902, 908, 911, 913, 914, 919, 920, 923, 925, 927 and No. 928. On the other hand, the healthy seedling percentage was above 70% in those inoculated with the following 22 strains: Nos. 547, 549, 553, 568, 789, 832, 833, 838, 839, 854, 860, 861, 864, 870, 871, 873, 877, 888, 890, 899, 901 and No. 937. At least under such circumstances as the present experiment, the former 19 strains may be assumed to be strongly pathogenic to wheat seedlings, while the latter 22 strains to have no pathogenecity.

Experiment II.

In the similar manner, Experiment II was carried out. Wheat grains were inoculated with the conidium of the above stated fungus strains, and were sown on October 23, 1933. The wheat seedlings developed from these grains were examined on November 11, 1933. The percentage of the germinated wheat, and of the healthy seedlings secured were computed as before, and the results are given in Table I.

The data given in columns 6 to 9, Table I, show that the results of the second experiment are similar to those of the first experiment. When the healthy seedling percentage in the control was 76.6%, it was less than 10% in those inoculated with the following strains: Nos. 540, 555, 558, 780, 782, 784, 786, 840, 858, 859, 865, 873, 874, 879, 881, 882, 887, 838, 889, 893, 895, 896, 897, 901, 902, 903, 907, 908, 909, 913, 914, 916, 917, 920, 927 and No. 928. Meanwhile in the strains: Nos. 548, 549, 552, 553, 554, 556, 564, 567, 787, 833, 833, 839, 854, 860, 864, 870, 871, 883, 921 and No. 937, the healthy seedling percentage was above 70%.

Experiment III.

Further, on November 18, 1933, the third experiment was set about in the same way. The results secured on December 23, 1933, are given in columns 10 to 13, Table I, which verify the results of the foregoing two experiments. The healthy seedling percentage was less than 10% in the following strains: Nos. 541, 547, 559, 780, 782, 784, 785, 786, 788, 790, 836, 858, 859, 863, 868, 869, 874, 879, 881, 887, 893, 902, 907, 908, 914, 916, 920 and No. 923.

V. Discussions.

In most of the above given experiments, the germination percentage of the control, uninoculated wheat was very high and were 73.4, 76.6 and 68.2%, in each of the three experiments respectively. Meanwhile the germination percentage

of the wheat inoculated with some strongly pathogenic strains were very small, and the seedlings were also affected after the germination. Therefore both the percentages of the germinated grains and of the diseased seedlings after germination seemed to be applicable in the comparison of the pathogenecity.

For these reasons the writers preferred the percentage of the healthy seedlings, which may represent the above stated both percentages, for the comparison of the pathogenecity of the strains studied. The mean percentage of the above three experiments is given in column 2, Table II.

Table II.

Mean Value of the Healthy Seedling Percentage of Wheat, Inoculated with Various Strains of *Gibberella saubinetii* (Mont.) Sacc., and its Comparison to that of the Control Wheat.

Fungus strains studied	Mean of the healthy seedling percentage and the probable error	Difference in mean of the healthy seedling percentage of the inoculated and the control	Difference in the mean percentage, divided by it probable error
No. 523	64.1 ± 1.07	8.6 ± 1.72	5.0
40	28.1 ± 6.22	44.6 ± 6.36	7.0
41	31.4 ± 7.93	41.3 ± 8.07	5.1
42	37.6 ± 5.56	35.1 ± 5.71	6.2
43	48.5 ± 6.51	24.2 ± 6.79	3.6
44	70.3 ± 1.31	2.4 ± 1.88	1.3
45	66.1 ± 2.23	6.6 ± 2.61	2.5
47	47.9 ± 9.60	24.8 ± 9.73	2.5
48	54.7 ± 9.12	18.0 ± 9.23	2.0
49	76.6 ± 0.52	3.9 ± 1.44	2.7
550	60.4 ± 2.87	12.3 ± 3.17	3.9
51	63.0 ± 3.17	9.7 ± 3.44	2.8
52	73.9 ± 2.50	1.2 ± 2.84	0.4
53	75.0 ± 3.28	2.3 ± 3.55	0.6
54	69.8 ± 1.25	2.9 ± 1.84	1.6
55	17.7 ± 5.27	54.8 ± 5.44	10.1
56	70.3 ± 2.74	2.4 ± 3.07	0.8
57	53.1 ± 1.72	19.6 ± 2.19	9.0
58	9.9 ± 2.73	62.8 ± 3.06	20.5
59	21.9 ± 5.90	50.8 ± 6.04	8.4
564	71.4 ± 2.98	1.4 ± 3.27	0.4
65	74.5 ± 3.61	1.8 ± 3.84	0.5
66	52.6 ± 5.05	20.1 ± 5.15	3.9
67	67.7 ± 4.64	5.0 ± 4.83	1.0
68	64.1 ± 4.08	8.6 ± 4.24	2.0
778	57.8 ± 3.89	14.9 ± 4.11	3.6
79	59.4 ± 2.15	13.3 ± 2.50	5.3

Table II. (Continued.)

Fungus strains studied	Mean of the healthy seedling percentage and the probable error	Difference in mean of the healthy seedling percentage of the inoculated and the control	Difference in the mean percentage, divided by it probable error
No. 780	3.7 ± 5.80	69.1 ± 1.47	47.1
81	17.7 ± 2.39	55.0 ± 2.80	19.6
82	13.0 ± 5.91	59.7 ± 6.80	8.8
83	38.1 ± 3.20	34.6 ± 3.47	10.0
84	12.0 ± 2.75	60.7 ± 3.06	19.9
85	15.6 ± 2.77	57.1 ± 3.08	18.6
86	15.6 ± 8.16	57.1 ± 8.03	7.1
87	71.8 ± 0.86	0.9 ± 1.60	0.6
88	20.8 ± 4.98	5.2 ± 5.15	10.1
89	70.8 ± 0.76	1.9 ± 1.55	1.2
790	10.9 ± 2.64	61.8 ± 2.97	20.8
832	53.6 ± 5.50	19.1 ± 5.66	3.4
33	80.2 ± 2.36	7.5 ± 2.72	2.8
36	26.0 ± 1.47	46.7 ± 1.99	23.4
37	46.9 ± 0.98	25.8 ± 1.67	15.4
38	79.2 ± 1.43	6.5 ± 1.97	3.3
39	80.7 ± 1.60	8.0 ± 2.04	3.9
40	15.7 ± 3.94	5.7 ± 4.17	13.7
53	56.3 ± 1.31	16.4 ± 1.88	8.7
54	74.5 ± 1.32	1.8 ± 1.88	1.0
855	47.4 ± 7.11	25.3 ± 7.26	3.5
56	40.6 ± 3.36	32.1 ± 3.62	8.9
57	24.5 ± 3.79	48.2 ± 3.98	12.1
58	7.3 ± 0.30	72.0 ± 1.38	52.1
59	14.1 ± 5.19	58.6 ± 5.36	11.1
60	75.5 ± 1.45	2.8 ± 1.98	1.4
61	50.5 ± 10.15	22.2 ± 10.23	2.3
62	47.9 ± 5.88	24.8 ± 6.08	4.1
63	24.2 ± 6.98	48.5 ± 7.06	6.8
64	79.1 ± 0.74	6.4 ± 1.54	4.1
865	27.1 ± 5.32	45.6 ± 5.48	8.3
66	40.6 ± 6.58	32.1 ± 6.71	4.8
67	22.4 ± 3.20	50.3 ± 3.47	14.5
68	23.4 ± 6.51	49.3 ± 6.64	7.4
69	22.4 ± 7.92	50.3 ± 8.04	6.4
70	67.7 ± 5.34	5.0 ± 5.50	0.9
71	72.9 ± 1.61	0.2 ± 2.09	0.1
72	21.3 ± 4.88	51.4 ± 5.06	10.2
73	55.7 ± 15.35	17.0 ± 15.40	1.1

Table II. (Continued.)

Fungus strains studied	Mean of the healthy seedling percentage and the probable error	Difference in mean of the healthy seedling percentage of the inoculated and the control	Difference in the mean percentage, divided by it probable error
No. 874	20.9 ± 6.33	51.8 ± 6.47	8.0
75	28.2 ± 4.99	44.5 ± 5.16	8.6
76	31.8 ± 4.58	40.9 ± 4.77	8.6
77	54.7 ± 6.74	18.0 ± 6.86	2.6
78	39.6 ± 2.88	33.1 ± 3.14	10.6
79	6.3 ± 2.32	65.4 ± 2.68	24.4
80	36.4 ± 1.07	36.3 ± 1.72	21.1
81	11.5 ± 5.46	61.2 ± 5.63	10.9
82	14.6 ± 6.40	58.1 ± 6.53	9.0
83	72.9 ± 2.09	0.2 ± 2.48	0.1
884	21.3 ± 3.18	5.1 ± 3.46	14.9
85	67.2 ± 2.26	5.5 ± 2.63	2.1
86	68.7 ± 5.04	4.0 ± 5.21	0.8
87	10.9 ± 3.95	61.8 ± 4.17	14.8
88	7.3 ± 3.60	65.4 ± 3.84	17.0
89	25.0 ± 11.69	47.7 ± 11.76	4.1
90	53.1 ± 5.73	19.6 ± 5.88	3.3
91	13.5 ± 4.79	59.2 ± 4.98	12.0
92	35.4 ± 3.59	37.3 ± 3.84	9.7
93	6.8 ± 2.18	65.8 ± 2.56	25.7
894	45.3 ± 5.27	27.4 ± 5.44	5.0
95	62.3 ± 1.79	66.5 ± 2.24	29.7
96	15.6 ± 5.04	57.1 ± 5.22	11.0
97	29.7 ± 8.71	43.0 ± 8.84	4.9
99	62.6 ± 8.34	10.1 ± 8.45	1.2
900	29.2 ± 5.21	43.5 ± 5.38	8.1
01	45.8 ± 10.48	26.9 ± 10.55	2.6
02	0.5 ± 0.10	72.2 ± 1.38	52.3
03	10.4 ± 2.56	62.3 ± 2.89	21.6
04	32.8 ± 0.68	39.9 ± 6.97	5.7
905	65.6 ± 0.83	7.1 ± 18.6	4.4
06	57.8 ± 1.30	14.9 ± 1.83	8.0
07	12.0 ± 3.60	60.7 ± 3.84	15.8
08	4.2 ± 1.48	68.5 ± 1.97	34.7
09	24.0 ± 0.71	48.7 ± 7.23	6.7
10	53.1 ± 6.06	19.6 ± 6.20	3.2
11	27.5 ± 6.12	45.2 ± 6.26	7.2
12	27.0 ± 2.32	45.7 ± 2.68	17.1
13	6.8 ± 2.40	65.9 ± 2.75	24.0

Table II. (Continued.)

Fungus strains studied	Mean of the healthy seedling percentage and the probable error	Difference in mean of the healthy seedling percentage of the inoculated and the control	Difference in the mean percentage, divided by it probable error
No. 914	3.1 ± 0.94	69.9 ± 1.65	42.2
15	18.7 ± 2.29	54.0 ± 2.65	20.4
16	11.3 ± 5.54	61.4 ± 5.70	10.8
17	17.7 ± 6.99	55.0 ± 6.15	9.0
18	43.2 ± 0.76	29.5 ± 1.55	19.0
919	18.8 ± 3.77	53.9 ± 4.00	13.5
20	2.6 ± 1.04	70.1 ± 1.71	41.1
21	70.9 ± 2.74	1.8 ± 3.05	0.6
22	35.9 ± 2.94	36.8 ± 3.23	11.4
23	21.6 ± 4.44	51.1 ± 4.64	11.0
24	31.3 ± 3.97	41.4 ± 4.19	9.9
25	26.0 ± 9.82	46.7 ± 9.92	4.7
26	51.0 ± 2.32	21.7 ± 2.72	8.0
27	8.9 ± 4.46	63.8 ± 4.65	13.7
28	14.1 ± 6.10	58.6 ± 6.24	9.4
934	52.6 ± 3.80	20.1 ± 4.03	5.0
35	44.8 ± 5.53	27.9 ± 5.70	4.9
31	30.7 ± 3.24	42.0 ± 3.51	12.0
37	75.0 ± 3.43	2.3 ± 3.73	0.6
Control	72.7 ± 1.37		

Only the inspection of the figures in column 2, Table II, reveals that there exists a great difference in the pathogenecity to wheat seedlings, according to the strains inoculated. However to ascertain this relation more clearly, the writers computed the differences between the healthy seedling percentage of the control, uninoculated wheat and that of the wheat inoculated with various strains. The results are given in the column 3 in the same table (Table II). Further these differences were compared with their own probable errors, and the ratios are given in the column 4 in the same table.

According to the data in column 2, Table II, the healthy seedling percentage of the wheat inoculated with some fungus strains, such as No. 552 and No. 556, etc. is only 0.4 and 0.8% respectively. In the following strains, the differences were less than 5 times of their probable errors so that these strains might be assumed to have no pathogenecity to wheat seedlings.

Fungus strains	$\frac{M_{diff.}}{E_{diff.}}$	Fungus strains	$\frac{M_{diff.}}{E_{diff.}}$	Fungus strains	$\frac{M_{diff.}}{E_{diff.}}$	Fungus strains	$\frac{M_{diff.}}{E_{diff.}}$	Fungus strains	$\frac{M_{diff.}}{E_{diff.}}$
No. 871	0.1	No. 870	0.9	No. 885	2.1	No. 838	3.3	No. 889	4.1
883	0.1	854	1.0	861	2.3	890	3.3	905	4.4
552	0.4	567	1.0	545	2.5	832	3.4	925	4.7
564	0.4	873	1.1	547	2.5	855	3.5	866	4.8
565	0.5	789	1.2	877	2.6	543	3.6	897	4.9
553	0.6	899	1.2	901	2.6	778	3.6	935	4.9
787	0.6	553	1.4	549	2.7	550	3.9	523	5.0
921	0.6	860	1.4	543	2.8	566	3.9	894	5.0
937	0.6	554	1.6	551	2.8	839	3.9	934	5.0
556	0.8	548	2.0	833	2.8	862	4.1		
886	0.8	568	2.0	910	3.2	864	4.1		

On the other hand, as in the case inoculated with the strains No. 902 and No. 858, the differences were very large and attained to more than fifty times of their probable errors. The following strains showed large differences.

Fungus strains	$\frac{M_{diff.}}{E_{diff.}}$	Fungus strains	$\frac{M_{diff.}}{E_{diff.}}$	Fungus strains	$\frac{M_{diff.}}{E_{diff.}}$	Fungus strains	$\frac{M_{diff.}}{E_{diff.}}$
No. 902	52.3	No. 908	34.7	No. 836	23.4	No. 915	20.4
858	52.1	895	29.7	903	21.6	784	19.9
780	47.1	893	25.7	880	21.1	781	19.6
914	42.2	879	24.4	790	20.8		
920	41.1	913	24.0	558	20.5		

These strains may be assumed to have a strong pathogenecity to the wheat seedlings, at least under such circumstances as the writers' experiments were carried out.

The above stated results of the inoculation-experiments of *Gibberella saubinetii* are similar to those of the writers' previous experiments on *Gibberella Fujikuroi*, the causal fungus of the rice-"bakanae"-disease. They also resemble to those of the Tu's (1930) experiments on Fusarium-blight of wheat in America. His experiments were carried out on wheat ears in the fields by using three strains of *Gibberella saubinetii* together with other fungi to wheat ears in the flowering period or later. From his results of inoculations, he compared the percentage of diseased ears induced by the strains inoculated. Among the strains, great differences in the percentage of the diseased ears were observed, and he concluded that the three strains studied may represent three different physiological

forms. His results resemble to the writers' above results, in the point that great differences in the pathogenecity to wheat were observed among the strains studied.

At the same time, the results of the writers' inoculation-experiments with 124 strains of *Gibberella saubinetii* show that there exists a number of strains of intermediate strength in the pathogenecity, between the groups of strains having extremely strong and weak pathogenecity.

VI. Summary.

The present paper is an introductory report of the writers' studies on the Fusarium-blight of cereals, caused by *Gibberella saubinetii* (MONT.) SACC. (*Fusarium graminearum* SCHWABE), and deals with the physiological specialization of the causal fungus.

The fungus attacks wheat, barley and other cereals and causes not only the head-blight but also the seedling-blight everywhere in Japan. It is one of the most serious menace to the wheat industry in our country.

The physiological specialization has been proved to be common in many of pathogenic species of Fusarium, and the studies on this problem are important. Therefore the writers began their investigation on this phase of the causal fungus. One hundred and twenty-four strains of *Gibberella saubinetii* (MONT.) SACC. were isolated from the diseased ears of wheat and barley, which were sent to the writers from various parts of Japan. The pathogenecity of these strains was studied by inoculation-experiments. After surface disinfection, wheat grains were inoculated with the conidium suspension of each of these strains, and were sown in sand in flower-pots, which were previously sterilized under fifteen pounds pressure for from two to four hours. The percentages of the germinated wheat grains and of the diseased seedling affected after the germination were studied by triplicated inoculation-experiments.

For the comparison of pathogenecity of each of the Fusarium strains to wheat seedlings, the writers preferred the percentages of the healthy seedlings secured, to the total wheat grains sown. The mean percentages of the healthy seedlings developed from the inoculated grains were computed, together with the differences between each of these mean percentages and that of the un-inoculated control wheat, and the ratios of these differences to their probable errors.

The figures secured show that some of the strains tested were very strong in their pathogenecity to the wheat seedlings. The differences between the mean percentages of healthy seedlings of some strains and that of the control are 20 to 50 times of their probable errors. Evidently such strains are strongly pathogenic to wheat, at least under the circumstances tested. On the other hand, in some strains the differences are only under three or five times of their probable errors.

Such strains should be assumed to be non-pathogenic to wheat. Between the strains showing the extremely strong and weak pathogenecity, a number of strains of intermediate strength are found, according to these results.

Literature Cited.

Appel, O. und Wollenweber, H. W.

1910: Grundlagen einer Monographie der Gattung *Fusarium* (Link). Arbeiten aus der Kaiserl. Biologisch. Anstalt f. Land- u. Forstw., 8: 1: 1—207.

Atanasoff, D.

1920: Fusarium-blight (scab) of wheat and cereals. Journ. Agr. Research, 20: 1—32.

Bennett, F. T.

1930: *Gibberella saubinetii* (Mont.) Sacc. on British cereals. Ann. Appl. Biology, 17: 45—58.

1931: Ditto II. Physiological and Pathological studies. Ibid., 18: 158—177.

1933: Ditto III. Occurrence under natural conditions. Ibid., 20: 377—380.

Bokura, U.

1933: Mugirui-Byôgai-Ron (VIII). Mugi-rui Akakabi-Byô. Byôchû-gai Zasshi, 20: 5: 390—396.

Dickson, J. G.

1923: Influence of soil temperature and moisture on the development of the seedling-blight of wheat and corn caused by *Gibberella saubinetii*. Journ. Agr. Research, 23: 11: 837—870.

Hara, K.

1910: Komugi no Akakabi-Byô to Ine no Hûsikûro-Byô. Nôgyô-Koku, 4: 12: 30–34.

1930: Zikken Sakumotu Byôrigaku, pp. 179; 216—217.

Hopkins, E. F.

1922: Hydrogen-ion concentration in relation to wheat scab. Amer. Journ. Bot. 9: 159—179.

Ito, S.

1910: Enbaku no Kokuten-Byô ni tukite. Hokkaidô Nôkai-Hô, 12 Kan, 133—4 Gô.

Kasai, M.

1923: Cultural studies with *Gibberella saubinetii* (Mont.) Sacc. which is parasitic on rice plant. Berichte d. Ōhara Inst. f. landw. Forsch., 2: 3: 259—272.

Miyake, C.

1924: *Gibberella saubinetii* (Mont.) Sacc. as a causal fungus of the wilt disease of horse-bean. Ibid., 2: 4: 435—442.

Miyake, I.

1910: Studien über die Pilze der Reispflanze in Japan. Journ. Coll. Agric. Tokyô, 2: 4: 237—276, (*Gibberella saubinetii*, p. 241—2).

Nisikado, Y., Matsumoto, H. and Yamauti, K.

1933: Reports on the physiological specialization of Fusarium. I. On the differenciation of the pathogenicity among the strains of the rice-"bakanae"-fungus. Berichte d. Ōhara Inst. f. landw. Forsch., 6: 1: 113—130.

1933: Studies on the physiological specialization of *Gibberella Fujikuroi*, the causal fungus of the rice-"bakanae"-disease. Transactions of the Tottori Soc. of Agric. Science, 4:3:200—211. *(Japanese.)*

PUGH, G. W., JOHANN, H. and DICKSON, J. D.

1932: Relation of the semipermeable membranes of the wheat kernel to infection by *Gibberella saubinetii*. Journ. Agr. Research, 45:609—626.

1933: Factors affecting infection of wheat heads by *Gibberella saubinetii*. Ibid., 46: 771—797.

SAWADA, K.

1919: Descriptive catalogue of the Formosan Fungi. Part I. pp. 252—261. *(Japanese.)*

TOCHINAI, Y.

1933: Kwakoku-Rui no Kokuten-Byô ni tuite (I—II). Byôchû-Gai Zasshi, 20:106—114, 179—188.

TANJA, A. F.

1933: Untersuchungen über *Gibberella saubinetii* (DUR. et MONT.) SACC. und die Fusariose des Weizens. Phytopath. Zts., 6:4:375—428.

TU, C.

1930: Physiological specialization in Fusarium spp. causing head-blight of small grains. Minnesota Agric. Exper. Station, Tech. Bull. 74, 27 pp.

WOLLENWEBER, H. W.

1913: Pilzparasitäre Welkkrankheiten der Kulturpflanzen. Ber. deut. bot. Gesell., 31:17—34.

1917: Über *Fusarium roseum* LINK. Ibid., 35:743—745.

1922: Tracheomykosen und andere Welkkrankheiten nebst Aussichten ihrer Abwehr. Angew. Botanik, 4:1—14.

Errata

In page 433, line 4,

for "DICKSON and his fellows (1923, 1932, 1933)"

read "DICKSON (1923), PUGH and his fellows (1932, 1933)".