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PHYSIOLOGICAL STUDIES ON THE CAUSAL FUNGI OF SCLEROTIUM DISEASES OF RICE PLANT WITH SPECIAL REFERENCE TO SOME FACTORS CONTROLLING THE OCCURRENCE OF THE DISEASES

By

SIGERU ENDÔ

I. Introduction

The Sclerotium diseases of the rice plant are very destructive and, being widely distributed throughout Japan, cause great damage every year. In 1917, SAKURAI⁽⁸⁹⁾ published a report on the diseases in which he stated that the causal fungi belong to four different species. Since that time, some brief notes have been published by several authors. (12-18, 20-25, 29-31, 33-38, 49-52, 53, 57-59, 66-69, 71, 73, 81, 93-94, 115) The writer (12-27, 29-31, 33, 36-38) also has been studying the diseases since 1926 and has published several reports on the results obtained.

The present work was started at the suggestion of Dr. T. HEMMI, Professor of Phytopathology of the Kyoto Imperial University, and a part of the experiments herein recorded was performed in the Phytopathological Laboratory of that University. The work subsequent to 1929 has been carried on under the supervision of Dr. I. HINO, Professor of the Miyazaki College of Agriculture and Forestry. The writer here wishes to express his sincere gratitude to them for their valuable suggestions and kind advices. A part of the expense of this investigation has been defrayed by the Department of Education and the Japan Society for the Promotion of Scientific Research for which the writer expresses his heartiest thanks.

II. Symptoms of the diseases

1. Symptoms of the disease caused by *Corticium Sasakii*
(SHIRAI) MATSUMOTO

The disease of rice plant caused by *Corticium Sasakii* (SHIRAI) MATSUMOTO⁽⁹⁰⁾ (*Hypochnus Sasakii* SHIRAI)⁽⁹¹⁾ appears in the growing season and continues until harvest time. The fungus attacks the leaf and leaf sheath, producing elongated

or roundish spots on them. When the spots appear on the ligule, they are elongated and parallel to the axis of the stem. The spots become confluent often forming large irregular patches. The action of the fungus on the leaf sheath differs greatly according to the season and also to the growth condition of the host. The diseased spots appear mostly on the first leaf sheath and also on the second leaf sheath, but rarely found on the third. When the disease is very severe, both the leaf sheath and leaf blade are moulded by the mycelium of the fungus and numerous spots are produced causing the plant to die.

The color of the diseased spots is at first pale green or grayish brown, and then gradually turns into gray or greenish gray in the inner region with a border of somewhat deeper color such as greenish brown. When the diseased stems are examined after their death, the spots are found to be "Buffy Brown"⁽³⁶⁾ and to differ clearly from the "Cream Color" of the healthy portion. The diseased plants change color to brown in the ripening period and fall to the ground.

The sclerotia of the causal fungus produced on the spots fall off very easily. It is, therefore, very difficult to find them on the stem except in the early morning or after a rain.

2. Symptoms of the disease caused by *Sclerotium* *Oryzae-sativae* SAWADA

Sclerotium Oryzae-sativae SAWADA was first described by SAWADA⁽³⁴⁾ in 1923, but he had not proved its pathogenicity to the rice plant experimentally. The fungus attacks the leaf sheath and culm, especially the part near the ground, under natural conditions. In 1927 HEMMI⁽⁴⁷⁾ proved experimentally the pathogenicity of the fungus on the root of rice seedlings. The writer obtained the same results under natural conditions and also confirmed experimentally its pathogenicity to the leaf sheath and the stem near the ground. Under natural conditions, especially in Hokkaido, the affected portions are often found on the stem at the height of about 40 cm. above the ground.⁽²⁷⁾ The color of the spots is pale brown with a brown border, and numerous brown sclerotia are produced in the tissue of the leaf sheath and the culm. The affected plants break down at the lower part of the stem and die.

According to the writer's experiments the pathogenicity of the fungus to the parts mentioned above seems to be greater than that of *Sclerotium hydrophilum*.

3. Symptoms of the disease caused by *Sclerotium hydrophilum* SACC.

The fungus was first noted by SAKURAI⁽⁸⁹⁾ in 1915, and NAKATA⁽⁷⁹⁾ described it under the new name *Sclerotium sphaeroides* NAKATA in his work, without giving its diagnosis, while recently NAKATA⁽⁸⁰⁾ adopted the name *Sclerotium hydrophilum* SACC. for the fungus. SAKURAI⁽⁸⁹⁾ stated that the affected plants showed little difference from healthy ones and that few sclerotia were produced in the tissue of the diseased stem. The writer carried out inoculation experiments as many as 23 times on full grown plants and seedlings of rice in 1927 and 1928. The experiments yielded mostly negative results, except for the cases when the sclerotia were inserted into the tissue of the leaf sheath through wounds made with a sterilized needle and when inoculated on the weakened plant. The writer, therefore, comes to the conclusion that the pathogenicity of the fungus to the leaf sheath and the root of the rice plant seems to be very weak.

Under natural conditions, the fungus develops most vigorously from early September to the ripening season of the rice plant in the southern part of Japan. The blackish brown sclerotia generally appear in a small number in the tissues on the under surface of the discolored leaf sheath, but rarely on the surface of the stem.

4. Symptoms of the disease caused by *Leptosphaeria Salvinii* CAVARA

In 1877, *Sclerotium Oryzae* CATT. was first found by CATTANEO.⁽⁸⁾ In Japan the fungus was stated by SAKURAI⁽⁸⁹⁾ to belong to his *Sclerotium* No. 4 which has been accepted by several workers for many years. However, recently NAKATA and KAWAMURA⁽⁸¹⁾ identified SAKURAI's *Sclerotium* No. 3 with *Sclerotium Oryzae* of CATTANEO. The writer also confirmed the fact by examining the original description of CATTANEO. In 1933, TULLIS⁽¹⁰³⁾ published a paper on this fungus applying the name *Leptosphaeria Salvinii* CAVARA (*Helminthosporium sigmoideum* CAV.).

In Japan, the pathogenicity of the fungus to rice plants was first noted by SAKURAI⁽⁸⁹⁾, but the grade of pathogenicity remained in question. The writer, therefore, proved by experiments that the fungus attacks the leaf sheath, the culm, the ligule and root. Under natural conditions, the fungus attacks the culm and leaf sheath of rice plants showing irregular dark spots and produces numerous small blackish sclerotia in their tissues. The diseased plants break down at the lower part of the stem and die.

5. Symptoms of the disease caused by *Helminthosporium sigmoideum* Cav. var. *irregulare* Cr. et Tull.

As stated in the preceding section, the fungus was first found in Japan by SAKURAI⁽⁸⁹⁾ and described as *Sclerotium Oryzae* Catt. However, as a result of recent investigations it has been verified that *Sclerotium Oryzae* is identical with SAKURAI's *Sclerotium* No. 3. In 1935 CRALLY and TULLIS⁽¹⁰⁾ published a paper on the present fungus calling it *Helminthosporium sigmoideum* Cav. var. *irregulare* CRALLY et TULLIS. The fungus attacks the leaf sheath and the culm of the rice plant showing dark spots, and numerous sclerotia are produced in the tissues of the diseased parts. The symptoms are quite similar with those caused by *Leptosphaeria Salvinii* but the sclerotia of the present fungus are smaller and more irregular in shape than those of the latter, and their tissues are not differentiated into outer and inner parts.

6. Symptoms of the disease caused by *Sclerotium fumigatum* NAKATA

This fungus was first found by NAKATA⁽⁷⁹⁾ and described under the new name *Sclerotium fumigatum* NAKATA. However, its latin diagnosis has not yet been published. The fungus attacks the leaf sheath and the leaf blade in September. When it attacks plants severely, numerous grayish brown sclerotia are produced on the diseased parts and the plants mostly fall and die eventually.

According to the writer's experiment, the pathogenicity of the fungus to the rice plant is somewhat weaker than that of *Corticium Sasakii*.

7. Symptoms of the disease caused by *Corticium Rolfsii* (Sacc.) Curzi*

The fungus attacks the leaf blade, the leaf sheath, the culm and the root; it has never been found under natural conditions in paddy rice fields in Japan, but frequently observed in upland fields. The diseased spots appear both on the leaf blade and the leaf sheath. The spots are at first elongated and brown, and later their inner regions become discolored and change into grayish brown with a brown border. By experiments the writer has proved the pathogenicity of the fungus to rice seedlings and found that the fungus attacks not only the aerial parts, but also the root and that it grows vigorously

* The name, *Hypochnus centrifugus* (LÉV.) TUL. (*Corticium centrifugum* (LÉV.) BRES., has long been used to denote the perfect stage of *Sclerotium Rolfsii* SACC. by many Japanese pathologists, but recently CURZI proposed to adopt the name *Corticium Rolfsii* (SACC.) CURZI for the fungus.

in the soil covering the stem near the ground with white mycelium. The affected seedlings having poor roots may turn yellow and die.

8. Symptoms of the disease caused by *Sclerotium japonicum*

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This fungus was first found on *Phyllostachys reticulata* C. KOCH. and its pathogenicity to the rice plant was proved by the writer and his coworker.⁽⁴⁵⁾ However the fungus has not yet been noticed on the rice plant under natural conditions. According to the writer's inoculation experiments, the leaf sheath of the rice plant is very susceptible to its attacks producing elongated brown spots.

III. Overwintering of the causal fungi

There are three possible way in which the causal fungi of Sclerotium diseases of rice plant survive over the winter: (1) in the form of sclerotia, (2) in the form of mycelia or (3) in the form of spores (Basidiospores in the case of *Corticium Sasakii* and *Corticium Rolfsii*. Conidia in the case of *Leptosphaeria Salvinii* and *Helminthosporium sigmoideum* var. *irregulare*). According to the writer's observations on diseased rice plants under natural conditions, the basidiospores are rarely found in general. The conidia of *Leptosphaeria Salvinii* and *Helminthosporium sigmoideum* var. *irregulare* are found on sclerotia floating on the surface of water. Therefore, it may be naturally considered that these fungi usually overwinter in the form of sclerotia or mycelia. The writer studied their ability of overwintering, in the laboratory and also under natural conditions, using the sclerotia or mycelia. The results have already been reported.⁽⁴⁷⁾ A summary of the results formerly obtained as well as those of the later investigations are as follows.

1. Ability of the causal fungi to overwinter in the soil

Unglazed pots (10 cm. in diameter) containing field soil, were sterilized in autoclave, and then sclerotia or mycelia covered with clean camellia leaves were put in the soil. For each pot 20 sclerotia or 10 pieces of the fungous mycelia were used. After a certain number of months, the sclerotia or the mycelia were taken out of the soil and washed with distilled water. Then their viability was determined by culturing them on apricot decoction agar for two weeks at least.

(A) Experiments with *Corticium Sasakii*

The first preliminary experiment was made on December 25, 1925 and

the result showed that the viability of sclerotia lasts for ten months and that of mycelia for eight months. On December 25, 1926, the writer began the second experiment. The temperatures during the period are given in Table 1.

TABLE 1. Temperature from December 1926 to September 1927.

Month	Temperature (C.)			Month	Temperature (C.)		
	Minimum	Maximum	Average		Minimum	Maximum	Average
December, 1926	-0.52	9.37	3.66	May	9.75	22.92	16.33
January, 1927	-1.46	9.05	3.88	June	15.13	28.08	21.60
February	-2.29	7.87	2.84	July	22.20	32.70	27.19
March	1.01	12.55	6.70	August	21.60	31.39	26.57
April	6.11	19.96	12.90	September	19.26	26.60	21.93

The results of the experiment are tabulated as follows.

TABLE 2. The viability of *Corticium Sasakii* in the soil.

	Number of tests in each month	Number of living mycelial pieces or sclerotia after—							
		1.5	2	3	4	5	6	7	8 months
Mycelia	10	10	10	10	10	10	10	1	0
Sclerotia	20	—	—	—	20	20	15*	16*	15*

Remarks: "—" no test. * Number of sclerotia tested is the same as that of living sclerotia in the table.

To learn the relation between the depth of soil, in which the fungus was put, and the ability to overwinter, a third experiment was begun on December 1, 1927, using three culture strains, namely, No. 7, No. 13 and No. 23. Three different depths of soil, namely 2 cm., 5 cm. and 10 cm. were tested. The soil temperatures during the period are given in Table 3.

TABLE 3. Soil temperature from December 1927 to May 1928

Month	Soil temperature at —								
	2 cm. depth			5 cm. depth			10 cm. depth		
	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
December, 1927	2.0	8.0	5.64	3.0	9.7	6.53	3.5	10.2	7.23
January, 1928	0	3.5	0.94	1.0	4.0	2.08	1.5	4.5	2.61
February	0	3.0	1.11	1.0	3.5	2.00	1.5	3.5	2.45
March	1.5	5.0	2.83	2.0	5.5	3.71	2.5	7.5	4.92
April	3.0	13.5	6.79	4.0	14.5	8.11	5.0	14.5	9.53
May	9.0	15.0	13.13	9.0	17.5	14.58	13.0	19.0	15.45

The results of the experiment are tabulated as follows.

TABLE 4. The viability of the sclerotia of *Corticium Sasakii* in the soil

Number of months elapsed	Depth of soil	Number of sclerotia tested from each culture strain	Number of living sclerotia—		
			Culture strain No. 7	Culture strain No. 13	Culture strain No. 23
1	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
2	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
3	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
4	2 cm.	20	20	20	20
	5 cm.	20	19	20	20
	10 cm.	20	20	20	20
5	2 cm.	20	20	20	19
	5 cm.	20	20	19	20
	10 cm.	20	20	20	20
6	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20

TABLE 5. The viability of the mycelia of *Corticium Sasakii* in the soil

Number of months elapsed	Depth of soil	Number of mycelial pieces tested from each culture strain	Number of living mycelial pieces of—		
			Culture strain No. 7	Culture strain No. 13	Culture strain No. 23
1	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
2	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
3	2 cm.	10	9	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
4	2 cm.	10	9	9	10
	5 cm.	10	8	10	10
	10 cm.	10	9	9	10
5	2 cm.	10	8	10	9
	5 cm.	10	9	10	10
	10 cm.	10	9	9	10
6	2 cm.	10	10	8	9
	5 cm.	10	9	9	9
	10 cm.	10	9	9	10

In these three experiments, not only the sclerotia through all the culture strains but also the mycelia have the ability to overwinter in the soil. In general, when they were put on culture media, the mycelia developed after 2 days and formed sclerotia after 10 days.

(B) Experiments with *Sclerotium Oryzae-sativae*

On December 3, 1926, the first experiment was started in the same way as in the case of *Corticium Sasakii*. The results obtained are given in Table 6.

TABLE 6. The viability of the mycelia and the sclerotia of *Sclerotium Oryzae-sativae* in the soil

Number of months elapsed	1.5	2	3	4	5	6	7	8	9
Number of mycelial pieces tested	10	10	20	30	40	20	20	20	20
Number of living mycelial pieces	6	4	1	1	1	1	1	1	1
Number of sclerotia tested	20	20	—	—	—	—	—	—	—
Number of living sclerotia	17	10	—	—	—	—	—	—	—

Remarks: "—" no test.

To learn the relation of viability of the fungus to the depth of soil, in which the fungus was put, the second experiment was begun on December 1, 1927. In this case, three culture strains, namely, No. 2, No. 5 and No. 7 were used. The results obtained are given in Tables 7 and 8.

TABLE 7. The viability of the mycelia of *Sclerotium Oryzae-sativae* in the soil

Number of months elapsed	Depth of soil	Number of mycelial pieces tested from each culture strain	Number of living mycelial pieces of—		
			Culture strain No. 2	Culture strain No. 5	Culture strain No. 7
1	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
2	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
3	2 cm.	10	8	9	10
	5 cm.	10	8	10	9
	10 cm.	10	9	10	10
4	2 cm.	10	5	5	7
	5 cm.	10	6	5	6
	10 cm.	10	5	7	7
5	2 cm.	10	5	4	3
	5 cm.	10	4	5	4
	10 cm.	10	5	5	4
6	2 cm.	10	2	2	2
	5 cm.	10	3	2	2
	10 cm.	10	3	2	3

TABLE 8. The viability of the sclerotia of *Sclerotium Oryzae-sativae* in the soil

Number of months elapsed	Depth of soil	Number of sclerotia tested from each culture strain	Number of living sclerotia of—		
			Culture strain No. 2	Culture strain No. 5	Culture strain No. 7
1	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
2	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20

TABLE 8. (Continued)

Number of months elapsed	Depth of soil	Number of sclerotia tested from each culture strain	Number of living sclerotia of—		
			Culture strain No. 2	Culture strain No. 5	Culture strain No. 7
3	2 cm.	20	20	19	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
4	2 cm.	20	19	20	20
	5 cm.	20	19	18	20
	10 cm.	20	20	20	20
5	2 cm.	20	18	16	18
	5 cm.	20	18	17	17
	10 cm.	20	19	17	18
6	2 cm.	20	17	18	16
	5 cm.	20	18	18	18
	10 cm.	20	19	17	18

From these results, it is evident that the mycelia and the sclerotia of *Sclerotium Oryzae-sativae* are able to overwinter in the soil at least in the vicinity of Kyoto.

(C) Experiments with *Sclerotium hydrophilum* Sacc.

To determine the viability of sclerotia of the fungus in soil, the first experiment was started on December 3, 1926, using culture strain No. 1. The results obtained are tabulated in the following table.

TABLE 9. The viability of the sclerotia of *Sclerotium hydrophilum* in the soil

Number of months elapsed	1.5	2	3	4	5	6	7	8	9	10
	Number of sclerotia tested	20	20	20	20	20	20	20	20	20
Number of living sclerotia	20	18	15	20	20	20	20	20	20	5

A similar experiment was also begun on December 1, 1927, using three culture strains, namely, No. 1, No. 3 and No. 9. In this case, the viability of the fungus in three different soil depths was tested. The results obtained are shown in Tables 10 and 11.

TABLE 10. The viability of the mycelia of *Sclerotium hydrophilum* in the soil

Number of months elapsed	Depth of soil	Number of mycelial pieces tested from each culture strain	Number of living mycelial pieces of—		
			Culture strain No. 1	Culture strain No. 3	Culture strain No. 9.
1	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
2	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
3	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10

TABLE 10. (Continued)

Number of months elapsed	Depth of soil	Number of mycelial pieces tested from each culture strain	Number of living mycelial pieces of—		
			Culture strain No. 1	Culture strain No. 3	Culture strain No. 9
4	2 cm.	10	9	10	9
	5 cm.	10	10	10	9
	10 cm.	10	10	10	10
5	2 cm.	10	8	9	8
	5 cm.	10	10	9	9
	10 cm.	10	10	10	9
6	2 cm.	10	9	8	9
	5 cm.	10	9	9	10
	10 cm.	10	9	9	10

TABLE 11. The viability of the sclerotia of *Sclerotium hydrophilum* in the soil

Number of months elapsed	Depth of soil	Number of sclerotia tested from each culture strain	Number of living sclerotia of—		
			Culture strain No. 1	Culture strain No. 3	Culture strain No. 9
1	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
2	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
3	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
4	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
5	2 cm.	20	20	19	20
	5 cm.	20	19	19	20
	10 cm.	20	20	20	20
6	2 cm.	20	18	19	18
	5 cm.	20	18	19	20
	10 cm.	20	19	19	19

From the results above shown, it is clear that the mycelia and the sclerotia of *Sclerotium hydrophilum* have the ability to overwinter in the soil in the vicinity of Kyoto.

(D) Experiments with *Leptosphaeria Salvinii*

On December 3, 1926, the first experiment was commenced using culture strain No. 1. The results obtained are shown in Table 12.

TABLE 12. The viability of the sclerotia of *Leptosphaeria Salvinii* in the soil

Number of months elapsed	1.5	2	3	4	5	6	7	8	9
Number of sclerotia tested	20	20	20	20	20	20	20	20	20
Number of living sclerotia	20	10	10	5	10	2	1	4	9

A similar experiment was begun on December 1, 1927, using the mycelia and the sclerotia of three different culture strains, namely, No. 1, No. 2 and No. 5. The results obtained are given in Tables 13 and 14.

TABLE 13. The viability of the mycelia of *Leptosphaeria Salvinii* in the soil

Number of months elapsed	Depth of soil	Number of mycelial pieces tested from each culture strain	Number of pieces of living mycelia of—		
			Culture strain No. 1	Culture strain No. 2	Culture strain No. 5
1	2 cm.	10	6	7	8
	5 cm.	10	8	8	9
	10 cm.	10	8	9	7
2	2 cm.	10	7	6	8
	5 cm.	10	6	7	7
	10 cm.	10	8	8	8
3	2 cm.	10	4	5	4
	5 cm.	10	5	4	5
	10 cm.	10	5	6	4
4	2 cm.	10	2	3	4
	5 cm.	10	2	2	4
	10 cm.	10	4	3	3
5	2 cm.	10	0	0	0
	5 cm.	10	0	0	0
	10 cm.	10	0	0	0
6	2 cm.	10	0	0	0
	5 cm.	10	0	0	0
	10 cm.	10	0	0	0

TABLE 14. The viability of the sclerotia of *Leptosphaeria Salvinii* in the soil

Number of months elapsed	Depth of soil	Number of sclerotia tested from each culture strain	Number of living sclerotia of—		
			Culture strain No. 1	Culture strain No. 2	Culture strain No. 5
1	2 cm.	20	16	17	19
	5 cm.	20	18	17	18
	10 cm.	20	18	19	19
2	2 cm.	20	17	16	15
	5 cm.	20	15	16	18
	10 cm.	20	17	17	16
3	2 cm.	20	13	16	15
	5 cm.	20	14	15	15
	10 cm.	20	15	14	16
4	2 cm.	20	14	13	14
	5 cm.	20	15	15	14
	10 cm.	20	14	14	16
5	2 cm.	20	10	8	10
	5 cm.	20	11	9	12
	10 cm.	20	10	9	11
6	2 cm.	20	8	9	7
	5 cm.	20	8	10	8
	10 cm.	20	7	8	9

From these experiments it is evident that *Leptosphaeria Salvinii* in the soil has the ability to overwinter. However, the mycelia survive only for 4 months and die within 5 months under the above conditions.

(E) Experiments with *Corticium Rolfsii*

Starting on December 25, 1925, the first experiment was made using

TABLE 15. The viability of the mycelia and the sclerotia of *Corticium Rolfsii* in the soil

Number of months elapsed	Experiment on mycelia		Experiment on sclerotia	
	Number of mycelial pieces tested	Number of living mycelial pieces	Number of sclerotia tested	Number of living sclerotia
1	10	10	—	—
2	10	10	—	—
3	10	10	—	—
4	10	10	20	20
5	10	10	20	20
6	10	10	20	18
7	10	10	20	20
8	10	4	20	20
9	10	5	20	17
10	10	0	—	—

Remarks: "—" no test

TABLE 16. The viability of the mycelia of *Corticium Rolfsii* in the soil

Number of months elapsed	Depth of soil	Number of mycelial pieces tested from each culture strain	Number of living mycelial pieces of—		
			Culture strain No. 6	Culture strain No. 17	Culture strain No. 20
1	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
2	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
3	2 cm.	10	10	10	10
	5 cm.	10	10	10	10
	10 cm.	10	10	10	10
4	2 cm.	10	9	10	9
	5 cm.	10	9	9	10
	10 cm.	10	10	10	10
5	2 cm.	10	9	9	8
	5 cm.	10	9	10	9
	10 cm.	10	9	10	9
6	2 cm.	10	8	9	8
	5 cm.	10	8	10	9
	10 cm.	10	9	8	8

culture strain No. 1. It was found that both the sclerotia and the mycelia retain viability for 8 months in the soil at least in the vicinity of Kyoto. The second experiment was started on December 3, 1926, using the same strain as in the first. The results obtained are shown in Table 15.

The third experiment was begun on December 1, 1927, using three culture strains, namely, No. 6, No. 17 and No. 20. In this case, the relation between the viability of the fungus and the depth of the soil, in which the fungus was buried, was tested. The results obtained are shown in Tables 16 and 17.

TABLE 17. The viability of the sclerotia of *Corticium Rolfsii* in the soil

Number of months elapsed	Depth of soil	Number of sclerotia tested from each culture strain	Number of living sclerotia of—		
			Culture strain No. 6	Culture strain No. 17	Culture strain No. 20
1	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
2	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
3	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
4	2 cm.	20	20	20	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
5	2 cm.	20	20	19	20
	5 cm.	20	20	20	20
	10 cm.	20	20	20	20
6	2 cm.	20	19	20	20
	5 cm.	20	19	19	20
	10 cm.	20	20	20	20

The results show clearly that both the mycelia and the sclerotia of *Corticium Rolfsii* are able to overwinter in the soil of the Kyoto region.

2. Overwintering of the causal fungi under natural conditions

The writer tested the mode and ability of overwintering of the causal fungi under natural conditions and obtained the following results.

(A) Overwintering of *Sclerotium hydrophilum*

The sclerotia of the fungus were collected in a paddy rice field at Miyakehatiman in Kyoto on March 2, April 30 and May 28, 1928, and their viability

was tested by culturing them on apricot decoction agar, using ten sclerotia each time. The results showed that they were all surely alive.

(B) Overwintering of *Leptosphaeria Salvinii*

The fungus overwinters on rice stubble and in rice straw. In the irrigated field, which is left untilled after harvest till the following May without planting any crops, the stubbles decay with time and the sclerotia in the stubble distribute into the soil. The writer chose a field at Miyakehatiman in Kyoto as an experimental field, where the stubbles about 10 cm. high were left, as they stand. The sclerotia were collected from the stubble on February 19, April 28 and May 28, 1928, for the purpose of testing their viability by culturing them on apricot decoction agar. In all experiments, 10 sclerotia were used each time. In all cases the results showed that they were all alive. The reaction of the water in this field was pH 4.6, when tested on May 28, 1928. The same experiments performed at Mototanaka and Itizyôzi in Kyoto showed similar results.

In the dry field in the Kyoto region, barley and other crops are commonly sown after the rice is harvested, and the rice stubble is plowed into the soil, or left to decay on the ground in winter. The writer chose a field near Tyayama in Kyoto as an experimental field. The sclerotia were collected on September 19, 1927, April 30 and May 30, 1928, from the stubble left untouched on the ground. In all cases the sclerotia tested were all alive. On February 23, 1929, the writer tested also the viability of the sclerotia overwintered in the stubble left untouched on the ground in a dry field at Unebi, Nara Prefecture. It was proved that all the sclerotia were alive.

In the next experiment, the viability of the sclerotia overwintered in diseased straws kept in a storehouse or of out doors, were tested. The sclerotia from the storehouse were planted on apricot decoction agar on April 20 and May 28, 1928, while those from the field were planted on April 20 of the same year. In all cases they proved to be alive. The sclerotia in straw left on the field at Unebi, Nara Prefecture, was also tested on February 25, 1929, and was found to be perfectly alive.

From the results above stated, it is clear that the sclerotia of the fungus possess the ability to overwinter in the stubble in both the dry and irrigated fields and also in the straw kept in a storehouse or left on the field.

(C) Overwintering of *Helminthosporium sigmoideum* var. *irregularare*

On February 22, 1929, the writer collected 10 sclerotia of this fungus from

rice stubble at Tyayama in Kyoto and found that these sclerotia were still alive. Similar results were obtained by the sclerotia collected from the straw left on the field at Miyazaki on June 8, 1934.

(D) Overwintering of *Sclerotium Oryzae-sativae*

The viability of the sclerotia of this fungus found in rice stubble in the paddy rice field at Miyakehatiman in Kyoto was tested on October 29, 1927 and on May 28, 1928. In all cases, these sclerotia retained their viability. The reaction of the water of the field showed pH 4.6 in the latter.

(E) Overwintering of *Sclerotium fumigatum*

On July 5, 1928, the writer tested the viability of the sclerotia on rice straw kept in a storehouse in Kyoto during the winter. All sclerotia tested were alive.

From the above experiments it is evident that *Leptosphaeria Salvinii* and *Helminthosporium sigmoideum* var. *irregulare* overwinter both in the stubble and in the straw. The writer also proved that *Sclerotium Oryzae-sativae* hibernates in the stubble, while *Sclerotium hydrophilum* and *Sclerotium fumigatum* overwinter in the straw.

IV. Influence of environmental factors upon the growth of mycelia, formation of sclerotia and viability of the causal fungi, and upon the occurrence and severity of the diseases

1. Influence of environmental factors upon the growth of mycelia

(A) Influence of hydrogen-ion concentrations

Investigation on the effect of hydrogen-ion concentration on the growth of mycelia of the causal fungi of Sclerotium diseases of the rice plant is considered to be very important in applying to a change of soil reaction for control of the diseases. The writer performed some experiments on this problem and has already reported the results⁽²⁹⁾.

Potato decoction was prepared using redistilled water, and controlled for different pH values with N/10 solutions of hydrochloric acid and of sodium hydroxide. In this experiment 100 cc. ERLLENMYER'S flasks were used, each containing 30 cc. of the medium. A sclerotium of the fungus to be tested was transplanted into each flask and incubated at 28°C. After a certain

number of days the cultures were filtered through filter paper and the reactions of the filtrates were tested. In this case the contents of three flasks of

TABLE 18. Influence of hydrogen-ion concentrations on the growth of mycelium of *Corticium Sasakii*

pH value of medium prepared			pH value of filtrate			Average dry weight of mycelium grown in a flask (gm.)		
1st exp.	2nd exp.	3rd exp.	1st exp.	2nd exp.	3rd exp.	1st exp.	2nd exp.	3rd exp.
2.46	2.57	2.39	2.46	2.65	2.39	0	0.002	0
2.72	2.73	2.47	2.72	2.82	2.47	0.030	0.007	0
2.96	3.24	2.65	3.13	3.43	2.65	0.050	0.016	0.005
3.72	3.77	3.43	4.14	4.12	4.03	0.113	0.012	0.020
4.14	4.12	3.86	5.73	4.46	4.46	0.198	0.016	0.023
4.57	4.53	4.21	6.32	4.81	5.00	0.190	0.033	0.025
5.23	5.16	4.64	6.58	5.59	5.52	0.245	0.048	0.035
5.73	5.51	5.44	7.17	6.11	5.96	0.285	0.100	0.140
5.91	5.77	5.61	6.91	6.20	5.78	0.295	0.105	0.075
6.67	6.29	6.48	6.67	6.37	4.38	0.315	0.085	0.070
6.82	6.55	6.60	7.07	6.46	4.55	0.223	0.058	0.070
7.07	7.33	6.74	7.34	6.72	6.22	0.170	0.055	0.053
7.76		7.08	7.34		6.22	0.167		0.048
7.85		7.26	7.85		6.39	0		0.035

Remarks: The culture period of the fungus was 5 days in the first experiment, and 3 days in the others.

TABLE 19. Influence of hydrogen-ion concentrations on the growth of mycelium of *Sclerotium Oryzae-sativae*

pH value of medium prepared			pH value of filtrate			Average dry weight of mycelium grown in a flask (gm.)		
1st exp.	2nd exp.	3rd exp.	1st exp.	2nd exp.	3rd exp.	1st exp.	2nd exp.	3rd exp.
2.40	2.40	2.39	2.40	2.40	2.39	0	0	0
2.58	2.58	2.58	2.58	2.58	2.58	0	0	0
2.84	2.67	2.93	2.84	2.67	3.01	0.008	0.003	0.005
3.12	3.27	3.55	3.01	3.37	3.64	0.019	0.010	0.020
3.72	3.64	3.72	3.83	3.72	3.72	0.028	0.030	0.068
4.17	4.24	4.41	4.35	4.33	4.61	0.058	0.040	0.095
5.68	5.13	5.30	5.68	5.13	5.39	0.040	0.025	0.065
5.96	5.75	5.84	5.56	5.75	5.66	0.038	0.022	0.063
7.27	6.18	6.10	6.30	6.10	5.45	0.015	0.020	0.045
7.59	7.07	6.95	6.39	6.95	6.55	0.010	0.015	0.017
7.67	7.61	7.33	5.33	7.15	7.00	0.005	0.008	0.008
7.99	7.69	7.86	6.67	7.60	7.62	0.004	0.002	0.007
8.26	8.30	8.30	5.87	8.30	8.30	0.001	0	0
	8.49	8.49		8.49	8.49		0	0

Remarks: The culture period of the fungus was 6 days in each experiment.

the same pH value were mixed altogether. The dry weight of these mycelial masses were then determined. The results obtained are summarized in Tables 18-24.

TABLE 20. Influence of hydrogen-ion concentrations on the growth of mycelium of *Sclerotium hydrophilum*

pH value of medium prepared			pH value of filtrate			Average dry weight of mycelium grown in a flask (gm.)		
1st exp.	2nd exp.	3rd exp.	1st exp.	2nd exp.	3rd exp.	1st exp.	2nd exp.	3rd exp.
2.30	2.13	2.21	2.30	2.13	2.21	0	0	0
2.39	2.21	2.47	2.39	2.21	2.47	0	0	0
2.84	2.58	2.56	2.84	2.58	2.56	0	0	0
3.18	2.67	3.27	3.46	2.84	3.53	0.028	0.005	0.015
3.89	3.20	3.62	3.98	3.29	3.98	0.080	0.018	0.015
4.51	4.17	4.24	5.14	4.43	5.02	0.110	0.127	0.055
5.63	5.06	5.02	6.11	5.52	5.39	0.150	0.107	0.078
6.03	6.13	5.56	6.37	5.97	5.73	0.160	0.148	0.078
6.29	6.56	5.99	6.19	5.89	5.73	0.090	0.130	0.148
7.53	7.64	6.70	6.29	6.43	5.91	0.076	0.120	0.115
7.72	7.81	7.31	6.91	6.77	6.08	0.068	0.120	0.110
7.79	7.90	7.40	7.08	6.88	5.99	0.025	0.020	0.115
8.05	8.35	7.66	8.05	7.19	5.82	0.005	0.080	0.048
8.23	8.52	7.85	8.23	7.12	6.53	0.001	0.075	0.028

Remarks: The culture period of the fungus was 5 days in the first experiment and 4 days in the others.

TABLE 21. Influence of hydrogen-ion concentrations on the growth of mycelium of *Leptosphaeria Salvinii*

pH value of medium prepared				pH value of filtrate				Average dry weight of mycelium grown in a flask (gm.)			
1st exp.	2nd exp.	3rd exp.	4th exp.	1st exp.	2nd exp.	3rd exp.	4th exp.	1st exp.	2nd exp.	3rd exp.	4th exp.
4.22	3.86	3.03	2.46	6.95	4.43	3.03	2.46	0.099	0.003	0	0
4.48	4.28	3.27	2.70	7.43	4.87	3.27	2.70	0.105	0.033	trace	0
4.66	4.43	3.69	3.20	7.52	4.93	3.86	3.24	0.115	0.035	0.013	0.015
5.07	4.88	4.19	4.41	7.21	5.75	4.76	6.95	0.144	0.043	0.020	0.100
5.71	5.02	4.48	5.00	7.27	6.08	5.66	7.53	0.115	0.038	0.031	0.135
6.10	5.18	5.51	5.94	6.95	6.25	5.91	7.03	0.085	0.048	0.045	0.139
6.46	5.26	5.75	6.82	6.94	6.82	6.56	7.96	0.071	0.033	0.030	0.116
6.88	5.42	6.17	7.15	6.75	6.82	6.86	8.28	0.071	0.045	0.031	0.115
	5.51	6.74	7.45		5.26	7.04	7.79		0.020	0.031	0.103
	6.08	7.24	8.24		5.18	7.22	8.07		0.020	0.025	0.090
	6.34	7.31	8.64		6.67	7.40	7.92		0.015	0.017	0.050
	6.36	7.48	8.73		6.75	7.40	8.07		0.010	0.016	0.050
	7.21	7.55	9.01		7.10	7.50	8.37		0.003	0.015	0.015
	7.24	7.66			7.17	7.64			trace	0.006	

Remarks: The culture period of the fungus was 4 days in the first and fourth experiments, and 2 days in the second and third.

TABLE 22. Influence of hydrogen-ion concentrations on the growth of mycelium of *Sclerotium fumigatum*

pH value of medium prepared				pH value of filtrate				Average dry weight of mycelium grown in a flask (gm.)			
1st exp.	2nd exp.	3rd exp.	4th exp.	1st exp.	2nd exp.	3rd exp.	4th exp.	1st exp.	2nd exp.	3rd exp.	4th exp.
3.86	3.03	2.46	3.17	3.89	3.10	2.37	3.24	0.028	0.005	0	0.020
4.28	3.27	2.70	4.35	4.22	3.37	2.70	4.43	0.035	0.017	0.003	0.025
4.43	3.69	3.20	4.09	4.40	3.84	3.27	4.09	0.038	0.022	0.010	0.025
4.88	4.19	4.41	4.48	4.81	4.41	4.43	4.43	0.045	0.024	0.018	0.020
5.02	4.48	5.00	4.59	4.99	5.23	5.26	4.54	0.040	0.021	0.020	0.030
5.18	5.51	8.73	5.10	5.06	5.56	8.23	5.01	0.050	0.033	0.010	0.025
5.26	5.75	9.01	5.37	5.40	6.39	7.85	5.32	0.035	0.028	0	0.040
5.42	6.17		5.75	4.99	6.56		5.68	0.035	0.025		0.055
5.51	6.74		5.96	5.45	6.66		5.71	0.050	0.024		0.050
6.08	7.24		7.07	5.80	6.88		6.56	0.043	0.025		0.025
6.34			7.24	5.94			6.74	0.050			0.035
6.36			7.52	6.25			6.91	0.033			0.030
7.21			7.92	7.17			7.21	0.035			0.030
7.24			8.60	7.95			7.34	0.010			0.025

Remarks: The culture period of the fungus was 3 days in the first and fourth experiments, and 2 days in the second and third.

TABLE 23. Influence of hydrogen-ion concentrations on the growth of mycelium of *Corticium Rolfsii*

pH value of medium prepared				pH value of filtrate				Average dry weight of mycelium grown in a flask (gm.)			
1st exp.	2nd exp.	3rd exp.	4th exp.	1st exp.	2nd exp.	3rd exp.	4th exp.	1st exp.	2nd exp.	3rd exp.	4th exp.
2.54	2.21	2.21	3.17	2.37	2.21	2.18	2.99	0.115	0.058	0.175	0.050
2.70	2.39	2.34	4.35	2.54	2.25	2.21	3.72	0.125	0.083	0.115	0.050
3.52	2.42	3.01	4.09	2.61	2.30	2.70	2.65	0.167	0.110	0.215	0.140
3.67	2.67	3.29	4.48	2.54	2.49	2.84	3.08	0.152	0.118	0.360	0.190
3.86	3.01	3.83	4.59	2.37	2.49	2.92	3.08	0.160	0.120	0.158	0.150
4.45	3.64	4.80	5.11	2.37	2.58	3.20	2.99	0.165	0.150	0.120	0.140
5.19	4.52	4.62	5.37	2.37	2.67	4.00	3.93	0.168	0.145	0.148	0.120
5.63	6.11	4.88	5.75	2.37	2.70	2.58	3.95	0.168	0.095	0.095	0.120
5.81	6.63	5.33	5.96	2.54	2.75	2.67	3.24	0.165	0.100	0.065	0.140
6.25	7.34	5.77	7.07	2.37	3.89	3.01	5.07	0.126	0.055	0.070	0.050
6.41	7.53	6.30	7.24	2.37	5.61	3.01	4.55	0.123	0.055	0.075	0.040
6.69	7.62	6.75	7.52	2.61	5.75	2.58	4.75	0.131	0.043	0.055	0.010
7.26	7.79	7.47	7.92	7.26	6.63	4.54	7.71	trace	0.030	0.033	0.008
7.68	7.92	7.85	8.60	7.68	7.17	6.13	8.50	0	0	0.010	0

Remarks: The culture period of the fungus was 4 days in the first and second experiments, and 3 days in the third and fourth.

TABLE 24. Influence of hydrogen-ion concentrations on the growth of mycelium of *Sclerotium japonicum*

pH value of medium prepared				pH value of filtrate				Average dry weight of mycelium grown in a flask (gm.)			
1st exp.	2nd exp.	3rd exp.	4th exp.	1st exp.	2nd exp.	3rd exp.	4th exp.	1st exp.	2nd exp.	3rd exp.	4th exp.
4.03	3.86	3.03	2.46	3.79	3.79	3.03	2.46	0.118	0.078	0.008	0
4.22	4.28	3.27	2.70	4.03	4.09	3.27	2.70	0.113	0.070	0.015	0.010
4.48	4.43	3.69	3.20	4.54	4.26	3.53	3.12	0.165	0.078	0.058	0.043
4.66	4.88	4.19	4.41	4.71	4.38	4.68	4.35	0.158	0.106	0.095	0.110
5.07	5.02	4.48	5.00	5.26	4.68	5.09	5.18	0.173	0.078	0.113	0.150
5.33	5.18	5.51	5.93	5.18	4.97	5.42	5.75	0.173	0.083	0.115	0.140
5.56	5.26	5.75	6.82	5.44	4.97	5.75	6.34	0.188	0.105	0.088	0.130
5.61	5.42	6.17	7.15	5.78	5.23	5.94	5.35	0.170	0.088	0.118	0.103
5.71	5.51	6.74	7.45	6.32	5.06	6.17	5.75	0.195	0.113	0.110	0.100
6.10	6.08	7.24	7.76	5.94	5.56	6.17	6.43	0.190	0.113	0.111	0.100
6.88	6.34	7.31	8.24	6.11	5.73	6.39	7.08	0.188	0.080	0.080	0.098
7.53	6.36	7.48	8.64	6.37	5.23	6.82	7.33	0.170	0.070	0.080	0.088
7.92	7.21	7.55	8.73	6.46	6.30	6.56	8.27	0.118	0.040	0.086	0.015
	7.24	7.66	9.01		6.89	6.58	8.34		0.005	0.077	0.008

Remarks: The culture period of the fungus was 3 days in the first experiment and 2 days in the others.

As shown in the above tables, the mycelium of *Corticium Sasakii* is able to grow between pH 2.57 and pH 7.76 and most vigorously in the medium ranging from pH 5.44 to pH 6.67. *Sclerotium Oryzae-sativae* grows between pH 2.67 and pH 8.26, but the optimum hydrogen-ion concentration for its growth seems to lie between pH 4.17 and pH 4.41. *Sclerotium hydrophilum* grew slightly at pH 2.67 and pH 8.52; its vigorous growth took place in the medium ranging from pH 5.99 to pH 6.13. *Leptosphaeria Salvini* is able to grow between pH 3.20, and pH 9.01; its most vigorous growth was observed at the hydrogen-ion concentrations between pH 5.07 and pH 5.94. The growth of mycelium of *Sclerotium fumigatum* occurred slightly at pH 2.70 and also at pH 8.73, showing vigorous growth in the medium ranging from pH 5.51 to pH 5.75. *Corticium Rolfsii* showed the growth of mycelium at hydrogen-ion concentrations ranging from pH 2.21 to pH 7.92, with the optimum concentration between pH 3.29 and pH 5.63. The growth of mycelium of *Sclerotium japonicum* occurred between pH 2.70 and pH 9.01 showing the most vigorous growth in the medium ranging from pH 5.00 to pH 6.17.

(B) Influence of temperature

The influence of temperature upon the growth of mycelia of some causal

fungi of *Sclerotium* diseases of the rice plant was reported by HEMMI and YOKOGI⁽⁶⁹⁾ in 1927. They used sclerotia as inocula in their investigation. In order to know the influence of temperature on the growth of mycelia in

TABLE 25. Influence of temperature on the growth of mycelium of *Corticium Sasakii*

Strain used	Culture media used	Series of experiments	Average diameter of colonies after 2 days at—						
			10°C.	16°C.	20°C.	24°-25°C.	28°C.	32°C.	36°C.
Japanese strain	Apricot decoction agar	1st experiment	0.50	0.75	1.50	1.94	4.22	4.40	1.18
		2nd experiment	0.50	0.84	1.08	1.45	2.80	3.08	1.24
		3rd experiment	0.50	0.70	0.94	1.36	2.20	2.50	0.96
	Potato decoction agar	1st experiment	0.50	1.66	3.90	5.84	8.50*	8.44	1.70
		2nd experiment	0.50	1.62	4.00	7.44	8.50*	8.50	3.98
		3rd experiment	0.50	3.14	4.90	8.56*	8.50*	8.50*	3.28
	SARRO'S soy agar ⁽⁶⁸⁾	1st experiment	0.50	1.38	2.74	4.00	8.10	8.24	3.60
		2nd experiment	0.50	2.74	5.00	6.60	8.50*	8.50*	5.00
		3rd experiment	0.50	1.40	2.54	3.98	8.12	8.25	3.54
Philippine strain	Apricot decoction agar	1st experiment	0.50	0.64	0.84	1.10	1.26	2.08	0.58
		2nd experiment	0.50	1.74	2.82	5.34	7.12	6.64	1.92
		3rd experiment	0.50	0.60	0.60	1.40	2.54	3.04	1.50
	Potato decoction agar	1st experiment	0.50	0.72	0.90	0.94	3.50	3.76	0.76
		2nd experiment	0.50	1.12	3.58	3.86	8.50*	8.50*	2.46
		3rd experiment	0.50	2.08	3.52	4.70	8.50*	8.50*	3.84
	SARRO'S soy agar	1st experiment	0.50	1.02	1.40	2.92	6.32	6.34	4.00
		2nd experiment	0.50	1.54	3.14	4.92	8.50	8.50*	4.98
		3rd experiment	0.50	1.04	1.20	2.98	6.28	6.40	4.10

Remarks: * As the fungus colonies covered the whole surface of the medium the actual diameter would be greater than the figures given.

TABLE 26. Influence of temperature on the growth of mycelium of *Sclerotium Oryzae-sativae*

Culture media used	Series of experiments	Average diameter of colonies after 2 days at—							
		10°C.	16°C.	20°C.	24°C.	28°C.	32°C.	36°C.	40°C.
Rice straw decoction agar	1st experiment	0.60	1.68	2.90	4.56	6.30	4.82	0.80	0.50
	2nd experiment	0.60	2.10	2.95	4.20	5.57	5.02	0.80	0.50
	3rd experiment	0.70	2.17	3.33	5.12	6.45	6.18	0.85	0.50
Potato decoction agar	1st experiment	0.60	1.62	2.90	4.68	6.52	5.80	0.90	0.50
	2nd experiment	0.60	1.80	2.92	4.56	6.12	5.00	0.85	0.50
	3rd experiment	0.70	1.47	2.82	4.62	6.52	6.85	0.81	0.50
SARRO'S soy agar	1st experiment	0.50	1.10	1.75	2.95	4.20	3.65	0.65	0.50
	2nd experiment	0.56	1.40	1.85	3.08	3.95	4.38	0.80	0.50
	3rd experiment	0.50	1.17	1.95	2.80	3.98	4.42	0.70	0.50

the case of using a bit of mycelia (0.5 cm. in diam.) as inocula and on the development of mycelia from sclerotia, the present writer conducted some experiments on *Corticium Sasakii*, *Corticium Rolfsii* and *Sclerotium Oryzae-sativae*. The experiments were repeated three times using 5 dishes at each temperature.

The results obtained are summarized in Tables 25-30.

TABLE 27. Influence of temperature on the growth of mycelium of *Corticium Rolfsii*

Culture media used	Series of experiments	Average diameter of colonies after 3 days at—							
		10°C.	16°C.	20°C.	24°C.	28°C.	32°C.	36°C.	40°C.
Rice straw decoction agar	1st experiment	0.50	0.80	1.97	2.60	6.47	6.60	0.90	0.50
	2nd experiment	0.50	0.70	2.37	2.55	4.50	6.40	0.80	0.50
	3rd experiment	0.50	0.60	1.05	2.80	6.50	6.70	0.90	0.50
Potato decoction agar	1st experiment	0.50	0.90	3.96	5.20	7.44	8.50	1.20	0.70
	2nd experiment	0.50	0.60	3.48	4.22	8.12	8.50	2.30	0.70
	3rd experiment	0.50	0.65	3.50	3.80	8.17	8.20	1.20	0.65
Sarro's soy agar	1st experiment	0.50	0.80	3.05	4.32	8.20	8.35	2.50	0.70
	2nd experiment	0.50	1.30	3.12	5.63	7.65	8.37	3.20	0.70
	3rd experiment	0.50	0.80	4.10	5.70	8.00	8.37	2.50	0.50

TABLE 23. Influence of temperature on the development of mycelium from a sclerotium of *Corticium Sasakii*

Strain used	Culture media used	Series of experiments	Average length of mycelia after 2 days at—							
			10°C.	16°C.	20°C.	24°C.	28°C.	32°C.	36°C.	40°C.
Japanese strain	Apricot decoction agar	1st experiment	0	0.16	0.50	1.22	1.68	1.88	0.74	0
		2nd experiment	0	0.10	0.50	1.10	1.84	1.88	0.76	0
		3rd experiment	0	0.12	0.42	1.08	2.00	2.02	0.96	0
	Potato decoction agar	1st experiment	0	0.52	0.98	2.50	3.10	5.00	0.92	0
		2nd experiment	0	0.60	0.96	2.42	3.62	3.20	0.76	0
		3rd experiment	0	0.54	1.52	1.84	3.46	3.28	0.84	0
	Sarro's soy agar	1st experiment	0	0.18	0.54	0.98	2.32	2.40	1.46	0
		2nd experiment	0	0.12	0.58	1.22	1.26	2.08	1.48	0
		3rd experiment	0	0.20	0.60	1.22	2.00	2.02	1.48	0
Philippine strain	Apricot decoction agar	1st experiment	0	0.26	0.46	1.08	1.84	1.92	0.84	0
		2nd experiment	0	0.24	0.68	1.12	1.78	1.90	1.04	0
		3rd experiment	0	0.23	0.62	1.48	1.64	2.00	1.26	0
	Potato decoction agar	1st experiment	0	1.10	0.70	2.58	3.50	4.06	1.20	0
		2nd experiment	0	0.08	0.88	3.40	3.60	4.16	1.64	0
		3rd experiment	0	0.54	1.18	2.22	3.68	4.16	1.86	0
	Sarro's soy agar	1st experiment	0	0.22	0.58	1.12	2.02	2.52	1.42	0
		2nd experiment	0	0.20	0.48	1.20	2.16	2.72	1.48	0
		3rd experiment	0	0.12	0.54	1.06	2.04	2.44	1.48	0

TABLE 29. Influence of temperature on the development of mycelium from a sclerotium of *Sclerotium Oryzae-sativae*

Culture media used	Series of experiments	Average length of mycelia after 3 days at—							
		10°C.	16°C.	20°C.	24°C.	28°C.	32°C.	36°C.	40°C.
Rice straw decoction agar	1st experiment	0	0.20	1.07	2.08	3.08	3.00	0.20	0
	2nd experiment	0	0.97	1.47	2.82	3.85	2.37	0.30	0
	3rd experiment	0	0.60	1.62	3.20	3.75	4.00	0.58	0
Potato decoction agar	1st experiment	0.04	0.70	1.26	2.14	3.10	0.95	0.40	0
	2nd experiment	0	0.40	1.48	1.84	3.82	1.77	0.51	0
	3rd experiment	0	0.63	1.60	2.45	3.80	2.64	0.70	0
Sarro's soy agar	1st experiment	0	0.23	0.50	1.05	1.63	0.50	0.30	0
	2nd experiment	0	0.33	0.60	1.25	1.90	1.08	0.40	0
	3rd experiment	0	0.33	0.78	1.23	2.20	1.60	0.45	0

TABLE 30. Influence of temperature on the development of mycelium from a sclerotium of *Corticium Rolfsii*

Culture media used	Series of experiments	Average length of mycelia after 3 days at—							
		10°C.	16°C.	20°C.	24°C.	28°C.	32°C.	36°C.	40°C.
Potato decoction agar	1st experiment	0	0.06	0.98	1.55	3.15	3.26	1.60	0.15
	2nd experiment	0	0.06	1.00	1.50	2.75	3.20	1.60	0.15
	3rd experiment	0	0.08	0.90	1.95	2.10	2.70	1.15	0.10
Sarro's soy agar	1st experiment	0	0.10	0.70	1.08	3.30	4.37	0.90	0.20
	2nd experiment	0	0.10	1.70	2.84	5.04	5.65	1.20	0.21
	3rd experiment	0	0.10	1.67	2.80	5.00	5.50	0.90	0.20
Rice straw decoction agar	1st experiment	0	0.10	1.00	1.60	2.02	3.00	0	0
	2nd experiment	0	0.10	1.15	2.10	3.00	2.20	0.50	0
	3rd experiment	0	0.10	1.10	1.50	2.10	2.50	0	0

The above tables show that the growth of mycelia of the causal fungi of Sclerotium diseases of the rice plant differs according to temperatures and to the kind of culture media. Little or no growth occurred at about 10°C. or 40°C. The optimum temperature for the growth of mycelia of *Corticium Sasakii* and *Corticium Rolfsii* seemed to lie between 28°C. and 32°C., while *Sclerotium Oryzae-sativae* grew most vigorously at 28°C. The results of the effects of temperature upon the development of mycelium from a sclerotium were quite similar to those of the effects upon the growth of mycelia.

These results are almost similar to those given by HEMMI and YOKOGI⁽⁵²⁾ in the case of *Corticium Sasakii* and *Corticium Rolfsii*, but in the case of *Sclerotium Oryzae-sativae* they stated that the optimum temperature is about 32°C.

(C) Influence of sunlight

It has been known for a long time that the growth of mycelia of fungi is influenced by sunlight. But the subject as related to fungi causing Sclerotium diseases of the rice plant remained untouched. The writer has investigated the influence of sunlight on the growth of mycelia of such fungi as *Corticium Sasakii*, *Corticium Rolfsii*, *Sclerotium Oryzae-sativae*, *Sclerotium hydrophilum*, *Leptosphaeria Salvini*, *Sclerotium fumigatum* and *Sclerotium japonicum*. In this experiment a piece of mycelial mass (0.5 cm. in diameter) was transplanted on potato decoction agar in each Petri dish, and all dishes were kept in a chamber where the temperature was regulated to 32°C. All dishes were thus exposed through glass to the sunlight in the laboratory. At definite

TABLE 31. Influence of sunlight on the growth of the mycelia of the causal fungi of Sclerotium diseases of the rice plant

Name of fungus	Duration of exposure to sunlight (hours)	Average diameter of mycelial colonies after 24 hours			
		1st experiment	2nd experiment	3rd experiment	Average
<i>Corticium Sasakii</i>	0	2.50	2.44	1.86	2.27
	3	2.32	2.24	1.72	2.09
	6	2.02	1.98	1.44	1.81
	12	1.58	1.54	1.26	1.46
<i>Sclerotium Oryzae-sativae</i>	0	1.98	1.26	1.26	1.50
	3	1.76	0.98	1.00	1.25
	6	1.38	0.80	0.82	1.00
	12	1.28	0.66	0.72	0.87
<i>Sclerotium hydrophilum</i>	0	0.90	0.80	0.82	0.84
	3	0.74	0.64	0.66	0.68
	6	0.72	0.62	0.60	0.65
	12	0.66	0.52	0.52	0.57
<i>Leptosphaeria Salvini</i>	0	0.86	1.08	1.00	0.98
	3	0.72	0.84	0.90	0.82
	6	0.70	0.68	0.66	0.68
	12	0.60	0.60	0.60	0.60
<i>Sclerotium fumigatum</i>	0	1.54	1.40	1.68	1.54
	3	1.30	1.34	1.32	1.32
	6	1.22	1.22	1.22	1.22
	12	1.20	1.10	1.10	1.13
<i>Corticium Rolfsii</i>	0	1.12	1.16	1.28	1.19
	3	0.92	0.98	1.02	0.97
	6	0.80	0.78	0.80	0.79
	12	0.60	0.70	0.66	0.65
<i>Sclerotium japonicum</i>	0	1.54	1.74	1.82	1.69
	3	1.08	1.30	1.00	1.13
	6	0.75	1.16	0.88	0.93
	12	0.72	1.06	0.84	0.87

intervals, the dishes were transferred into a dark chamber regulated to maintain the same condition as the former chamber, except for the absence of light. After twenty-four hours from the beginning of the experiment the results were observed and summarized in Table 31. The experiments were repeated three times, using 5 dishes for each series of experiments.

From the results shown in Table 31 it is clear that sunlight exerts an inhibiting effect on the mycelial growth of the fungi tested.

(D) Influence of water content of soil

The water content of the soil may be an important factor for the growth of fungi in the soil. The writer, therefore, tested the influence of water content of the soil on the growth of mycelia of *Corticium Sasakii* and *Sclerotium Oryzae-sativae* using sand and sandy loam. In this experiment 100 cc. ERLENMYER's flasks containing 30 cc. of soil were used. Sand (28.07% water holding

TABLE 32. Influence of water content of the soil on the growth of mycelia of *Corticium Sasakii* and *Sclerotium Oryzae-sativae*

Name of fungus	Kind of soil	Water content	Rate of growth of mycelium		
			1st experiment	2nd experiment	3rd experiment
<i>Corticium Sasakii</i>	Sand	1%	—	—	—
		5%	++++	++++	++++
		10%	+++++	+++++	+++++
		20%	+++++	+++++	+++++
		30%	+++++	+++++	+++++
		40%	+++++	+++++	+++++
		50%	++++	+++	++
	Sandy loam	1%	—	—	—
		5%	++	++	++
		10%	++++	++++	++++
		20%	++++	++++	++++
		30%	++++	++++	++++
		40%	+++++	+++++	++++
		50%	+++++	+++++	+++++
<i>Sclerotium Oryzae-sativae</i>	Sand	1%	—	—	—
		5%	—	—	—
		10%	—	—	—
		20%	+++	+++	+++
		30%	+++	+++	+++
		40%	++++	++++	++++
		50%	++++	++++	++++
	Sandy loam	1%	—	—	—
		5%	—	—	—
		10%	—	—	—
		20%	—	—	—
		30%	+++	++	+++
		40%	++++	++++	++++
		50%	+++++	+++++	+++++

Remarks: + indicates mycelial growth; — no mycelial growth.

capacity) and sandy loam (46.75% water holding capacity) were adjusted to different water contents (as gravimetric %) such as 1%, 5%, 10%, 20%, 30%, 40% and 50%. A sclerotium of the fungus was transplanted onto the soil and kept at 28°C. After 21 days the rate of mycelial growth of the fungus on the surface of the soil was observed. The same experiments were repeated three times using 5 flasks for each series. The results obtained are summarized in Table 32.

The rate of growth of the mycelia of these fungi in the soil differs greatly according to the kind of soil and its water content. No growth of *Corticium Sasakii* occurred at 1% of water content in either the sand or sandy loam, but in the former soil the most vigorous growth was observed at 10–40%, especially at 20–30%, while in the latter it was at 20–50%, especially at 50%. In the case of *Sclerotium Oryzae-sativae*, no growth was obtained at 1–10% of the sand and 1–20% of the sandy loam and the most vigorous growth at 40% and 50% in the former and at 50% in the latter.

The difference in the rate of growth of mycelium in soils showing different moistures may be influenced directly by the water or indirectly by the insufficient oxygen supply. According to ABE⁽¹⁾ *Corticium Sasakii* can not grow when the oxygen is deficient.

2. Influence of environmental factors upon the formation of sclerotia

As the overwintering of the causal fungi of Sclerotium diseases by means of sclerotia and mycelia has been demonstrated, it seems very important to ascertain the possible relation between the formation of sclerotia and the environmental factors. YOKOGI⁽¹⁶⁾ has already dealt with this subject with respect to *Corticium Rolfsii*, and the present writer⁽⁵¹⁾ has also been studying on the same line.

(A) Effect of a temporary rise of temperature

The effect of a temporary rise of temperature on the formation of sclerotia was studied in *Corticium Rolfsii*. The mycelial colonies developed from sclerotia of the fungus on apricot decoction agar at 24°–25°C. were allowed to grow to about 5 cm. in diameter, then kept at 40°C. for 5 days, and again exposed to 24°–25°C. Although the growth of the fungus ceased at 40°C, the sclerotia were abundantly formed at the margin of the older zone which had been developed before the change of temperature. In this case, the size of the sclerotia was greater than that of the sclerotia formed under the constant

temperature of 24°–25°C.

Similar results were also obtained in another experiment. The fungus was cultured at 26°–28°C., and when the colony developed to about 5 cm. in diameter, it was kept at 40°C. for 3 days, then exposed to 26°–28°C. for 10 days. The results obtained are given in the following table.

TABLE 33. Effect of a temporary rise of temperature on the formation of sclerotia of *Corticium Rolfsii*

	Number of sclerotia formed on—	
	Treated dishes	Control dishes
Sclerotia developed before the treatment	14	15
Sclerotia developed after the treatment	525	166
Ratio	ca 3	1

From these results, it is clear that a temporary rise of temperature promoted the formation of sclerotia of the fungus tested.

(B) Effect of a temporary fall of temperature

In 1927, Yokoci⁽¹¹⁶⁾ reported that the sclerotia of *Corticium Rolfsii* were formed abundantly after it was exposed to a temporary fall of temperature. This fact was later confirmed by the present writer⁽⁶¹⁾ using *Corticium Sasakii*, *Sclerotium Oryzae-sativae* and *Sclerotium hydrophilum*. In all these experiments, the fungus was first cultured on apricot decoction agar in Petri dishes at a certain temperature, and then the dishes were exposed to a low temperature and returned again to the original temperature.

(1) Results of experiments with *Corticium Sasakii*

In the first experiment, the fungus was cultured for 5 days at 32°C., then kept at 6°C. for 1 day, and again cultured at the original temperature for 3 days. The second experiment was conducted in a similar manner: the fungus was cultured for 4 days at 32°C., then exposed to 6°–7°C. for 1 day, and again kept at the original temperature for 13 days. In these two experiments the number of sclerotia formed showed no difference between the treated dishes and the control. In the third experiment, the fungus was cultured for 4 days at 32°C., exposed to 12°C. for 4 days and then kept at the original temperature for 8 days. The sclerotia formed in the treated dishes were more abundant than those in the control, showing a ratio 5:1.

(2) Results of experiments with *Sclerotium Oryzae-sativae*

Two experiments were made using *Sclerotium Oryzae-sativae*. In the first experiment, the fungus was cultured at 32°C. for 5 days, then exposed to 6°-7°C. for 1 day and again kept at the original temperature for 8 days. Sclerotia were abundantly found on the zone formed before the exposure to low temperature and the number of sclerotia was greater than that of sclerotia in the control.

In the second experiment, the fungus was cultured at 32°C. for 3 days, then exposed to a temperature of 10°-12°C. for 1 day, and again kept at the original temperature for 8 days. The results obtained were similar to those of the first experiment.

(3) Results of experiments with *Sclerotium hydrophilum*

In this experiment the fungus was first cultured at 32°C. for 5 days, and then some of these cultures were exposed to a low temperature of 6°-7°C. for 1 day and other cultures to the same temperature for 2 days. After the treatment these cultures were kept at the original temperature for 13 days. The sclerotia were formed more abundantly in the series treated for 2 days than in the other.

From the above results of the experiments it may be said at least in the case of these three fungi tested, that the sclerotia are rather abundantly formed when the fungus meets with a temporary fall of temperature during its growing period.

(C) Influence of light

In 1927, YOKOGI⁽¹¹⁶⁾ mentioned that *Corticium Rolfsii* isolated from diseased soy bean produced more abundant sclerotia in the light than in the dark. The writer also studied along the same line using *Corticium¹ Sasakii*, *Sclerotium Oryzae-sativae* and *Sclerotium hydrophilum*. In these experiments the fungus was cultured on apricot decoction agar on Petri dishes at 32°C., and before the sclerotia were formed, some were covered with black paper, while others were left uncovered as controls.

(1) Results of experiment with *Corticium Sasakii*

In the first experiment, the fungus was cultured under the above described conditions for 5 days, and then kept in the greenhouse for 14 days. For each series of experiment three dishes were used. In the second experiment 5 dishes were used for each series. The fungus was cultured under the experimental condition for 5 days, and then kept in the greenhouse for 10

days. The results obtained in two experiments are tabulated in Table 34.

TABLE 34. Influence of light on the formation of sclerotia of *Corticium Sasakii*

	1st experiment		2nd experiment	
	In the dark	In the light	In the dark	In the light
Total number of sclerotia	71	231	71	290
Average number of sclerotia per dish	23.7	77.0	14.2	58.0
Ratio	1	3.3	1	4.1

As shown in this table, the sclerotia were formed more abundantly in the light than in the dark, while the aerial mycelia grow more vigorously in the dark than in the light.

In the third experiment, the fungus was cultured under the experimental conditions for 4 days, and then kept in a greenhouse for 13 days. In this case the total weight of sclerotia was compared. The weight of those formed in the light was 2.5 gm., while the same in the dark was only 0.3 gm.

(2) Results of experiments with *Sclerotium Oryzae-sativae*

Two experiments were made with this fungus. The fungus was cultured under two different conditions for 5 days and then kept in the greenhouse for 15 days in the first experiment, and for 10 days in the second experiment. In these two experiments, the aerial mycelia grew vigorously and were "Cinnamon-Buff"⁽⁸⁶⁾ in color when kept in the dark, while it grew poorly and showed "Cream Color" in the light. The formation of sclerotia showed a similar tendency with that observed in *Corticium Sasakii*, though it was not so clearly demonstrated.

(3) Results of experiments with *Sclerotium hydrophilum*

The fungus was first cultured under experimental conditions for 5 days and then kept in a greenhouse for 18 days. In this experiment five dishes were used for each series of experiments. The sclerotia formed more abundantly in the light than in the dark, but the aerial mycelium showed a rather poor growth in the former.

From the above results it is obvious that light is a powerful factor to promote the formation of sclerotia.

(D) Effect of temporary dipping of mycelia in water

The effect of temporary dipping of mycelia on the formation of sclerotia was tested with *Corticium Rolfsii*. In the first experiment, 250 cc. ERLENMYER'S flasks containing 100 cc. of apricot decoction agar were used. The

fungus was cultured at 24°-25°C. and before the formation of sclerotia was began, sterilized water kept at 24°-25°C. had been poured into the flasks. After 2 days the water was removed and the culture was continued for 6 days. For each series of experiment three dishes were used. The formation of sclerotia was about 5 times greater in the treated cultures than in the control.

A similar experiment was made using large test tubes (3.5 cm. in diam., 30 cm. in length), each containing 50 cc. of apricot decoction agar. The fungus had been cultured at 26°-28°C., before sterilized water was poured into the tubes. After 3 days the water was removed from the tubes and the fungus was grown again for 5 days. The number of sclerotia formed was 122 when the fungus had been dipped in water, while it was only 5 in the control.

The results of these two experiments show that the formation of sclerotia is promoted greatly by a temporary dipping of mycelia in water.

(E) Effect of toxic substances

It seems to be important to know the effect of toxic substances on the formation of sclerotia in order to get some practical hints on the application of various fungicides. In this experiment, copper sulphate was used as representative of the toxic substances. 20 cc. of Sarro's soy agar or apricot decoction agar were poured into Petri dishes and a sclerotium of *Corticium Rolfsii* was planted on one side of each dish and a piece of copper sulphate crystal on the opposite side. These dishes were kept at 28°C. The experi-

TABLE 35. Effect of copper sulphate on the formation of sclerotia of *Corticium Rolfsii*

Experiments	Number of sclerotia formed on—		
		Part of the colony facing copper sulphate	Counter part of the colony facing copper sulphate
First experiment	Total Ratio	106 17.7	6 1
Second experiment	Total Ratio	305 9	39 1
Control in the second experiment (No copper sulphate added)	Total Ratio	409 2.7	149 1

Remarks: Six and five dishes respectively were used in these experiments.

ments were twice repeated. The fungus was cultured for 17 days in the first and for 11 days in the second experiment. The results obtained are shown in Table 35.

The table shows that copper sulphate and possibly other similar toxic substances exert a great effect on the sclerotial formation of *Corticium Rolfsii*.

(F) Effect of various microorganisms

HEMMI and the present writer⁽⁵¹⁾ showed that the presence of other fungi

TABLE 36. Formation of sclerotia of *Corticium Sasakii* in mixed cultures with various bacteria at 24°C., 28°C. and 32°C.

Bacteria added	Sclerotia formed at—					
	24°C.		28°C.		32°C.	
	Number	Weight (gm.)	Number	Weight (gm.)	Number	Weight (gm.)
None	8	0.483	9	0.415	9	0.417
<i>Bac. aroideae</i>	0		0		0	
<i>Bac. butyricus</i>	0		0		0	
<i>Bac. cereus</i>	0		0		0	
<i>Bac. coli</i>	0		0		0	
<i>Bac. corallinus</i>	1	trace	0		0	
<i>Bac. dendroides</i>	0		0		0	
<i>Bac. fluorescens liquefaciens</i>	0		0		0	
<i>Bac. fluorescens non-liquefaciens</i>	5	2.00	6	0.205	3	trace
<i>Bac. megatherium</i>	0		0		0	
<i>Bac. mesentericus</i>	0		0		0	
<i>Bac. mycooides</i>	0		0		0	
<i>Bac. phytophthorus</i>	2	trace	6	0.200	2	trace
<i>Bac. prodigiosus</i>	0		0		0	
<i>Bac. subtilis</i>	0		0		0	
<i>Bac. ureae</i>	0		0		0	
<i>Bact. beticola</i>	0		0		0	
<i>Bact. Cannae</i>	0		0		0	
<i>Bact. Citri</i>	0		0		0	
<i>Bact. marginale</i>	0		0		0	
<i>Bact. Martyniae</i>	0		0		0	
<i>Bact. medicaginis</i>	0		0		2	trace
<i>Bact. michiganense</i>	4	1.700	0		2	trace
<i>Bact. Phaseoli</i>	0		0		0	
<i>Bact. rossicum</i>	0		0		0	
<i>Bact. Sojae</i>	0		0		0	
<i>Bact. Syringae</i>	0		0		0	
<i>Bact. tumefaciens</i>	0		0		0	
<i>Bact. Vignae</i>	0		0		0	
<i>Bact. vitans</i>	0		0		0	

may be a factor to promote the formation of the sclerotia. To determine the effect of various microorganisms on the formation of sclerotia of the causal fungi of Sclerotium diseases, the following experiments were made using 29 species of bacteria and 48 species of fungi. The results obtained are given in Tables 36-50.

TABLE 37. Formation of sclerotia of *Corticium Sasakii* in mixed cultures with *Aspergillus niger* at 24°C., 28°C. and 32°C.

Fungi added	Sclerotia formed at—		
	24°C.	28°C.	32°C.
None	0.673 gm.	1.330 gm.	1.300 gm.
<i>Asp. niger</i> (Stock No. 1)	0.120	0.320	0.210
<i>Asp. niger</i> (Stock No. 2)	0.400	0.673	0.460
<i>Asp. niger</i> (Stock No. 3)	0.097	0.100	0
<i>Asp. niger</i> (Stock No. 4)	0.270	0	0
<i>Asp. niger</i> (Stock No. 5)	0.150	0.130	0.100
<i>Asp. niger</i> (Stock No. 6)	0.070	0.075	0.210
<i>Asp. niger</i> (Stock No. 7)	0.113	0.115	0
<i>Asp. niger</i> (Stock No. 8)	0.190	0.070	trace
<i>Asp. niger</i> (Stock No. 9)	0.163	0	0
<i>Asp. niger</i> (Stock No. 10)	0	0	0.460
<i>Asp. niger</i> (Stock No. 11)	0.063	0.060	trace
<i>Asp. niger</i> (Stock No. 12)	0.450	0.090	0
<i>Asp. niger</i> (Stock No. 13)	0.080	0	0.365
<i>Asp. niger</i> (Stock No. 14)	0.043	0	0.245
<i>Asp. niger</i> (Stock No. 15)	0.320	0.175	0
<i>Asp. niger</i> (Stock No. 16)	0.240	0.220	0

TABLE 38. Formation of sclerotia of *Corticium Sasakii* in mixed cultures with various species of *Aspergillus* at 24°C., 28°C. and 32°C.

Fungi added	Sclerotia formed at—		
	24°C.	28°C.	32°C.
None	0.700 gm.	0.570 gm.	1.050 gm.
<i>Asp. candidus</i>	0.500	0.502	1.000
<i>Asp. celluloseae</i>	0.450	0.300	0.550
<i>Asp. cinnamomeus</i>	0.050	0	0
<i>Asp. clavatus</i>	0.710	0.740	0.750
<i>Asp. echinulatus</i>	0.720	0.715	0.722
<i>Asp. Fischeri</i>	0.800	0.910	0.355
<i>Asp. flavipes</i>	0.200	0.210	0.205
<i>Asp. flavus</i>	0.620	0.500	0.205
<i>Asp. fumigatus</i>	0.710	0.725	0.700
<i>Asp. gracilis</i>	0.502	0.500	0.520
<i>Asp. insuetus</i>	0.400	0.340	0.150
<i>Asp. Oryzae</i>	0.352	0.400	0.385
<i>Asp. parasiticus</i>	0.450	0.410	0.505
<i>Asp. quercinus</i>	0.350	0.380	0.345
<i>Asp. repandus</i>	0.300	0.370	0.400
<i>Asp. repens</i>	0.200	0.080	0.600
<i>Asp. Schiemanni</i>	0.180	0.211	0.105
<i>Asp. sulphureus</i>	0.530	0.580	0.600
<i>Asp. Sydowi</i>	0	0	0.774
<i>Asp. Tamarii</i>	0.200	0.140	0.300
<i>Asp. terricola var. americana</i>	0.200	0.085	0.310
<i>Asp. ustus</i>	0.810	0.820	0.260
<i>Asp. versicolor</i>	0	0	0
<i>Asp. violaceo-fuscus</i>	0.450	0.360	0.365

TABLE 39. Formation of sclerotia of *Corticium Sasakii* in mixed cultures with various species of *Penicillium* at 24°C., 28°C. and 32°C.

Fungi added	Sclerotia formed at—		
	24°C.	28°C.	32°C.
None	1.830 gm.	0.955 gm.	0.900 gm.
<i>Pen. awellaneum</i>	1.200	0.940	0.995
<i>Pen. brevicaulis</i>	0.850	0.900	0.995
<i>Pen. chrysogenum</i>	1.830	0.700	0.500
<i>Pen. citrinum</i>	0.683	0.753	0.760
<i>Pen. commune</i>	1.030	1.230	0.575
<i>Pen. divaricatum</i>	1.600	1.100	0.470
<i>Pen. granulatum</i>	0.700	0.450	0.490
<i>Pen. lilacinum</i>	1.130	0.940	0.700
<i>Pen. Olsoni</i>	1.100	0.930	0.625
<i>Pen. oxalicum</i>	0.295	0	0.500
<i>Pen. roseum</i>	0.400	1.520	0.990
<i>Pen. silvaticum</i>	0.730	0.500	0
<i>Pen. Thomi</i>	0.370	0.680	0.870

TABLE 40. Formation of sclerotia of *Corticium Sasakii* in mixed cultures with various species of *Mucor* and *Absidia* at 24°C., 28°C. and 32°C.

Fungi added	Sclerotia formed at—		
	24°C.	28°C.	32°C.
None	0.800 gm.	0.950 gm.	0.800 gm.
<i>M. bedrechani</i>	0.370	1.010	1.000
<i>M. circinelloides</i>	0.270	1.000	0.900
<i>M. racemosus</i>	0	0.170	0.580
<i>A. coerulea</i>	0.216	1.280	1.050

TABLE 41. Formation of sclerotia of *Sclerotium Oryzae-sativae* in mixed cultures with various bacteria at 24°C., 28°C. and 32°C.

Bacteria added	Sclerotia formed at—		
	24°C.	28°C.	32°C.
None	+++	+++	+++
<i>Bac. aroideae</i>	+++	—	—
<i>Bac. cereus</i>	—	—	—
<i>Bac. coli</i>	—	—	—
<i>Bac. corallinus</i>	—	—	—
<i>Bac. dendroides</i>	—	—	—
<i>Bac. fluorescens liquefaciens</i>	—	—	—
<i>Bac. fluorescens non-liquefaciens</i>	—	—	—
<i>Bac. mesentericus</i>	—	—	—
<i>Bac. mycoides</i>	—	—	—
<i>Bac. prodigiosus</i>	—	—	—
<i>Bac. subtilis</i>	—	—	—
<i>Bac. ureae</i>	—	—	—
<i>Bact. beticolum</i>	—	—	—
<i>Bact. Citri</i>	—	—	—
<i>Bact. medicaginis</i>	—	—	—
<i>Bact. michiganense</i>	(+)	—	—
<i>Bact. rossicum</i>	—	—	—
<i>Bact. Sojae</i>	(+)	—	—

Remarks: + sclerotia present;—sclerotia absent; (+) sclerotia present in small quantity.

TABLE 42. Formation of sclerotia of *Sclerotium Oryzae-sativae* in mixed cultures with various bacteria at 24°C., 28°C., and 32°C.

Bacteria added	Sclerotia formed at—		
	24°C.	28°C.	32°C.
None	+++	+++	+++
<i>Bac. aroideae</i>	—	—	—
<i>Bac. cereus</i>	—	—	—
<i>Bac. coli</i>	—	—	—
<i>Bac. corallinus</i>	—	—	—
<i>Bac. dendroides</i>	—	—	—
<i>Bac. fluorescens liquefaciens</i>	—	—	—
<i>Bac. fluorescens non-liquefaciens</i>	—	—	—
<i>Bac. mesentericus</i>	—	—	—
<i>Bac. mycoides</i>	—	—	—
<i>Bac. prodigiosus</i>	—	—	—
<i>Bac. subtilis</i>	—	—	—
<i>Bac. ureae</i>	—	—	—
<i>Bact. beticolum</i>	—	—	—
<i>Bact. Citri</i>	—	—	—
<i>Bact. medicaginis</i>	—	—	—
<i>Bact. michiganense</i>	—	—	—
<i>Bact. rossicum</i>	—	—	—
<i>Bact. Sojae</i>	—	—	—

Remarks: After *Sclerotium Oryzae-sativae* had developed to 3 cm. in diameter the bacterium was inoculated.

TABLE 43. Formation of sclerotia of *Sclerotium Oryzae-sativae* in mixed cultures with various fungi at 24°C., 28°C. and 32°C.

Fungi added	Sclerotia formed at—		
	24°C.	28°C.	32°C.
None	+++++	+++++	+++++
<i>Asp. alliaceus</i>	(+)	+	+
<i>Asp. amsterodami</i>	+++++	+++++	+++
<i>Asp. cinnamomeus</i>	(+)	—	—
<i>Asp. echinulatus</i>	+	+	—
<i>Asp. flavus</i>	+	+	+
<i>Asp. fumigatus</i>	—	—	—
<i>Asp. niger</i> (Stock No. 1)	—	—	—
<i>Asp. niger</i> (Stock No. 2)	—	—	—
<i>Asp. niger</i> (Stock No. 3)	—	—	—
<i>Asp. niger</i> (Stock No. 4)	—	—	—
<i>Asp. niger</i> (Stock No. 6)	—	—	—
<i>Asp. niger</i> (Stock No. 7)	—	—	—
<i>Asp. niger</i> (Stock No. 8)	—	—	—
<i>Asp. niger</i> (Stock No. 9)	—	—	—
<i>Asp. niger</i> (Stock No. 10)	—	—	—

TABLE 43. (Continued)

Fungi added	Sclerotia formed at—		
	24°C.	28°C.	32°C.
<i>Asp. niger</i> (Stock No. 11)	—	—	—
<i>Asp. niger</i> (Stock No. 12)	—	—	—
<i>Asp. niger</i> (Stock No. 13)	—	—	—
<i>Asp. niger</i> (Stock No. 14)	—	—	—
<i>Asp. niger</i> (Stock No. 15)	—	—	—
<i>Asp. niger</i> (Stock No. 16)	—	—	—
<i>Asp. parasiticus</i>	—	—	—
<i>Asp. quercinum</i>	(+)	—	—
<i>Asp. sulphureus</i>	+++	—	+
<i>Asp. Sydowi</i>	+	+	(+)
<i>Asp. Tamarii</i>	—	—	—
<i>Asp. terreus</i>	+	+	+
<i>Asp. violaceo-fuscus</i>	(+)	—	—
<i>Pen. chrysogenum</i>	+++++	+++++	+++++
<i>Pen. citrinum</i>	+++	+++	+++
<i>Pen. commune</i>	+++++	++	+++++
<i>Pen. granulatum</i>	+++++	+++++	+++++
<i>Pen. lilacinum</i>	++	+++++	+++++
<i>Pen. oxalicum</i>	+++++	+++++	+++++
<i>Pen. roseum</i>	+++++	+++	++++
<i>Mucor bedrechani</i>	+	+	+++
<i>M. racemosus</i>	+++++	+++++	+++++
<i>Absidia coerulea</i>	+	+	+

TABLE 44. Formation of sclerotia of *Corticium Rolfii* in mixed cultures with various bacteria at 24°C., 28°C. and 32°C.

Bacteria added	Sclerotia formed at—					
	24°C.		28°C.		32°C.	
	Number	Weight(gm.)	Number	Weight(gm.)	Number	Weight(gm.)
None	1	trace	28	0.030	47	0.042
<i>Bac. aroideae</i>	0		0		0	
<i>Bac. butyricus</i>	0		0		7	0.007
<i>Bac. corallinus</i>	0		0		40	0.041
<i>Bac. cereus</i>	0		0		0	
<i>Bac. dendroides</i>	0		0		0	
<i>Bac. fluorescens liquefaciens</i>	0		0		0	
<i>Bac. fluorescens non-liquefaciens</i>	1	trace	25	0.030	8	0.004
<i>Bac. megatherium</i>	0		9	0.009	2	trace
<i>Bac. mesentericus</i>	0		0		4	0.004
<i>Bac. phytophthorus</i>	0		5	0.018	41	0.040
<i>Bac. prodigiosus</i>	0		0		0	
<i>Bac. ureae</i>	0		0		0	
<i>Bact. beticola</i>	0		0		3	trace

TABLE 44. (Continued)

Bacteria added	Sclerotia formed at—					
	24°C.		28°C.		32°C.	
	Number	Weight(gm.)	Number	Weight(gm.)	Number	Weight(gm.)
<i>Bact. Cannae</i>	0		0		0	
<i>Bact. Citri</i>	0		12	0.011	2	trace
<i>Bact. marginale</i>	0		0		2	trace
<i>Bact. Martyniae</i>	0		0		0	
<i>Bact. medicaginis</i>	0		0		8	0.009
<i>Bact. michiganense</i>	0		33	0.028	37	0.038
<i>Bact. Phaseoli</i>	0		0		76	0.049
<i>Bact. rossicum</i>	0		0		0	
<i>Bact. Sojae</i>	0		0		0	
<i>Bact. Syringae</i>	0		16	0.019	7	0.008
<i>Bact. tumefaciens</i>	0		11	0.016	0	
<i>Eact. Vignae</i>	0		0		42	0.030
<i>Bact. vitans</i>	0		0		0	

TABLE 45. Formation of sclerotia of *Corticium Rolfsii* in mixed cultures with various bacteria at 24°C., 28°C. and 32°C.

Bacteria added	Sclerotia formed at—					
	24°C.		28°C.		32°C.	
	Number	Weight(gm.)	Number	Weight(gm.)	Number	Weight(gm.)
None	1	trace	20	0.024	30	0.830
<i>Bac. aroideae</i>	0		0		1	trace
<i>Bac. butyricus</i>	0		0		0	
<i>Bac. cereus</i>	0		0		0	
<i>Bac. corallinus</i>	0		0		26	0.026
<i>Bac. dendroides</i>	0		0		0	
<i>Bac. fluorescens liquefaciens</i>	0		2	trace	0	
<i>Bac. fluorescens non-liquefaciens</i>	0		0		5	0.007
<i>Bac. megatherium</i>	0		0		0	
<i>Bac. mesentericus</i>	0		0		1	trace
<i>Bac. phytophthorus</i>	0		0		0	
<i>Bac. prodigiosus</i>	0		0		0	
<i>Bac. ureae</i>	0		0		0	
<i>Bact. beticolum</i>	0		0		0	
<i>Bact. Cannae</i>	0		0		0	
<i>Bact. Citri</i>	0		0		0	
<i>Bact. marginale</i>	0		0		0	
<i>Bact. Martyniae</i>	0		0		0	
<i>Bact. medicaginis</i>	0		0		0	
<i>Bact. michiganense</i>	0		0		0	
<i>Bact. Phaseoli</i>	0		0		30	0.031
<i>Bact. rossicum</i>	0		0		2	trace
<i>Bact. Sojae</i>	0		0		6	0.008
<i>Bact. tumefaciens</i>	0		0		0	
<i>Bact. Vignae</i>	0		0		0	
<i>Bact. vitans</i>	0		0		0	

Remarks: After *Corticium Rolfsii* had developed to 3 cm. in diameter, the bacterium was inoculated.

TABLE 46. Formation of sclerotia of *Corticium Rolfsii* in mixed cultures with *Aspergillus niger* at 24°C., 28°C. and 32°C.

Fungi added	Sclerotia formed at—					
	24°C.		28°C.		32°C.	
	Number	Weight (gm.)	Number	Weight (gm.)	Number	Weight (gm.)
None	306	1.084	192	0.695	371	1.000
<i>Asp. niger</i> (Stock No. 1)	66	0.520	77	0.595	174	0.786
<i>Asp. niger</i> (Stock No. 2)	39	0.340	59	0.540	113	0.520
<i>Asp. niger</i> (Stock No. 3)	19	0.130	78	0.420	93	0.373
<i>Asp. niger</i> (Stock No. 4)	62	0.497	45	0.470	84	0.300
<i>Asp. niger</i> (Stock No. 5)	45	0.383	54	0.580	69	0.635
<i>Asp. niger</i> (Stock No. 6)	59	0.443	11	0.575	90	0.189
<i>Asp. niger</i> (Stock No. 7)	40	0.200	14	0.110	62	0.305
<i>Asp. niger</i> (Stock No. 8)	38	0.230	36	0.275	62	0.150
<i>Asp. niger</i> (Stock No. 9)	56	0.251	89	0.575	88	0.473
<i>Asp. niger</i> (Stock No. 10)	92	0.570	9	0.460	107	0.300
<i>Asp. niger</i> (Stock No. 11)	24	0.200	80	0.450	95	0.590
<i>Asp. niger</i> (Stock No. 12)	50	0.310	62	0.550	132	0.518
<i>Asp. niger</i> (Stock No. 13)	41	0.500	42	0.465	79	0.560
<i>Asp. niger</i> (Stock No. 14)	83	0.635	80	0.540	96	0.340
<i>Asp. niger</i> (Stock No. 15)	37	0.410	70	0.520	84	0.563
<i>Asp. niger</i> (Stock No. 16)	0		46	0.455	159	0.535

 TABLE 47. Formation of sclerotia of *Corticium Rolfsii* in mixed cultures with various species of *Aspergillus* at 24°C., 28°C. and 32°C.

Fungi added	Sclerotia formed at—					
	24°C.		28°C.		32°C.	
	Number	Weight (gm.)	Number	Weight (gm.)	Number	Weight (gm.)
None	244	0.930	180	0.918	294	0.965
<i>Asp. amtserodami</i>	322	0.510	74	0.410	227	0.650
<i>Asp. candidus</i>	327	1.080	218	1.150	296	0.990
<i>Asp. cellulosa</i>	107	0.770	218	0.967	257	0.783
<i>Asp. cinnamomeus</i>	87	0.570	77	0.440	123	0.525
<i>Asp. clavatus</i>	106	0.640	108	1.150	146	0.575
<i>Asp. echinulatus</i>	171	0.583	151	0.733	226	1.060
<i>Asp. Fischeri</i>	148	0.825	131	0.577	178	0.665
<i>Asp. flavipes</i>	320	0.970	115	0.505	247	0.620
<i>Asp. flavus</i>	80	0.683	106	0.455	96	0.455
<i>Asp. fumigatus</i>	99	0.730	166	0.680	123	0.370
<i>Asp. glaucus</i> (Stock No. 1)	128	0.875	181	0.917	215	0.780
<i>Asp. glaucus</i> (Stock No. 2)	105	0.770	106	0.400	182	0.647
<i>Asp. gracilis</i>	10	0.775	141	0.860	149	0.465
<i>Asp. insuetus</i>	155	0.790	103	0.460	187	0.730

TABLE 47. (Continued)

Fungi added	Sclerotia formed at—					
	24°C.		28°C.		32°C.	
	Number	Weight (gm.)	Number	Weight (gm.)	Number	Weight (gm.)
<i>Asp. japonicus</i>	11	0.100	115	0.880	97	0.375
<i>Asp. medius</i>	182	0.815	119	0.667	181	0.730
<i>Asp. Oryzae</i>	107	0.775	144	0.390	184	0.925
<i>Asp. parasiticus</i>	62	0.440	51	0.275	120	0.570
<i>Asp. quercinus</i>	128	0.700	187	1.140	183	0.850
<i>Asp. repandus</i>	228	0.773	113	0.740	207	0.910
<i>Asp. repens</i>	166	0.837	118	1.150	153	0.650
<i>Asp. Schiemanni</i>	80	0.460	96	0.393	97	0.370
<i>Asp. Sydowi</i>	155	0.857	104	0.479	124	0.690
<i>Asp. Tamarii</i>	68	0.505	64	0.317	165	0.585
<i>Asp. terreus</i>	117	0.650	128	0.373	178	0.590
<i>Asp. terricola</i> var. <i>americana</i>	200	0.660	73	0.287	103	0.430
<i>Asp. ustus</i>	160	0.700	146	0.723	160	0.711
<i>Asp. versicolor</i>	253	0.863	148	1.360	196	0.585
<i>Asp. violaceo-fuscus</i>	148	0.730	89	0.455	130	0.315

TABLE 48. Formation of sclerotia of *Corticium Rolfsii* in mixed cultures with various species of *Penicillium* at 24°C., 28°C. and 32°C.

Fungi added	Sclerotia formed at—					
	24°C.		28°C.		32°C.	
	Number	Weight (gm.)	Number	Weight (gm.)	Number	Weight (gm.)
None	306	1.083	294	1.010	181	0.917
<i>Pen. avellaneum</i>	121	0.826	262	0.850	114	0.710
<i>Pen. brevicaulis</i>	193	0.596	285	1.060	166	0.443
<i>Pen. chrysogenum</i>	116	0.620	208	0.710	133	0.640
<i>Pen. citrinum</i>	114	0.900	184	0.725	167	0.693
<i>Pen. commune</i>	128	0.690	307	0.900	163	0.805
<i>Pen. divaricatum</i>	122	0.692	142	0.415	122	0.663
<i>Pen. granulatum</i>	56	0.423	173	0.650	108	0.517
<i>Pen. lilacinum</i>	230	1.010	134	0.720	115	0.573
<i>Pen. Olsoni</i>	134	1.030	241	0.910	136	0.673
<i>Pen. oxalicum</i>	153	0.910	197	0.800	81	0.305
<i>Pen. roseum</i>	169	0.810	257	0.850	126	0.710
<i>Pen. silvaticum</i>	209	0.857	186	1.050	159	0.660
<i>Pen. Thomi</i>	99	0.740	221	0.750	153	0.600

TABLE 49. Formation of sclerotia of *Corticium Rolfsii* in mixed cultures with various species of *Mucor* and *Absidia* at 24°C., 28°C. and 32°C.

Fungi added	Sclerotia formed at—					
	24°C.		28°C.		32°C.	
	Number	Weight (gm.)	Number	Weight (gm.)	Number	Weight (gm.)
None	240	1.000	244	0.508	269	0.900
<i>M. bedrechani</i>	122	0.917	221	0.497	244	0.850
<i>M. circinelloides</i>	89	0.753	203	0.392	193	0.750
<i>M. racemosus</i>	51	0.750	251	0.292	141	0.700
<i>A. coerulea</i>	116	0.960	262	0.454	119	0.690

As shown in these tables, the formation of sclerotia of the causal fungi of Sclerotium diseases in the mixed culture with various microorganisms differs greatly according to the species of microorganisms added. The formation of sclerotia in respect to both number and weight, seemed to be promoted by the presence of certain microorganisms, while it was on the contrary by certain others. Therefore, it may be stated that the microorganisms are sometimes one of the factors controlling the formation of the sclerotia of the causal fungi.

3. Influence of environmental factors upon the viability of the causal fungi

To learn the effect of environmental factors on the viability of certain important fungi causing Sclerotium diseases of the rice plant, such as *Corticium Sasakii*, *Sclerotium Oryzae-sativae*, *Sclerotium hydrophilum* and *Corticium Rolfsii*, the writer conducted some experiments. A part of the results of these experiments has already been reported.⁽¹²⁾

(A) Effect of temperature

In 1917, SAKURAI⁽⁸⁹⁾ touched on this subject and recorded a preliminary observation. The writer also investigated on this subject adopting a different method. A part of the results was previously reported.⁽¹²⁾

From the above tables, it is evident that the thermal death points of the sclerotia of the causal fungi differs according to the species tested and, also to the method adopted. In general, their resistance to high temperatures is greater under dry condition than under moist condition.

The thermal death points of the sclerotia under dry condition are given as follows: 90°C. for 50 minutes or 95°C. for 40 minutes in *Corticium Sasakii*; 90°C. for 30 minutes or 95°C. for 20 minutes in *Sclerotium Oryzae-sativae*; 95°C. for 80 minutes in *Sclerotium hydrophilum*; 90°C. for 40 minutes or 95°C. for 30 minutes in *Corticium Rolfsii*.

The thermal death points of the sclerotia in water are given as follows: 50°C. for 40 minutes or above 55°C. for 5 minutes in *Corticium Sasakii*; above 50°C. for 5 minutes in *Sclerotium Oryzae-sativae*; 55°C. for 5 minutes in *Sclerotium hydrophilum*; 50°C. for 30 minutes or 55°C. for 5 minutes in *Corticium Rolfsii*.

The thermal death points of mycelia are lower than those of the sclerotia. Under dry condition they are given as follows: 65°C. for 70 minutes in *Corticium Sasakii*; 70°C. for 40 minutes or above 75°C. for 5 minutes in *Sclerotium Oryzae-sativae*; 55°C. for 40 minutes 60°C., 70°C. and 75°C. for 20 minutes or 80°C. for 5 minutes in *Corticium Rolfsii*. Their thermal death points in water are as follows: 50°C. for 5 minutes in *Corticium Sasakii*; 50°C. for 5 minutes in *Sclerotium Oryzae-sativae*; 45°C. for 80 minutes, 50°C. for 10 minutes or 55°C. for 5 minutes in *Corticium Rolfsii*.

(B) Effect of drying

The effect of drying on the viability of the causal fungi of *Sclerotium* diseases was studied with *Corticium Sasakii*, *Sclerotium Oryzae-sativae*, *Sclerotium hydrophilum* and *Corticium Rolfsii*.

a. Experiments using the desiccator

The sclerotia and mycelia covered with filter paper were placed in a

TABLE 57. Effect of drying on the viability of the sclerotia of the causal fungi

Fungi used	Number of sclerotia tested for each series	Number of living sclerotia after—					
		6	9	12	16	19	21 months
<i>C. Sasakii</i>	20	20	20	20	20	20	20
<i>S. Oryzae-sativae</i>	20	20	20	20	20	20	20
<i>Sclerotium hydrophilum</i>	20	20	20	20	20	20	20
<i>C. Rolfsii</i>	20	20	20	20	20	20	20

desiccator containing calcium chloride and after definite length of time their viability was tested by growing them on apricot decoction agar. The results obtained are given in Tables 57-58.

TABLE 58. Effect of drying on the viability of the mycelia of the causal fungi

Fungi used	Number of mycelial pieces tested for each series	Number of living mycelial pieces after—					
		6	9	12	16	19	21 months
<i>C. Sasakii</i>	10	10	10	10	10	10	10
<i>C. Rolfsii</i>	10	10	10	10	10	10	10

In these experiments, the sclerotia as well as the mycelia of the fungi tested retained a strong viability at least for 21 months in the desiccator.

b. Experiments using dry soil

Unglazed pots (10 cm. in diameter) together with soil were sterilized by dry heat, and then the sclerotia or the mycelia covered with sterilized camellia leaves were put in the soil. These pots (for each pot, 20 sclerotia or 10 mycelial pieces were used) were kept in the laboratory. After definite length of time, the sclerotia or the mycelial pieces were taken out from the soil, washed with distilled water, and planted on apricot decoction agar. The viability of the fungus was determined by observing the cultures at least after two weeks.

Since the results of the experiments have previously been reported by the writer,⁽¹⁷⁾ they are here only conclusively stated as follows:

The sclerotia of *Corticium Sasakii* and *Corticium Rolfsii*, kept in dry soil, lost their viability within twenty-one months, and the mycelia of *Corticium Sasakii* within seven months, where as the sclerotia of *Sclerotium Oryzae-sativae* and *Sclerotium hydrophilum* kept in dry soil retained their vitality for nine months.

(C) Effect of chemicals

The sclerotia or the mycelia treated with various chemicals in test tubes for certain lengths of time were washed thoroughly with sterilized water and their viability was tested by culturing them on sterilized straw. The results obtained are as follows:

TABLE 59. Resistance of sclerotia of *Corticium Sasakii* to various acid-solutions

Acids	Number of sclerotia tested for each series	Number of living sclerotia after treatment for—						
		6	12	24	48	72	96	120 hours
Arsenic acid	10	4	0	0	0	0	0	0
Asparaginic acid	10	10	10	10	10	6	2	0
Boric acid	10	6	9	7	10	2	3	6
Butyric acid	10	4	0	0	0	0	0	0
Carbolic acid	10	0	0	0	0	0	0	0
Chromic acid	10	0	0	0	0	0	0	0
Citric acid	10	9	6	9	9	5	5	0
Hippuric acid	10	2	2	8	1	0	1	1
Hydrochloric acid	10	0	3	0	0	0	0	0
Lactic acid	10	4	2	4	1	0	2	0
Malic acid	10	7	8	5	10	7	10	8
Nitric acid	10	3	8	0	0	0	0	0
Oxalic acid	10	7	0	0	0	0	0	0
Picric acid	10	0	0	0	0	0	0	0
Pyrogallic acid	10	0	0	0	0	0	0	0
Salicylic acid	10	0	0	0	0	0	0	0
Sulphuric acid	10	0	0	0	0	0	0	0
Tannic acid	10	8	9	5	10	0	7	6
Tartaric acid	10	9	7	2	9	6	9	5
Uric acid	10	10	5	5	9	5	9	5

Remarks: Concentration of the acids tested was 1%.

TABLE 60. Resistance of sclerotia of *Corticium Rolfsii* to various acid-solutions

Acids	Number of sclerotia tested for each series	Number of living sclerotia after treatment for—						
		6	12	24	48	72	96	120 hours
Arsenic acid	10	0	0	0	0	0	0	0
Asparaginic acid	10	7	7	6	0	6	9	5
Boric acid	10	5	1	0	0	0	0	0
Butyric acid	10	1	0	0	0	0	0	0
Carbolic acid	10	0	0	0	0	0	0	0
Chromic acid	10	0	0	0	0	0	0	0
Citric acid	10	7	10	9	4	5	7	8
Formic acid	10	8	3	5	6	10	9	7
Hippuric acid	10	2	0	2	2	2	0	0
Hydrochloric acid	10	7	4	8	4	0	0	0
Lactic acid	10	5	2	4	6	3	2	1
Malic acid	10	10	9	10	9	7	10	10
Nitric acid	10	2	5	3	0	0	0	0
Oxalic acid	10	10	8	7	6	4	2	2
Picric acid	10	0	0	0	0	0	0	0
Pyrogallic acid	10	10	8	10	9	9	10	8
Salicylic acid	10	0	0	0	0	0	0	0
Succinic acid	10	1	5	0	0	0	0	0
Sulphuric acid	10	2	1	0	0	0	0	0
Tannic acid	10	8	8	8	7	8	2	3
Tartaric acid	10	10	10	10	9	9	9	8
Uric acid	10	10	8	10	9	8	9	7

Remarks: Concentration of the acids was 1%.

TABLE 61. Resistance of sclerotia of *Corticium Sasakii* to various alkali-solutions

Alkalis	Concentration (%)	Number of sclerotia tested for each series	Number of living sclerotia after treatment for—			
			1	6	12	24 hours
Calcium carbonate	1	10	7	7	7	8
	5	10	6	8	7	8
	10	10	7	7	6	4
	15	10	6	5	4	2
Calcium nitrate	1	10	10	10	10	10
	5	10	10	10	10	10
	10	10	10	10	10	10
	15	10	10	10	10	9
Potassium chloride	1	10	10	10	10	10
	5	10	10	8	6	2
	10	10	7	7	5	7
	15	10	5	6	4	4
Potassium hydroxide	1	10	1	0	0	0
	5	10	0	0	0	0
	10	10	0	0	0	0
	15	10	0	0	0	0
Potassium nitrate	1	10	10	10	10	10
	5	10	10	7	8	8
	10	10	7	5	6	7
	15	10	4	4	5	4
Sodium carbonate	1	10	10	10	10	10
	5	10	8	7	5	5
	10	10	7	10	7	6
	15	10	5	5	6	3
Sodium chloride	1	10	10	10	10	10
	5	10	10	10	10	10
	10	10	10	10	8	7
	15	10	10	10	7	5
Sodium nitrate	1	10	9	9	7	4
	5	10	8	6	6	3
	10	10	7	5	5	2
	15	10	5	5	2	0
Sodium phosphate	1	10	10	10	10	10
	5	10	10	10	7	7
	10	10	10	10	7	6
	15	10	10	9	6	6
Sodium sulphite	1	10	10	10	10	10
	5	10	10	10	10	10
	10	10	10	10	10	10
	15	10	10	10	7	3

TABLE 62. Resistance of sclerotia of *Sclerotium hydrophilum* to various alkali-solutions

Alkalis	Concentration (%)	Number of sclerotia tested for each series	Number of living sclerotia after treatment for—			
			1	6	12	24 hours
Calcium carbonate	1	10	8	8	8	10
	5	10	6	8	6	8
	10	10	7	7	2	7
	15	10	7	8	5	6
Calcium nitrate	1	10	6	9	9	10
	5	10	8	9	9	10
	10	10	5	8	5	8
	15	10	5	9	8	4
Potassium chloride	1	10	10	10	10	10
	5	10	10	10	10	9
	10	10	10	10	10	9
	15	10	9	9	9	5
Potassium hydroxide	1	10	1	1	0	0
	5	10	1	0	0	0
	10	10	0	0	0	0
	15	10	0	0	0	0
Potassium nitrate	1	10	10	10	10	10
	5	10	10	10	10	10
	10	10	10	10	10	8
	15	10	5	6	4	1
Sodium carbonate	1	10	6	9	7	6
	5	10	3	6	6	10
	10	10	3	4	8	1
	15	10	5	3	2	2
Sodium chloride	1	10	7	7	8	8
	5	10	5	7	5	7
	10	10	5	5	3	7
	15	10	6	6	4	4
Sodium nitrate	1	10	5	5	7	6
	5	10	4	9	4	6
	10	10	1	6	5	6
	15	10	1	3	4	2
Sodium phosphate	1	10	10	7	3	3
	5	10	8	7	6	5
	10	10	7	8	9	7
	15	10	7	8	4	3
Sodium sulphite	1	10	8	8	10	10
	5	10	7	6	8	9
	10	10	3	5	6	7
	15	10	3	5	5	2

TABLE 63. Resistance of sclerotia of *Sclerotium Oryzae-sativae* to various alkali-solutions

Alkalis	Concentration (%)	Number of sclerotia tested for each series	Number of living sclerotia after treatment for—			
			1	6	12	24 hours
Calcium carbonate	1	10	6	6	2	3
	5	10	6	7	3	4
	10	10	6	8	1	1
	15	10	5	3	2	3
Calcium nitrate	1	10	8	4	3	3
	5	10	9	4	3	7
	10	10	5	2	2	1
	15	10	5	3	5	2
Potassium chloride	1	10	10	10	9	10
	5	10	10	10	8	10
	10	10	10	10	10	10
	15	10	4	2	1	0
Potassium hydroxide	1	10	0	0	0	0
	5	10	0	0	0	0
	10	10	0	0	0	0
	15	10	0	0	0	0
Potassium nitrate	1	10	10	10	9	10
	5	10	10	10	7	8
	10	10	10	10	10	10
	15	10	3	1	1	1
Sodium carbonate	1	10	10	10	10	10
	5	10	10	10	10	10
	10	10	10	10	9	8
	15	10	1	1	1	0
Sodium chloride	1	10	6	3	4	2
	5	10	3	2	2	2
	10	10	5	2	2	1
	15	10	1	1	1	1
Sodium nitrate	1	10	4	4	4	2
	5	10	6	4	3	2
	10	10	3	2	1	1
	15	10	2	2	2	0
Sodium phosphate	1	10	10	10	10	10
	5	10	10	9	9	10
	10	10	10	10	10	10
	15	10	0	0	1	0
Sodium sulphite	1	10	5	4	6	5
	5	10	5	6	6	7
	10	10	3	6	4	4
	15	10	3	5	4	2

TABLE 64. Resistance of sclerotia of *Corticium Rolfsii* to various alkali-solutions

Alkalis	Concentration (%)	Number of sclerotia tested for each series	Number of living sclerotia after treatment for—			
			1	6	12	24 hours
Calcium carbonate	1	10	9	7	10	7
	5	10	8	6	5	5
	10	10	9	9	6	8
	15	10	6	8	6	3
Calcium nitrate	1	10	10	9	8	10
	5	10	8	4	4	4
	10	10	8	6	6	7
	15	10	7	7	2	0
Potassium chloride	1	10	10	10	10	10
	5	10	9	10	7	3
	10	10	9	9	8	2
	15	10	4	8	4	1
Potassium hydroxide	1	10	0	0	0	0
	5	10	0	0	0	0
	10	10	0	0	0	0
	15	10	0	0	0	0
Potassium nitrate	1	10	7	6	6	4
	5	10	5	5	6	3
	10	10	5	10	5	2
	15	10	4	6	5	2
Sodium carbonate	1	10	10	8	8	10
	5	10	8	4	0	0
	10	10	4	1	0	0
	15	10	4	0	0	0
Sodium chloride	1	10	7	6	6	4
	5	10	5	8	4	1
	10	10	5	7	3	1
	15	10	3	6	0	1
Sodium nitrate	1	10	4	3	3	2
	5	10	3	3	0	0
	10	10	4	3	0	0
	15	10	2	1	0	0
Sodium phosphate	1	10	10	8	7	8
	5	10	4	9	5	3
	10	10	4	8	4	3
	15	10	3	7	2	3

As shown in these tables, among various acids tested, arsenic acid, butyric acid, carboic acid, chromic acid, hydrochloric acid, nitric acid, picric acid,

pyrogallic acid and salicylic acid were extremely harmful to the sclerotia of these fungi. Among alkalis, on the other hand, potassium hydroxide, sodium carbonate and sodium nitrate proved to be very deleterious to the sclerotia of these fungi.

4. Influence of environmental factors upon the occurrence and severity of the diseases

As to the influence of environmental factors on the occurrence and severity of Sclerotium diseases, the writer has already investigated the subject in relation to air temperature, soil temperature, soil moisture, soil reaction and sunlight. His results, in part, have been reported in previous papers.^(23, 30, 37, 52)

(A) Influence of air temperature

The influence of air temperature on the occurrence and severity of a

TABLE 65. Influence of air temperature on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Strain used	Temperature (C.)	Series of experiments	Number of plants used	Number of diseased spots appeared after—				
				1 day	2 days	3 days	4 days	5 days
Japanese strain	24°	Inoculated	50	0	20	58	99	160*
		Control	50	0	0	0	0	
	28°	Inoculated	50	0	41	123	162	234*
		Control	50	0	0	0	0	
	32°	Inoculated	50	0	85	221	307*	406*
		Control	50	0	0	0	0	
	36°	Inoculated	50	0	0	0	0	0
		Control	50	0	0	0	0	0
Philippine strain	24°	Inoculated	40	0	16	31	38*	—
		Control	40	0	0	0	0	
	28°	Inoculated	90	0	130	333	560*	—
		Control	90	0	0	0	0	
	32°	Inoculated	70	0	145	377	635*	—
		Control	70	0	0	0	0	
	36°	Inoculated	20	0	0	0	0	—
		Control	20	0	0	0	0	

Remarks: * Diseased spots were so numerous that it was difficult to count clearly the number of them. Therefore, the actual number must be greater than those shown in the table.

Sclerotium disease caused by *Corticium Sasakii*, has been studied by the writer and his collaborator.⁽⁵²⁾

The development of the disease was observed in moist chambers at constant temperatures of 24°C., 28°C., 32°C. and 36°C. The sclerotium of the causal fungus was inserted between the leaf sheath and the culm of each fully grown plant in the pots, and then the treated plants were kept in moist chambers. The diseased spots on the inoculated plants were observed at previously determined intervals. The results are summarized in Table 65.

At 32°C. the disease was the most severe, and no diseased spots was produced at 36°C. The disease was less severe at 28°C. than at 32°C., but more serious than at 24°C. The writer was unable to find any marked difference between the Japanese and Philippine strains of the fungus.

Since it is also desirable to find the effect of moisture upon the infection by the fungus at known temperatures, the following experiments were conducted with the Japanese and Philippine strains. The plants were inoculated in the same manner as in the former experiments, and put in the moist chamber during a certain period and then placed on the greenhouse-bench. The fungus inoculated on the plant was removed as soon as the plant was taken out of the moist chamber. The experiments were repeated eight times for the Japanese strain and seven times for the Philippine strain. The results obtained are summarized in Table 66.

TABLE 66. Effect of moisture upon the infection by the fungus at various temperatures

Strain used	Experiment	Period in moist chamber (hours)	Number of plants used	Percentage of infection			
				24°C.	28°C.	32°C.	36°C.
Japanese strain	1st experiment	6	10	—	—	0	0
		12	10	—	—	0	0
		18	10	—	—	0	0
		24	10	—	—	0	0
	2nd experiment	6	10	—	—	0	0
		12	10	—	—	0	0
		18	10	—	—	0	0
		24	10	—	—	2)	0
	3rd experiment	6	10	—	—	0	0
		12	10	—	—	0	0
		18	10	—	—	0	0
		24	10	—	—	2)	0
	4th experiment	6	10	—	—	0	0
		12	10	—	—	0	0
		18	10	—	—	30	0
		24	10	—	—	40	0

TABLE 66. (Continued)

Strain used	Experiment	Period in moist chamber (hours)	Number of plants used	Percentage of infection				
				24°C.	28°C.	32°C.	36°C.	
Philippine strain	5th experiment	6	10	—	—	0	0	
		12	10	—	—	0	0	
		18	10	—	—	0	0	
		24	10	—	—	50	0	
	6th experiment	6	10	0	0	—	—	
		12	10	0	0	—	—	
		18	10	0	0	—	—	
		24	10	0	0	—	—	
	7th experiment	6	10	0	0	—	—	
		12	10	0	0	—	—	
		18	10	0	0	—	—	
		24	10	0	0	—	—	
	8th experiment	6	10	0	0	—	—	
		12	10	0	0	—	—	
		18	10	0	0	—	—	
		24	10	0	20	—	—	
	Philippine strain	1st experiment	6	10	—	—	0	0
			12	10	—	—	0	0
			18	10	—	—	10	0
			24	10	—	—	60	0
2nd experiment		6	10	—	—	0	0	
		12	10	—	—	0	0	
		18	10	—	—	0	0	
		24	10	—	—	10	0	
3rd experiment		6	10	—	—	0	0	
		12	10	—	—	0	0	
		18	10	—	—	20	0	
		24	10	—	—	60	0	
4th experiment		6	10	—	—	0	0	
		12	10	—	—	0	0	
		18	10	—	—	0	0	
		24	10	—	—	0	0	
5th experiment		6	10	—	—	0	0	
		12	10	—	—	0	0	
		18	10	—	—	0	0	
		24	10	—	—	40	0	
6th experiment		6	10	0	0	—	—	
		12	10	0	0	—	—	
		18	10	0	0	—	—	
		24	10	0	20	—	—	
7th experiment		6	10	0	0	—	—	
		12	10	0	0	—	—	
		18	10	0	20	—	—	
		24	10	0	20	—	—	

Remarks: "—" no test.

From these experiments it is evident that the most favorable temperatures for infection are 28°C. to 32°C. So far as the present experiments are concerned, infection is nearly impossible at 36°C. and 24°C. As already shown in Table 25 and Table 28 the mycelial growth and the mycelial development from the sclerotia are very vigorous at 28°C. to 32°C., showing the most vigorous growth at 32°C., where the infection by the fungus is also the most frequent. From these facts the writer comes to the conclusion that the effect of temperature on the infection by the fungus, is principally related to the direct effect of temperatures on the fungus itself.

(B) Influence of soil temperature

The influence of soil temperature on the occurrence and severity of a Sclerotium disease caused by *C. Sasakii*, has been studied by the writer⁽²⁶⁾ and a part of the results was published previously. In the experiment the writer used the constant soil temperature tanks⁽²⁴⁾ devised by him for maintaining a constant temperature of the soil. The fungus was first inoculated in the soil, and after 3 days clean seeds of rice (Sinriki variety) were sown. Five experiments were first made at the temperatures of 16°C., 20°C., 24°C. and 28°C., and also five experiments were repeated at the temperatures of 28°C., 32°C., 36°C. and 40°C. The results obtained are summarized in Table 67.

From these results it is clear that the occurrence of the disease is effected by soil temperature. The disease occurred slightly at 16°C., and gradually becomes severe with the increase of the temperature, being the most severe at 32°C. At temperatures above 32°C. the disease becomes again less severe with the rise of temperature and at 40°C. it ceases to occur.

In order to interpret these data correctly the relation of temperature to the mycelial growth and also to the mycelial development from the sclerotia must be taken into consideration. As described in the previous section, the mycelial growth and the mycelial development from the sclerotia are the most vigorous at 28°C. to 32°C. especially at 32°C. which agrees with the observation on the infection by the fungus.

The writer also investigated the relation of soil temperature to rice seedlings. The experiment was repeated six times in the same manner as was

employed in the inoculation experiment. The results obtained are summarized in Table 68.

TABLE 67. Influence of soil temperature on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

	Soil temperature (C.)	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings	Weight of healthy seedlings (gm.)
Inoculated	16°	400	380	27	353	15.6
	20°	400	390	168	222	11.8
	24°	400	380	223	157	9.8
	28°	400	394	308	86	6.1
	28°	400	387	173	214	15.5
	32°	400	382	196	186	15.6
	36°	400	377	122	255	20.0
	40°	400	381	0	381	22.5
Control	16°	400	389	0	389	17.6
	20°	400	390	0	390	21.2
	24°	400	390	0	390	25.3
	28°	400	387	0	387	27.1
	28°	400	395	0	395	25.1
	32°	400	391	0	391	26.0
	36°	400	391	0	391	25.5
	40°	400	389	0	389	22.5

TABLE 68. Influence of soil temperature on the growth of rice seedlings

Soil temperature (C.)	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
16°	300	289	14.1	0 - 8.0	3.965	0.5-11.5	6.388	1- 7	3
20°	300	296	17.4	0 -13.5	6.998	0.5-13.0	8.862	1- 6	4
24°	300	294	20.5	1.0-23.0	13.463	1.5-17.0	10.796	1- 6	5
28°	300	293	22.4	0.5-28.5	15.995	1.5-15.5	10.956	1- 6	5
28°	300	295	17.5	0 -26.0	17.784	2.5-22.3	12.612	1- 7	5
32°	300	293	19.5	0 -28.5	18.473	1.0-25.0	12.525	1- 9	5
36°	300	293	19.5	0.5-27.0	19.604	3.5-20.5	12.206	1-10	5
40°	300	292	17.0	0.5-24.0	16.475	2.0- 8.5	7.193	3-12	6

So far as shown by these experiments, the germination of rice seeds was most rapid at 32°-40°C. But the height and weight of seedlings were the

greatest at 32°–36°C. especially at 32°C. while length of roots was the greatest at 28°–36°C. From these results, the optimum soil temperature for the growth of rice seedlings seems to lie between 28°C. and 36°C. especially at about 32°C. This result agrees with those obtained in the other experiments^(61-63, 82, 100). On the other hand, the growth of mycelia and development of mycelia from sclerotia was most vigorous at 32°C. where the infection by the fungus was also the most frequent. The writer therefore came to the conclusion that the effect of soil temperature on the infection of rice seedlings by the fungus through the soil, is principally related to the direct effect of soil temperature on the fungus.

Similar experiments were made with *Sclerotium Oryzae-sativae*. Experiments were first repeated three times for 16°C., 20°C., 24°C. and 28°C. and then twice for temperatures of 28°C., 32°C., 36°C. and 40°C. The results obtained are summarized as follows:

TABLE 69. Influence of soil temperature on the occurrence and severity of the Sclerotium disease caused by *Sclerotium Oryzae-sativae*

Experiments	Soil temperature (C.)	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings	Weight of healthy seedlings (gm.)
Inoculated	16°	300	288	23	265	19.5
	20°	300	292	43	249	26.5
	24°	300	284	56	228	26.5
	28°	300	296	64	232	27.5
	28°	100	90	20	70	5.0
	32°	100	84	12	72	6.0
	36°	100	92	10	82	8.0
	40°	100	46	0	46	4.0
Control	16°	300	289	0	289	20.5
	20°	300	293	0	293	27.5
	24°	300	291	0	291	31.5
	28°	300	290	0	290	33.5
	28°	100	82	0	82	7.0
	32°	100	100	0	100	8.0
	36°	100	80	0	80	6.0
	40°	100	80	0	80	4.0

The infection of rice seedlings by *Sclerotium Oryzae-sativae* through the soil occurs at temperatures ranging from 16°C. to 36°C. From these results it is easily recognized that the optimum temperature for the occurrence of

disease caused by *Sclerotium Oryzae-sativae* is slightly lower than for *Corticium Sasakii*. The mycelial growth of the fungus is most vigorous at 28°C. to 32°C. especially at 28°C., which is lower than in the case of *Corticium Sasakii*. These facts suggest that the difference of the mode of the occurrence of the two diseases is due to the effect of soil temperature on the fungus and the fact that the optimum temperature for the mycelial growth of *Sclerotium Oryzae-sativae* is lower than that of *Corticium Sasakii* explains the occurrence of the former fungus in the northern parts of this country where the latter is never found.

(C) Influence of soil moisture

To learn the influence of soil moisture on the occurrence and severity of Sclerotium diseases of rice seedlings in the case of soil infection, experiments were made using *Corticium Sasakii* and *Sclerotium Oryzae-sativae*. The soil moistures were regulated by auto-irrigators^(48, 64) maintaining the mercury columns at 0 cm., 10 cm. and 20 cm. Experiments were repeated four times by the same method, but the soil moistures were slightly different in spite of the same height of mercury column of the auto-irrigator, according to the experiment. The results obtained are summarized as follows:

TABLE 70. Influence of soil moisture on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Experiments	Height of mercury column (cm.)	Soil moisture* (%)	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings
Inoculated	0	38.9-42.9	200	116	69	47
	10	29.9-35.5	200	143	66	77
	20	22.5-28.4	200	139	59	89
Control	0	38.9-42.9	200	123	0	123
	10	29.9-35.5	200	157	0	157
	20	22.5-28.4	200	163	0	163

Remarks: * percentage of the water holding capacity of soil in weight.

So far as these experiments show, the disease occurred at 22.5% to 42.9%, producing the greatest number of diseased seedlings at 38.9%-42.9%. Another experiment was made with dry soil and with soil covered with water. The results showed that the disease is more severe in the former than in the latter. The relation of the soil moisture to rice seedlings was also investigated and merely a slight difference was found in the height of the seedlings which had been grown at different soil moistures.

TABLE 71. Growth of rice seedlings at different soil moistures

Height of mercury column (cm.)	Soil moisture (%)	Number of seeds sown	Number of seeds germinated	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
0	38.9-42.9	200	116	6.5-27.5	17.957	4.5-14.5	9.627	3-16	9
10	29.9-35.5	200	127	2.5-26.5	14.413	7.0-14.5	9.773	1-11	8
20	22.5-28.4	200	139	2.0-22.5	13.585	3.5-15.0	9.543	1-12	7

From these results and those shown in Table 32, the close relation between the infection and mycelial growth is easily recognized. The results indicate that the effect of soil moisture on the mycelial growth of the fungus, at least in the case of rice seedling infected through the soil, is such as to favor greatly the occurrence and the severity of the disease. Similar experiments were made with *Sclerotium Oryzae-sativae* with four repetitions. The results are summarized in Table 72.

TABLE 72. Influence of soil moisture on the occurrence and severity of the disease caused by *Sclerotium Oryzae-sativae*

Experiments	Height of mercury column (cm.)	Soil moisture (%)	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings
Inoculated	0	45.2-52.2	200	194	71	123
	10	32.3-41.1	200	176	34	142
	20	23.5-25.8	200	160	9	151
Control	0	45.2-52.2	200	189	0	189
	10	32.3-41.1	200	163	0	163
	20	23.5-25.8	200	152	0	152

The result of these experiments shows that the occurrence of the disease varies according to the soil moisture. The disease took place at all percentages of soil moisture in these experiments, and it was the most severe at 45.2-52.2% moisture.

In these experiments the soil moisture did not cause any marked difference in the growth of rice seedlings, but it has already been shown in another section that it remarkably effects the mycelial growth which attains its most vigorous growth at 50%. The writer was thus led to the conclusion that the soil moisture directly effects the growth of the fungus.

(D) Influence of soil reaction

Recently the relation of the soil reaction to the occurrence of the disease was discussed by several investigators. The writer also studied the same problem in the case of rice seedlings infected through the soil by *Corticium Sasakii*. In this experiment glass-pots (10 cm. in diam. and 10.5 cm. in height) containing 400 cc. of clean sand were used. Two hundred cc. of KNOR's solution of different pH values adjusted with N/10 HCl and N/10 NaOH were put in the pots and the fungus was inoculated, and then rice seeds were planted. The experiments were repeated four times in the same manner, and the results obtained are summarized in Table 73.

TABLE 73. Influence of soil reaction on the occurrence and severity of the disease caused by *Corticium Sasakii*

pH of soil	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings	Weight of healthy seedlings (gm.)
2.61	200	163	46	117	10.0
2.79	200	166	62	104	9.0
2.96	200	154	52	102	8.5
3.12	200	157	65	92	7.5
3.39	200	165	78	87	7.0
3.81	200	167	64	103	7.5
4.05	200	164	74	90	8.0
4.81	200	160	95	65	5.5
5.68	200	169	97	72	6.5
6.36	200	168	95	73	6.5
6.60	200	168	94	74	6.5
7.01	200	169	55	114	10.0
7.75	200	167	50	117	11.5

The influence of soil reaction on the development of the disease is not yet absolutely clear. But, these results suggested that the disease occurs at pH 2.61 to pH 7.75 producing the infections most readily at pH 4.81 to pH 6.60 which corresponds to the condition at which the optimum growth of mycelia of the fungus occurs.

The writer also studied the relation of soil reaction to the growth of rice seedlings. The experiment was repeated six times using the same method as in the preceding experiment. The results obtained are summarized in Table 74.

So far as these experiments are concerned, the present writer could recognize no external difference on the growth of rice seedlings, and the physiological character remained untouched.

TABLE 74. Influence of soil reaction upon the growth of rice seedlings.

pH of soil	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
2.61	300	264	26.5	1.0-23.0	10.88	1.5-20.1	9.81	1- 9	5
2.79	300	253	27.0	0.5-24.0	9.95	0.8-20.3	9.62	1- 9	5
2.96	300	256	27.0	1.0-24.0	12.90	0.5-19.0	9.00	1-11	5
3.12	300	258	27.0	0.5-27.5	14.83	1.5-26.0	9.33	1-12	6
3.39	300	248	27.5	0.5-30.5	13.33	1.0-18.7	10.52	1- 9	5
3.81	300	231	27.5	1.5-23.5	14.24	1.5-18.5	9.48	1- 9	5
4.05	300	261	27.0	1.0-23.5	13.47	2.0-20.0	9.54	1- 9	6
4.81	300	261	27.0	0.5-29.3	13.79	1.5-20.0	9.49	1- 9	6
5.65	300	255	27.5	0.5-23.5	14.13	1.5-20.0	10.77	1- 9	5
6.36	300	267	27.0	0.5-20.5	12.58	1.5-20.0	10.39	1- 9	5
6.60	300	263	27.0	1.5-22.3	13.34	1.5-20.3	9.82	1- 9	5
7.01	300	268	27.0	0.5-23.5	12.68	0.5-21.0	10.22	1- 9	5
7.75	300	259	27.0	1.4-24.3	12.38	1.5-19.5	9.70	1- 9	6

In previous experiments the most vigorous mycelial growth of the fungus was observed at pH 5.44 to pH 6.67, at which the disease occurs most severely. From these results the close relation between the infection and the growth of mycelia is easily recognized. The writer therefore believes that the difference in the occurrence of the disease due to the soil reaction is principally attributed to the direct effect of the soil reaction on the fungus itself.

(E) Influence of sunlight

It has generally been known that the occurrence of plant disease is influenced greatly by sunlight. A good many papers on this subject have been published by several investigators^(41, 42, 65, 84, 98). These investigations, however, have been made on rust of cereals for the most part and on the development of the disease following infection, but studies on the effect upon the infection itself are as yet rather scanty. Recently ABE⁽²⁾ reported some interesting results of his study on rice blast. The present writer studied the effect of sunlight on the infection of the rice plant by *Corticium Sasakii*. In his investigation, rice plants (Miisinriki variety) fully grown in pots were used. A sclerotium for each plant was inserted between the leaf sheath and the culm. These inoculated plants were kept in the inoculation chamber regulated to maintain a constant temperature at 32°C. and were exposed to sunlight. After a certain lapse of time the pots were transferred into a dark inoculation chamber regulated to maintain the same condition as the former. Twenty-four hours after inoculation, all sclerotia were taken out from the host

plants and the pots were removed to the greenhouse at 28°—32°C. The water was not allowed to reach the aerial part of plants, and the results were observed after 5 days. The experiments were repeated seven times on bright sunny days in July and August, 1934. The results obtained are summarized as follows:

TABLE 75. Influence of sunlight on the infection of the rice plant by *Corticium Sasakii*

Length of exposure to sunlight (hours)	Number of plants tested	Number of plants infected	Number of diseased spots
0	70	21	37
3	70	9	13
6	70	4	5
12	70	0	0

As shown in the table, the infection occurred remarkably in the dark, the percentage of infection decreased with the increase of the time of exposure to sunlight, and when the plants were kept in the light for 12 hours, no infection was produced, although they had been kept for 24 hours under a moist condition.

In order to know the effect of sunlight on the growth of the fungus, an experiment was made employing the same apparatus as that used in the preceding experiment. The writer obtained a result indicating that the sunlight has a tendency to inhibit the development of mycelia from the sclerotia. From these facts, the writer concludes that the reduction of the infection on rice plants in the presence of sunlight is due to the direct effect of the sunlight on the fungus itself.

In the next experiment a study was made on the influence of sunlight upon the appearance of the diseased spot after the penetration of the fungus into the tissue of the rice plant. A sclerotium was put on the leaf sheath near the ligule in the same manner as in the previous experiment. The inoculated

TABLE 76. Influence of sunlight on the appearance of diseased spots on rice plants caused by *Corticium Sasakii*

	Number of plants used	Number of plants which showed diseased spots after—		
		1 day	2 days	3 days
In the light	26	9 (9)	13 (17)	13 (26)
In the dark	26	6 (6)	12 (9)	12 (19)

Remarks: () diseased spots.

plants were kept in a dark inoculation chamber at 32°C. After 24 hours all the sclerotia were taken out from the host plants, and one half of the inoculated plants were put in the greenhouse and the other half were placed in a dark chamber. Both series of the experiment were kept under the same conditions. The experiments were repeated three times in July and August, 1934. The results obtained are summarized in Table 76.

The above results show that the appearance of diseased spots after the penetration of the fungus into the tissue of the host plants is influenced by sunlight to a considerable extent. The diseased spots were produced more abundantly in sunlight than those in the dark.

(F) Influence of sodium chloride

The writer often observed that the Sclerotium disease caused by *Corticium Sasakii* occurred rarely on rice fields near the sea. It may be naturally attributed to a certain influence of sodium chloride either on the fungus or on the rice plant. Some experiments were made in order to learn the influence of sodium chloride on the rice seedlings and the fungus.

The fungus was inoculated in sand (100 cc.) put in a 250 cc. ERLENMYER'S flask, and the flask was moistened with 50 cc. of sodium chloride solutions of various concentrations. After one or two days clean rice seeds (Miisinriki variety) were sown in the sand. The experiments were repeated three times, with results as summarized in Table 77.

TABLE 77. Influence of sodium chloride on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Sodium chloride solution added	Inoculated			Control		
	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings
%						
0	120	120	76	120	120	0
0.01	120	120	52	120	120	0
0.05	120	120	35	120	120	0
0.10	120	120	29	120	120	0
0.50	120	120	8	120	120	0
1.00	120	120	0	120	120	0
5.00	120	0	0	120	0	0
10.00	120	0	0	120	0	0
15.00	120	0	0	120	0	0
20.00	120	0	0	120	0	0

The diseased seedlings greatly decreased in number with increase in the quantity of sodium chloride as shown in Table 77. The germination of seeds

was also depressed as the concentration of sodium chloride increased, and no germination was secured in the case of the concentration of 5% or more.

Similar experiments were also carried out with a 2000 cc. pot containing 150 cc. of field soil. Sodium chloride solution was applied in sufficient quantity to keep the water 2 cm. deep over the surface of the soil. The experiments were repeated twice and similar results were obtained, although the seedlings grown in 1% sodium chloride solution changed color to brown and finally died.

TABLE 78. Influence of sodium chloride on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Sodium chloride solution added	Inoculated			Control		
	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings
%						
0	200	200	47	200	200	0
0.01	200	200	43	200	200	0
0.05	200	200	16	200	200	0
0.10	200	200	4	200	200	0
0.50	200	200	0	200	200	0
1.00	200	200	0	200	200	0
5.00	200	0	0	200	0	0
10.00	200	0	0	200	0	0
15.00	200	0	0	200	0	0
20.00	200	0	0	200	0	0

From these results it is clear that the severity of the disease of rice seedlings caused by *Corticium Sasakii* decreases rapidly with increase in the quantity of sodium chloride in the soil. The disease never occurs when sodium chloride of 0.5% or more is added. The cause may be attributable to—(1) the influence of sodium chloride on the fungus, (2) the influence of sodium chloride on the host plant, or (3) the both. The writer, therefore, made some investigations on the influence of sodium chloride on the fungus alone. In this case a bit of the mycelial mass (0.5 cm. in diameter) was put on potato decoction agar containing sodium chloride of various concentrations. Experiments were conducted at 24°C., 28°C. and 32°C., each being repeated three times. The results obtained are summarized in Table 79.

As shown in Table 79, the growth of mycelium of the fungus on culture media was reduced by the addition of sodium chloride, and no growth was obtained when 10% or higher solution of sodium chloride was added. The host plant was also influenced by sodium chloride, and the growth or the germination was entirely stopped when sodium chloride of 1% or more was

TABLE 79. Effect of sodium chloride of various concentrations on the growth of mycelium of *Corticium Sasakii*

Sodium chloride added	Average diameter of the colony after 2 days at--		
	24°C.	28°C.	32°C.
0 %	7.766 cm.	8.166 cm.	9.266 cm.
0.01	7.266	8.000	8.766
0.05	7.266	7.633	8.966
0.10	6.133	7.400	9.044
0.50	5.166	6.600	7.266
1.00	4.066	5.666	6.333
5.00	0.533	0.666	0.800
10.00	0.500	0.500	0.500
15.00	0.500	0.500	0.500
20.00	0.500	0.500	0.500

added. These facts may show that the direct influence of sodium chloride on the fungus is one of the factors controlling the occurrence of this disease through soil infection, while the influence on the rice seedlings deserves further investigations.

V. Antagonistic action of microorganisms to the growth of mycelia and to the viability of the causal fungi, also their influence upon the occurrence and severity of the diseases

The diseases and their pathogenes are much influenced in their development and growth by the presence of other microorganisms. Since the appearance of PORTER'S⁽⁶⁶⁾ interesting report on the effect of bacteria on the infection of wheat seedlings by *Helminthosporium* a number of papers on similar subjects have been published by different authorities.^(4, 6, 18, 20, 21, 22, 24, 32, 33, 34, 38, 39, 40, 55, 56, 60, 72, 74, 75, 85, 91, 92, 105, 111, 112, 117) The writer has also been studying along the same line and has already published the results of his investigations on the antagonistic action of various microorganisms upon *Corticium Sasakii*, *Corticium Rolfsii* and *Sclerotium Oryzae-sativae*.^(18, 20, 21, 22, 24, 25, 31, 37, 38)

1. Influence of other microorganisms on the growth of mycelium

(A) Antagonistic action of various microorganisms on the growth of the causal fungi of *Sclerotium* diseases in culture media

A bacterium or a fungus and a sclerotium of the pathogene were ino-

culated on the agar medium (bouillon agar for the bacterium and SAITO's soy agar for the fungus) in a Petri dish to confront each other. All cultures (3 dishes for each series) were kept for 21 days at the temperatures of 24°C, 28°C. and 32°C. The first investigation was carried out on the effect of various microorganisms upon the growth of mycelium of *Corticium Sasakii*. The results are shown in Tables 80-97.

TABLE 80. Antagonistic action of various bacteria on the growth of *Corticium Sasakii* at 24°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	-	-	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	-	(+)
<i>Bac. butyricus</i>	++	++	-	+(+)
<i>Bac. cereus</i>	++	++	-	+++++
<i>Bac. coli</i>	+++	+++	-	+
<i>Bac. corallinus</i>	+++	+++	-	(+)
<i>Bac. dendroides</i>	+++	+++	-	(+)
<i>Bac. fluorescens liquefaciens</i>	++	+	-	+++++
<i>Bac. fluorescens non-liquefaciens</i>	-	+	+++++	+++++
<i>Bac. megatherium</i>	++	+	-	+++++
<i>Bac. mesentericus</i>	+++	+++	-	(+)
<i>Bac. mycoides</i>	+++	++	-	+++
<i>Bac. phytophthorus</i>	-	(+)	+++++	+++++
<i>Bac. prodigiosus</i>	+++	+++	-	(+)
<i>Bac. subtilis</i>	+++	+++	-	(+)
<i>Bac. ureae</i>	+++	+++	-	(+)
<i>Bact. beticolaum</i>	+++	+++	-	(+)
<i>Bact. Cannae</i>	++	++	-	+++++
<i>Bact. Citri</i>	+++	+++	-	(+)
<i>Bact. marginale</i>	++	++	-	+++++
<i>Bact. Martyniae</i>	+++	++	-	(+)
<i>Bact. medicaginis</i>	+++	+++	-	(+)
<i>Bact. michiganense</i>	-	(+)	+++++	+++++
<i>Bact. Phaseoli</i>	+++	+++	-	(+)
<i>Bact. rossicum</i>	++	++	+++	+++++
<i>Bact. Sojae</i>	+++	+++	-	(+)
<i>Bact. Syringae</i>	(+)	(+)	-	+++++
<i>Bact. tumefaciens</i>	+	+	-	+++++
<i>Bact. Vignae</i>	(+)	+	++++	+++++
<i>Bact. vitans</i>	+++	+++	-	(+)

Remarks: + present; - absent; (+) present, but very weak.

TABLE 81. Antagonistic action of various bacteria on the growth of *Corticium Sasakii* at 24°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	—	+++
<i>Bac. butyricus</i>	++	++	+++	+++++
<i>Bac. cereus</i>	+++	+++	+	+++++
<i>Bac. coli</i>	+++	+++	(+)	+++
<i>Bac. corallinus</i>	++	++	+++	+++++
<i>Bac. dendroides</i>	+++	+++	+	+++
<i>Bac. fluorescens liquefaciens</i>	+++	+++	+	+++++
<i>Bac. fluorescens non-liquefaciens</i>	—	+	+++++	+++++
<i>Bac. megatherium</i>	++	++	+++	+++++
<i>Bac. mesentericus</i>	+	+	+++	+++++
<i>Bac. mycoides</i>	+++	+++	+	+++++
<i>Bac. phytophthorus</i>	—	(+)	+++++	+++++
<i>Bac. prodigiosus</i>	+++	+++	(+)	+++
<i>Bac. subtilis</i>	+++	+++	(+)	++
<i>Bac. ureas</i>	+++	+++	+	+++++
<i>Bact. bellicolum</i>	+++	+++	(+)	+++
<i>Bact. Cannae</i>	++	+++	+++	+++++
<i>Bact. Citri</i>	+++	+++	+	+++
<i>Bact. marginale</i>	++	++	+	+++++
<i>Bact. Martyniae</i>	(+)	+	++++	+++++
<i>Bact. medicaginis</i>	(+)	+	++++	+++++
<i>Bact. michiganense</i>	—	+	+++++	+++++
<i>Bact. Phaseoli</i>	+++	+++	+	+++
<i>Bact. rossicum</i>	++	+++	+	+++++
<i>Bact. Sojae</i>	+++	+++	+	+++
<i>Bact. Syringae</i>	(+)	+	+++	+++++
<i>Bact. tumefaciens</i>	(+)	+++	+++	+++++
<i>Bact. Vignae</i>	(+)	+++	+++	+++++
<i>Bact. vitans</i>	+++	+++	+	+++

Remarks: The fungus was first inoculated and allowed to develop to 3 cm. in diam., and then the bacterium was inoculated on the opposite side of the dish.

TABLE 82. Antagonistic action of various bacteria on the growth of *Corticium Sasakii* at 28°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	-	-	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	-	(+)
<i>Bac. butyricus</i>	++	++	-	+(+)
<i>Bac. cereus</i>	++	++	-	+++++
<i>Bac. coli</i>	+++	+++	-	+
<i>Bac. corallinus</i>	+++	+++	-	(+)
<i>Bac. dendroides</i>	+++	+++	-	(+)
<i>Bac. fluorescens liquefaciens</i>	++	+	-	+++++
<i>Bac. fluorescens non-liquefaciens</i>	-	+	+++++	+++++
<i>Bac. megatherium</i>	++	+	-	+++++
<i>Bac. mesentericus</i>	+++	+++	-	(+)
<i>Bac. mycoides</i>	+++	+++	-	+++
<i>Bac. phytophthorus</i>	-	(+)	+++++	+++++
<i>Bac. prodigiosus</i>	+++	+++	-	(+)
<i>Bac. subtilis</i>	+++	+++	-	(+)
<i>Bac. ureae</i>	+++	+++	-	(+)
<i>Bact. beticolum</i>	+++	+++	-	(+)
<i>Bact. Cannae</i>	++	++	-	+++++
<i>Bact. Citri</i>	+++	+++	-	(+)
<i>Bact. marginale</i>	++	++	-	+++++
<i>Bact. Martyniae</i>	+++	++	-	(+)
<i>Bact. medicaginis</i>	+++	+++	-	-
<i>Bact. michiganense</i>	-	(+)	+++++	+++++
<i>Bact. Phaseoli</i>	+++	+++	-	(+)
<i>Bact. rossicum</i>	++	+++	++	+++++
<i>Bact. Sojae</i>	+++	+++	-	(+)
<i>Bact. Syringae</i>	(+)	(+)	-	+++++
<i>Bact. tumefaciens</i>	(+)	+	-	+++++
<i>Bact. Vignae</i>	(+)	+	+++++	+++++
<i>Bact. vitans</i>	+++	+++	-	(+)

TABLE 83. Antagonistic action of various bacteria on the growth of *Corticium Sasakii* at 28°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	++	+++	+	+++
<i>Bac. butyricus</i>	+	++	+++	+++
<i>Bac. cereus</i>	+++	+++	+	+++
<i>Bac. coli</i>	+++	+++	(+)	+++
<i>Bac. corallinus</i>	++	+++	+++	+++++
<i>Bac. dendroides</i>	+++	+++	+	+++
<i>Bac. fluorescens liquefaciens</i>	+++	+++	(+)	+++++
<i>Bac. fluorescens non-liquefaciens</i>	—	+	+++++	+++++
<i>Bac. megatherium</i>	+	+	+	+++
<i>Bac. mesentericus</i>	++	+++	+	++++
<i>Bac. mycoides</i>	+++	+++	+	+++
<i>Bac. phytophthorus</i>	—	+	+++++	+++++
<i>Bac. prodigiosus</i>	+++	+++	+	+++
<i>Bac. subtilis</i>	+++	+++	+	+++
<i>Bac. ureae</i>	+++	+++	+	+++
<i>Bact. beticolum</i>	+++	+++	+	+++
<i>Bact. Cannae</i>	++	+++	+++	+++++
<i>Bact. Citri</i>	+++	+++	(+)	+++
<i>Bact. marginale</i>	++	++	+	+++
<i>Bact. Martymiae</i>	++	++	+	+++
<i>Bact. medicaginis</i>	+++	+++	+	+++++
<i>Bact. michiganense</i>	—	+	+++++	+++++
<i>Bact. Phaseoli</i>	+++	+++	(+)	+++
<i>Bact. rossicum</i>	+++	+++	+	+++
<i>Bact. Sojae</i>	+++	+++	+	+++
<i>Bact. Syringae</i>	(+)	++	++++	+++++
<i>Bact. tumefaciens</i>	+	+++	+++	+++++
<i>Bact. Vignae</i>	(+)	+++	+++	+++++
<i>Bact. vitans</i>	+++	+++	+	+++

Remarks: The fungus was first inoculated and allowed to develop to 3 cm. in diam., and then the bacterium was inoculated on the opposite side of the dish.

TABLE 84. Antagonistic action of various bacteria on the growth of *Corticium Sasakii* at 32°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	—	(+)
<i>Bac. butyricus</i>	++	++	—	++
<i>Bac. cereus</i>	+++	+++	—	+++++
<i>Bac. coli</i>	+++	+++	—	+
<i>Bac. corallinus</i>	+++	+++	—	+++++
<i>Bac. dendroides</i>	+++	+++	—	+
<i>Bac. fluorescens liquefaciens</i>	+++	+++	—	+
<i>Bac. fluorescens non-liquefaciens</i>	—	+	+++++	+++++
<i>Bac. megatherium</i>	++	+	—	++++
<i>Bac. mesentericus</i>	+++	+++	—	+++
<i>Bac. mycoides</i>	+++	+++	—	+
<i>Bac. phytophthorus</i>	—	(+)	+++++	+++++
<i>Bac. prodigiosus</i>	+++	+++	—	+
<i>Bac. subtilis</i>	+++	+++	—	(+)
<i>Bac. ureae</i>	+++	+++	—	++++
<i>Bact. marginale</i>	++	++	—	(+)
<i>Bact. Martyniae</i>	+++	+++	(+)	++
<i>Bact. medicaginis</i>	+++	+++	(+)	+
<i>Bact. michiganense</i>	—	(+)	+++++	+++++
<i>Bact. Phaseoli</i>	+++	+++	—	(+)
<i>Bact. rossicum</i>	++	+++	++	+++++
<i>Bact. Sojae</i>	+++	+++	—	(+)
<i>Bact. Syringae</i>	(+)	(+)	—	++++
<i>Bact. tumefaciens</i>	(+)	(+)	+++	+++++
<i>Bact. Vignae</i>	(+)	+	+++++	+++++
<i>Bact. vitans</i>	+++	+++	—	(+)

TABLE 85. Antagonistic action of various bacteria on the growth of *Corticium Sasakii* at 32°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	+	+++
<i>Bac. butyricus</i>	++	+++	+++	++++
<i>Bac. cereus</i>	+++	+++	+	+++

TABLE 85. (Continued)

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
<i>Bac. coli</i>	+++	+++	(+)	+++
<i>Bac. corallinus</i>	+++	+++	+++	+++++
<i>Bac. dendroides</i>	+++	+++	+	+++++
<i>Bac. fluorescens liquefaciens</i>	+++	+++	(+)	+++
<i>Bac. fluorescens non-liquefaciens</i>	-	+	+++++	+++++
<i>Bac. megatherium</i>	++	++	+	+++++
<i>Bac. mesentericus</i>	+++	+++	++	+++++
<i>Bac. mycoides</i>	+++	+++	(+)	+++++
<i>Bac. phytophthorus</i>	-	-	+++++	+++++
<i>Bac. prodigiosus</i>	+++	+++	(+)	+++
<i>Bac. subtilis</i>	+++	+++	(+)	++
<i>Bac. ureae</i>	+++	+++	+	+++
<i>Bact. beticolum</i>	+++	+++	+	+++
<i>Bact. Cannae</i>	++	++	+++	+++++
<i>Bact. Citri</i>	+++	+++	(+)	+++
<i>Bact. marginale</i>	+++	+++	+	+++++
<i>Bact. Martyniae</i>	+++	+++	(+)	+++
<i>Bact. medicaginis</i>	+++	+++	++	+++
<i>Bact. michiganense</i>	-	+	+++++	+++++
<i>Bact. Phaseoli</i>	+++	+++	(+)	+++
<i>Bact. rossicum</i>	++	+++	++	+++
<i>Bact. Sojae</i>	+++	+++	+	+++
<i>Bact. Syringae</i>	(+)	+	+++++	+++++
<i>Bact. tumefaciens</i>	+	+++	+++	+++++
<i>Bact. Vignae</i>	(+)	+	+++++	+++++
<i>Bact. vitans</i>	+++	+++	+	+++

Remarks: The fungus was first inoculated and allowed to develop to 3 cm. in diam., and then the bacterium was inoculated on the opposite side of the dish.

TABLE 86. Antagonistic action of *Aspergillus niger* on the growth of *Corticium Sasakii* at 24°C.

Strain number of the fungus	Antagonistic action of <i>Asp. niger</i> used	Growth of mycelium of <i>Asp. niger</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony
None	-	-	+++++	+++++
<i>Asp. niger</i> (Stock No. 1)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 2)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 3)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 4)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 5)	++	+++	-	+++++

TABLE 86. (Continued)

Strain number of the fungus	Antagonistic action of <i>Asp. niger</i> used	Growth of mycelium of <i>Asp. niger</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony
<i>Asp. niger</i> (Stock No. 6)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 7)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 8)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 9)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 10)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 11)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 12)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 13)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 14)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 15)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 16)	++	+++	-	+++++

TABLE 87. Antagonistic action of *Aspergillus* spp. on the growth of *Corticium Sasakii* at 24°C.

Name of fungi	Antagonistic action of <i>Aspergillus</i> used	Growth of mycelium of <i>Aspergillus</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Aspergillus</i>	Counter part of the colony
None	-	-	+++++	+++++
<i>Asp. candidus</i>	-	+	+++++	+++++
<i>Asp. cellulosa</i>	++	++	-	+++++
<i>Asp. cinnamomeus</i>	+++	+++	-	+++++
<i>Asp. clavatus</i>	(+)	+	++++	+++++
<i>Asp. echinulatus</i>	-	+	+++++	+++++
<i>Asp. Fischeri</i>	(+)	++	++++	+++++
<i>Asp. flavipes</i>	-	+	+++++	+++++
<i>Asp. flavus</i>	+++	++	-	+++++
<i>Asp. fumigatus</i>	-	+	+	+++++
<i>Asp. gracilis</i>	++	++	-	+++++
<i>Asp. insuetus</i>	+	+	+++	+++++
<i>Asp. japonicus</i>	+	+	-	+++++
<i>Asp. Oryzae</i>	++	++	-	+++++
<i>Asp. parasiticus</i>	++	+++	-	+++++
<i>Asp. quercinus</i>	+	++	-	+++++
<i>Asp. repandus</i>	-	+	+++++	+++++
<i>Asp. repens</i>	++	++	-	+++++
<i>Asp. Schiemanni</i>	++	++	-	+++++
<i>Asp. sulphureus</i>	+	+	+++	+++++
<i>Asp. Sydowi</i>	-	+	++++	+++++
<i>Asp. Tamarii</i>	+++	+++	-	+++++
<i>Asp. tereus</i>	++	++	-	+++++
<i>Asp. terricola</i>				
<i>var. americana</i>	++	++	-	+++++
<i>Asp. ustus</i>	+	+	-	+++++
<i>Asp. versicolor</i>	-	+	+++++	+++++
<i>Asp. violaceo-fuscus</i>	++	++	-	+++++

TABLE 88. Antagonistic action of *Penicillium* spp. on the growth of *Corticium Sasakii* at 24°C.

Name of fungi	Antagonistic action of <i>Penicillium</i> used	Growth of mycelium of <i>Penicillium</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Penicillium</i>	Counter part of the colony
None	—	—	+++++	+++++
<i>Pen. avellaceum</i>	—	+	+++++	+++++
<i>Pen. brevicaulis</i>	—	+	+++++	+++++
<i>Pen. chrysogenum</i>	—	+	+++++	+++++
<i>Pen. citrinum</i>	+	+	—	+++++
<i>Pen. commune</i>	(+)	+	++++	+++++
<i>Pen. divaricatum</i>	—	++	+++++	+++++
<i>Pen. granulatum</i>	—	+	+++++	+++++
<i>Pen. lilacinum</i>	+	+	+	+++++
<i>Pen. Olsoni</i>	—	++	+++++	+++++
<i>Pen. oxalicum</i>	++	++	—	+++++
<i>Pen. roseum</i>	++	++	—	+++++
<i>Pen. silvaticum</i>	++	++	—	+++++
<i>Pen. Thomii</i>	+	++	+	+++++

TABLE 89. Antagonistic action of *Mucor* spp. and *Absidia* sp. on the growth of *Corticium Sasakii* at 24°C.

Name of fungi	Antagonistic action of the antagonist used	Growth of mycelium of the antagonist used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of antagonist	Counter part of the colony
None	—	—	+++++	+++++
<i>M. bedrechani</i>	+	+++	+++	+++++
<i>M. circinelloides</i>	++	+++	+	+++++
<i>M. racemosus</i>	+++	+++	—	+++++
<i>A. coerulea</i>	+++	+++	—	+++++

TABLE 90. Antagonistic action of *Aspergillus niger* on the growth of *Corticium Sasakii* at 28°C.

Strain number of the fungus	Antagonistic action of <i>Asp. niger</i> used	Growth of mycelium of <i>Asp. niger</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony
None	—	—	+++++	+++++
<i>Asp. niger</i> (Stock No. 1)	++	+++	—	+++++
<i>Asp. niger</i> (Stock No. 2)	++	+++	—	+++++
<i>Asp. niger</i> (Stock No. 3)	++	+++	—	+++++

TABLE 90. (Continued)

Strain number of the fungus	Antagonistic action of <i>Asp. niger</i> used	Growth of mycelium of <i>Asp. niger</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony
<i>Asp. niger</i> (Stock No. 4)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 5)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 6)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 7)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 8)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 9)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 10)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 11)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 12)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 13)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 14)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 15)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 16)	++	+++	-	+++++

TABLE 91. Antagonistic action of *Aspergillus* spp. on the growth of *Corticium Sasakii* at 28°C.

Name of fungi	Antagonistic action of <i>Aspergillus</i> used	Growth of mycelium of <i>Aspergillus</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Aspergillus</i>	Counter part of the colony
None	-	-	+++++	+++++
<i>Asp. candidus</i>	-	+	+++++	+++++
<i>Asp. cellulosa</i>	++	++	-	+++++
<i>Asp. cinnamomeus</i>	+++	+++	-	+++++
<i>Asp. clavatus</i>	(+)	+	+++++	+++++
<i>Asp. echinulatus</i>	-	++	+++++	+++++
<i>Asp. Fischeri</i>	(+)	+	-	+++++
<i>Asp. flavipes</i>	-	+	+++++	+++++
<i>Asp. flavus</i>	++	++	-	+++++
<i>Asp. fumigatus</i>	-	+	+++++	+++++
<i>Asp. gracilis</i>	++	++	-	+++++
<i>Asp. insuetus</i>	+	++	+++	+++++
<i>Asp. japonicus</i>	+++	+++	-	++
<i>Asp. Oryzae</i>	++	+++	-	+++++
<i>Asp. parasiticus</i>	++	++	-	+++++
<i>Asp. quercinus</i>	+	++	-	+++++
<i>Asp. repandus</i>	-	+	+++++	+++++
<i>Asp. repens</i>	++	++	-	+++++
<i>Asp. Schiemanni</i>	++	++	-	+++++
<i>Asp. sulphureus</i>	+	+	+++	+++++
<i>Asp. Sydowi</i>	-	+	+++++	+++++
<i>Asp. Tamaui</i>	+++	+++	-	(+)
<i>Asp. terreus</i>	++	++	-	+++++
<i>Asp. terricola var. americana</i>	++	++	-	+++++
<i>Asp. ustus</i>	+	+	-	+++++
<i>Asp. versicolor</i>	-	+	+++++	+++++
<i>Asp. violaceo-fuscus</i>	++	++	-	+++++

TABLE 92. Antagonistic action of *Penicillium* spp. on the growth of *Corticium Sasakii* at 28°C.

Name of fungi	Antagonistic action of <i>Penicillium</i> used	Growth of mycelium of <i>Penicillium</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Penicillium</i>	Counter part of the colony
None	—	—	+++++	+++++
<i>Pen. acellaneum</i>	—	+	+++++	+++++
<i>Pen. brevicaulis</i>	—	+	+++++	+++++
<i>Pen. chrysogenum</i>	—	+	+++++	+++++
<i>Pen. citrinum</i>	+	++	—	+++++
<i>Pen. commune</i>	(+)	+	++++	+++++
<i>Pen. divaricatum</i>	—	++	+++++	+++++
<i>Pen. granulatum</i>	—	+	+++++	+++++
<i>Pen. lilacinum</i>	+	++	++++	+++++
<i>Pen. Olsoni</i>	—	++	+++++	+++++
<i>Pen. oxalicum</i>	++	+++	—	(+)
<i>Pen. roseum</i>	++	+++	—	+++++
<i>Pen. silvaticum</i>	++	++	—	+++++
<i>Pen. Thomii</i>	+	++	+	+++++

TABLE 93. Antagonistic action of *Mucor* spp. and *Absidia* sp. on the growth of *Corticium Sasakii* at 28°C.

Name of fungi	Antagonistic action of the antagonist used	Growth of mycelium of the antagonist used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of antagonist	Counter part of the colony
None	—	—	+++++	+++++
<i>M. bedrchari</i>	+	+++	++++	+++++
<i>M. circinelloides</i>	++	++	—	+++++
<i>M. racemosus</i>	+++	+++++	—	+++++
<i>A. coerulea</i>	+++	+++	—	+++++

TABLE 94. Antagonistic action of *Aspergillus niger* on the growth of *Corticium Sasakii* at 32°C.

Strain number of the fungus	Antagonistic action of <i>Asp. niger</i> used	Growth of mycelium of <i>Asp. niger</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony
None	—	—	+++++	+++++
<i>Asp. niger</i> (Stock No. 1)	++	++	—	+++++
<i>Asp. niger</i> (Stock No. 2)	++	+++	—	+++++
<i>Asp. niger</i> (Stock No. 3)	+++	++	—	++
<i>Asp. niger</i> (Stock No. 4)	++	+++	—	+++++
<i>Asp. niger</i> (Stock No. 5)	++	+++	—	+++++

TABLE 94. (Continued)

Strain number of the fungus	Antagonistic action of <i>Asp. niger</i> used	Growth of mycelium of <i>Asp. niger</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony
<i>Asp. niger</i> (Stock No. 6)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 7)	+++	+++	-	+
<i>Asp. niger</i> (Stock No. 8)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 9)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 10)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 11)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 12)	++	+++	-	++++
<i>Asp. niger</i> (Stock No. 13)	++	+++	-	++++
<i>Asp. niger</i> (Stock No. 14)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 15)	++	+++	-	+++++
<i>Asp. niger</i> (Stock No. 16)	++	+++	-	+++++

TABLE 95. Antagonistic action of *Aspergillus* spp. on the growth of *Corticium Sasakii* at 32°C.

Name of fungi	Antagonistic action of <i>Aspergillus</i> used	Growth of mycelium of <i>Aspergillus</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Aspergillus</i>	Counter part of the colony
None	-	-	+++++	+++++
<i>Asp. candidus</i>	-	+	+++++	+++++
<i>Asp. cellulosa</i>	++	++	-	+++++
<i>Asp. cinnamomeus</i>	+++	+++	-	+++++
<i>Asp. clavatus</i>	(+)	+	++++	+++++
<i>Asp. echinulatus</i>	-	++	+++++	+++++
<i>Asp. Fischeri</i>	(+)	+	-	+++++
<i>Asp. flavipes</i>	-	+	+++++	+++++
<i>Asp. flavus</i>	++	++	-	+++++
<i>Asp. fumigatus</i>	-	+	+++++	+++++
<i>Asp. gracilis</i>	++	++	-	+++++
<i>Asp. insuetus</i>	+	++	+++	+++++
<i>Asp. japonicus</i>	++	+++	-	+++
<i>Asp. Oryzae</i>	++	++	-	+++++
<i>Asp. parasiticus</i>	++	++	-	+++++
<i>Asp. quercinus</i>	+	++	-	+++++
<i>Asp. repandus</i>	-	+	+++++	+++++
<i>Asp. repens</i>	++	++	-	+++++
<i>Asp. Schiemanii</i>	++	++	-	+++++
<i>Asp. sulphureus</i>	+	+	+++	+++++
<i>Asp. Sydowi</i>	-	+	+++++	+++++
<i>Asp. Tamarii</i>	+++	+++	-	+
<i>Asp. terreus</i>	++	++	-	+++++
<i>Asp. terricola</i> var. <i>americana</i>	++	++	-	+++++
<i>Asp. ustus</i>	+	+	-	+++++
<i>Asp. versicolor</i>	-	+	+++++	+++++
<i>Asp. violaceo-fuscus</i>	++	++	-	+++++

TABLE 96. Antagonistic action of *Penicillium* spp. on the growth of *Corticium Sasakii* at 32°C.

Name of fungi	Antagonistic action of <i>Penicillium</i> used	Growth of mycelium of <i>Penicillium</i> used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Penicillium</i>	Counter part of the colony
None	—	—	+++++	+++++
<i>Pen. avellaneum</i>	—	+	+++++	+++++
<i>Pen. brevicaulis</i>	—	+	+++++	+++++
<i>Pen. chrysogenum</i>	—	+	+++++	+++++
<i>Pen. citrinum</i>	+	+	—	+++++
<i>Pen. commune</i>	(+)	+	+++	+++++
<i>Pen. divaricatum</i>	—	+	+++++	+++++
<i>Pen. granulatum</i>	—	+	+++++	+++++
<i>Pen. lilacinum</i>	+	+	+++	+++++
<i>Pen. Olsoni</i>	—	+	+++++	+++++
<i>Pen. oxalicum</i>	++	++	—	+++++
<i>Pen. roseum</i>	++	++	—	+++++
<i>Pen. silvaticum</i>	++	++	—	+++++
<i>Pen. Thomii</i>	+	++	+++	+++++

TABLE 97. Antagonistic action of *Mucor* spp. and *Absidia* sp. on the growth of *Corticium Sasakii* at 32°C.

Name of fungi	Antagonistic action of the antagonist used	Growth of mycelium of the antagonist used	Growth of mycelium of <i>C. Sasakii</i>	
			Part of the colony facing the colony of antagonist	Counter part of the colony
None	—	—	+++++	+++++
<i>M. bedrechani</i>	+	+++	++	+++++
<i>M. circinelloides</i>	++	+++	+	+++++
<i>M. racemosus</i>	+++	+++	—	+++++
<i>A. coerulea</i>	+++	+++	—	+++++

From these results, it is shown that the antagonistic influence of bacteria upon the growth of *Corticium Sasakii* differs remarkably according to the species of bacteria.

Bacillus aroideae, *Bac. butyricus*, *Bac. coli*, *Bac. corallinus*, *Bac. cereus*, *Bac. dendroides*, *Bac. fluorescens liquefaciens*, *Bac. megatherium*, *Bac. mesentericus*, *Bac. mycoides*, *Bac. prodigiosus*, *Bac. subtilis*, *Bac. ureae*, *Bacterium beticolum*, *Bact. Cannae*, *Bact. Citri*, *Bact. marginale*, *Bact. Martyniae*, *Bact. medicaginis*, *Bact. Phaseoli*, *Bact. rossicum*, *Bact. Sojae*, and *Bact. vitans* were highly antagonistic to *Corticium Sasakii*. These bacteria infested the colony of the fungus and inhibited its mycelial growth.

Colonies of *Bacillus fluorescens non-liquefaciens*, *Bac. phytophthorus* and *Bact. michiganense* were entirely covered with the mycelia of *Corticium Sasakii*, thus showing no antagonistic influence upon the growth of the fungus.

Antagonistic action of 44 species of fungi, belonging to *Aspergillus*, *Penicillium*, *Mucor* and *Absidia*, was observed at various temperatures. *Aspergillus niger* (Stock No. 1), *Asp. niger* (Stock No. 2), *Asp. niger* (Stock No. 3), *Asp. niger* (Stock No. 4), *Asp. niger* (Stock No. 5), *Asp. niger* (Stock No. 6), *Asp. niger* (Stock No. 7), *Asp. niger* (Stock No. 8), *Asp. niger* (Stock No. 9), *Asp. niger* (Stock No. 10), *Asp. niger* (Stock No. 11), *Asp. niger* (Stock No. 12), *Asp. niger* (Stock No. 13), *Asp. niger* (Stock No. 14), *Asp. niger* (Stock No. 15), *Asp. niger* (Stock No. 16), *Asp. cellulosa*, *Asp. cinnamomeus*, *Asp. clavatus*, *Asp. Fischeri*, *Asp. flavus*, *Asp. gracilis*, *Asp. insuetus*, *Asp. japonicus*, *Asp. Oryzae*, *Asp. parasiticus*, *Asp. quercinus*, *Asp. repens*, *Asp. Schiemanni*, *Asp. sulphureus*, *Asp. Tamaris*, *Asp. terreus*, *Asp. terricola var. americana*, *Asp. ustus*, *Asp. violaceofuscus*, *Penicillium commune*, *Pen. lilacinum*, *Pen. oxalicum*, *Pen. roseum*, *Pen. silvaticum*, *Pen. Thomii*, *Mucor bedrchanii*, *M. circinelloides* and *Absidia coerulea* were proved to be antagonistic to the growth of *Corticium Sasakii* on the culture media, their mycelia covering the colony of the latter and retarding its growth.

Penicillium citrinum was somewhat antagonistic to *Corticium Sasakii*; both microorganisms stopped their growth leaving a sterile region between them.

Colonies of *Aspergillus candidus*, *Asp. echinulatus*, *Asp. flavipes*, *Asp. fumigatus*, *Asp. repandus*, *Asp. Sydowi*, *Asp. versicolor*, *Penicillium avellaneum*, *Pen. brevicaulis*, *Pen. chrysogenum*, *Pen. divaricatum*, *Pen. granulatum* and *Pen. Olsoni* were all covered with the mycelia of *Corticium Sasakii* on the culture media, having no effect on the growth of the latter.

The antagonistic action of various bacteria on the growth of *Sclerotium Oryzae-sativae* was studied by the same method as described above. The results obtained are tabulated in Tables 98-106.

TABLE 98. Antagonistic action of various bacteria on the growth of *Sclerotium Oryzae-sativae* at 24°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	+	+++
<i>Bac. cereus</i>	+++	+++	—	—
<i>Bac. coli</i>	+++	+++	(+)	+
<i>Bac. corallinus</i>	+++	+++	—	+
<i>Bac. dendroides</i>	+++	+++	—	+
<i>Bac. fluorescens liquefaciens</i>	+++	+++	—	+
<i>Bac. fluorescens non-liquefaciens</i>	—	+	+++++	+++++
<i>Bac. mesentericus</i>	++	++	—	+++
<i>Bac. mycoides</i>	+++	+++	—	+
<i>Bac. prodigiosus</i>	+++	+++	—	(+)
<i>Bac. subtilis</i>	+++	+++	—	(+)
<i>Bac. ureae</i>	+++	+++	—	(+)
<i>Bact. beticola</i>	++	+++	—	+
<i>Bact. Citri</i>	++	++	—	+
<i>Bact. medicaginis</i>	+++	+++	—	+
<i>Bact. michiganense</i>	+++	+++	—	(+)
<i>Bact. rossicum</i>	+++	+++	—	+++
<i>Bact. Sojae</i>	(+)	+	++	+++

TABLE 99. Antagonistic action of various bacteria on the growth of *Sclerotium Oryzae-sativae* at 24°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	—	++
<i>Bac. cereus</i>	+++	+++	—	++
<i>Bac. coli</i>	+++	+++	—	++
<i>Bac. corallinus</i>	+++	+++	—	++
<i>Bac. dendroides</i>	+++	+++	+	+++
<i>Bac. fluorescens liquefaciens</i>	+++	+++	+	+++
<i>Bac. fluorescens non-liquefaciens</i>	—	+	+++++	+++++
<i>Bac. mesentericus</i>	+	+	++	++++
<i>Bac. mycoides</i>	+++	+++	(+)	+++
<i>Bac. prodigiosus</i>	+++	+++	—	++
<i>Bac. subtilis</i>	+++	+++	—	++

TABLE 99. (Continued)

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the bacterium	Counter part of the colony
<i>Bac. ureae</i>	+++	+++	-	+++
<i>Bact. beticola</i>	+++	+++	-	++
<i>Bact. Citri</i>	+++	+++	-	++
<i>Bact. medicaginis</i>	++	+++	+++	+++++
<i>Bact. rossicum</i>	+++	+++	(+)	++
<i>Bact. Sojae</i>	+++	+++	-	++

Remarks: The fungus was first inoculated and allowed to develop to a diameter of 3 cm., and then the bacterium was inoculated on the opposite side of the dish.

TABLE 100. Antagonistic action of various bacteria on the growth of *Sclerotium Oryzae-sativae* at 28°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	-	-	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	+	+++
<i>Bac. cereus</i>	+++	+++	-	(+)
<i>Bac. coli</i>	+++	+++	-	+
<i>Bac. corallinus</i>	+++	+++	-	(+)
<i>Bac. dendroides</i>	+++	+++	-	+
<i>Bac. fluorescens liquefaciens</i>	+++	+++	-	++
<i>Bac. fluorescens non-liquefaciens</i>	-	(+)	+++	+++
<i>Bac. mesentericus</i>	++	++	-	+++
<i>Bac. mycoides</i>	+++	+++	-	(+)
<i>Bac. prodigiosus</i>	+++	+++	-	(+)
<i>Bac. subtilis</i>	+++	+++	-	(+)
<i>Bac. ureae</i>	+++	+++	-	(+)
<i>Bact. beticola</i>	+++	+++	-	+
<i>Bact. Citri</i>	+++	+++	-	(+)
<i>Bact. medicaginis</i>	+++	+++	-	(+)
<i>Bact. michiganense</i>	+++	+++	-	(+)
<i>Bact. rossicum</i>	+++	+++	+	+++
<i>Bact. Sojae</i>	+	+++	+++	+++++

TABLE 101. Antagonistic action of various bacteria on the growth of *Sclerotium Oryzae-sativae* at 28°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	—	++
<i>Bac. cereus</i>	+++	+++	+	+++
<i>Bac. coli</i>	+++	+++	—	++
<i>Bac. corallinus</i>	+++	+++	—	++
<i>Bac. dendroides</i>	+++	+++	—	+++
<i>Bac. fluorescens liquefaciens</i>	+++	+++	—	++
<i>Bac. fluorescens non-liquefaciens</i>	—	+	+++++	+++++
<i>Bac. mesentericus</i>	+	+++	+++	++++
<i>Bac. mycoides</i>	++	++	—	++++
<i>Bac. prodigiosus</i>	+++	+++	—	++
<i>Bac. subtilis</i>	+++	+++	—	++
<i>Bac. ureae</i>	+++	+++	—	++
<i>Bact. beticolum</i>	+++	+++	—	+++
<i>Bact. Citri</i>	+++	+++	+	+++
<i>Bact. medicaginis</i>	++	+++	+	++++
<i>Bact. rossicum</i>	+++	+++	+	+++
<i>Bact. Sojae</i>	+++	+++	—	++

Remarks: The fungus was first inoculated and allowed to develop to a diameter of 3 cm., and then the bacterium was inoculated on the opposite side of the dish.

TABLE 102. Antagonistic action of various bacteria on the growth of *Sclerotium Oryzae-sativae* at 32°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	+	++
<i>Bac. cereus</i>	+++	+++	—	(+)
<i>Bac. coli</i>	+++	+++	—	(+)
<i>Bac. corallinus</i>	+++	+++	—	(+)
<i>Bac. dendroides</i>	+++	+++	—	+
<i>Bac. fluorescens liquefaciens</i>	+++	+++	—	+
<i>Bac. fluorescens non-liquefaciens</i>	—	+	+++++	+++++
<i>Bac. mesentericus</i>	++	++	—	+++
<i>Bac. mycoides</i>	+++	+++	—	(+)
<i>Bac. prodigiosus</i>	+++	+++	—	+

TABLE 102. (Continued)

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the bacterium	Counter part of the colony
<i>Bac. subtilis</i>	+++	+++	-	(+)
<i>Bac. ureae</i>	+++	+++	-	(+)
<i>Bact. beticolum</i>	+++	+++	-	+
<i>Bact. Citri</i>	+++	+++	-	+
<i>Bact. medicaginis</i>	+++	+++	-	+
<i>Bact. michiganense</i>	+++	+++	-	(+)
<i>Bact. rossicum</i>	+++	+++	+	+++
<i>Bact. Sojae</i>	+++	+++	+++	++++

TABLE 103. Antagonistic action of various bacteria on the growth of *Sclerotium Oryzae-sativae* at 32°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	-	-	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	-	++
<i>Bac. cereus</i>	+++	+++	+	+++
<i>Bac. coli</i>	+++	+++	-	++
<i>Bac. corallinus</i>	++	+++	++	++++
<i>Bac. dendroides</i>	+++	+++	-	+++
<i>Bac. fluorescens liquefaciens</i>	+++	+++	-	++
<i>Bac. fluorescens non-liquefaciens</i>	-	+	+++++	+++++
<i>Bac. mesentericus</i>	+	+++	+++	++++
<i>Bac. mycoides</i>	++	++	-	++++
<i>Bac. prodigiosus</i>	+++	+++	-	++
<i>Bac. subtilis</i>	+++	+++	+	+++
<i>Bac. ureae</i>	+++	+++	-	++
<i>Bact. beticolum</i>	+++	+++	-	++
<i>Bact. Citri</i>	+++	+++	+	+++
<i>Bact. medicaginis</i>	++	+++	+	++++
<i>Bact. rossicum</i>	+++	+++	+	+++
<i>Bact. Sojae</i>	++	+++	-	++

Remarks: The fungus was first inoculated and allowed to develop to a diameter of 3 cm., and then the bacterium was inoculated on the opposite side of the dish.

TABLE 104. Antagonistic action of various fungi on the growth of *Sclerotium Oryzae-sativae* at 24°C.

Name of fungi	Antagonistic action of the antagonist used	Growth of mycelium of the antagonist used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the colony of antagonist	Counter part of the colony
None	—	—	+++++	+++++
<i>Asp. alliaceus</i>	++	++	+	++++
<i>Asp. amstelodami</i>	(+)	+	++++	+++++
<i>Asp. cinnamomeus</i>	+++	+++	—	++++
<i>Asp. echinulatus</i>	(+)	++	++++	+++++
<i>Asp. flavus</i>	++	++	+	++++
<i>Asp. fumigatus</i>	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 1)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 2)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 3)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 4)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 5)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 6)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 7)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 8)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 9)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 10)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 11)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 12)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 13)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 14)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 15)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 16)	+++	+++	—	+
<i>Asp. parasiticus</i>	+++	+++	—	(+)
<i>Asp. quercinus</i>	+++	+++	—	+++++
<i>Asp. sulphureus</i>	+	+	++	++++
<i>Asp. Sydowi</i>	++	++	+	+++++
<i>Asp. Tamarii</i>	+++	+++	—	(+)
<i>Asp. terreus</i>	+++	+++	—	+
<i>Asp. violaceo-fuscus</i>	+++	+++	—	+
<i>Pen. chrysogenum</i>	—	+	+++++	+++++
<i>Pen. citrinum</i>	++	++	+++	+++++
<i>Pen. commune</i>	(+)	+	++++	+++++
<i>Pen. granulatum</i>	—	(+)	+++++	+++++
<i>Pen. lilacinum</i>	—	++	+++++	+++++
<i>Pen. oxalicum</i>	—	+	+++++	+++++
<i>Pen. roseum</i>	—	+	+++++	+++++
<i>Mucor bedrechani</i>	+	+	+++	+++++
<i>M. racemosus</i>	—	+	+++++	+++++
<i>Absidia coerulea</i>	++	+++	++	+++++

TABLE 105. Antagonistic action of various fungi on the growth of *Sclerotium Oryzae-sativae* at 28°C.

Name of fungi	Antagonistic action of the antagonist used	Growth of mycelium of the antagonist used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the colony of antagonist	Counter part of the colony
None	—	—	+++++	+++++
<i>Asp. alliaceus</i>	++	++	+	+++++
<i>Asp. amstelodami</i>	(+)	+	++++	+++++
<i>Asp. cinnamomeus</i>	+++	+++	—	(+)
<i>Asp. echinulatus</i>	+	++	+++	+++++
<i>Asp. flavus</i>	+++	+++	(+)	++++
<i>Asp. fumigatus</i>	+++	+++	—	(+)
<i>Asp. niger</i> (Stock No. 1)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 2)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 3)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 4)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 5)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 6)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 7)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 8)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 9)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 10)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 11)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 12)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 13)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 14)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 15)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 16)	+++	+++	—	+
<i>Asp. parasiticus</i>	+++	+++	—	(+)
<i>Asp. quercinus</i>	+++	+++	(+)	++++
<i>Asp. sulphureus</i>	+	+	++	+++++
<i>Asp. Sydowi</i>	+++	+++	(+)	+++++
<i>Asp. Tamaritii</i>	+++	+++	—	(+)
<i>Asp. terreus</i>	+++	+++	—	+
<i>Asp. violaceo-fuscus</i>	+++	+++	—	+
<i>Pen. chrysogenum</i>	—	+	+++++	+++++
<i>Pen. citrinum</i>	++	++	+++	+++++
<i>Pen. commune</i>	(+)	+	++++	+++++
<i>Pen. granulatum</i>	—	(+)	+++++	+++++
<i>Pen. lilacinum</i>	—	(+)	+++++	+++++
<i>Pen. oxalicum</i>	—	+	+++++	+++++
<i>Pen. roseum</i>	++	++	++	+++++
<i>Mucor bedrchanii</i>	+	+	+++	+++++
<i>M. racemosus</i>	—	+	+++++	+++++
<i>Absidia coerulea</i>	++	++	+++	++++

TABLE 106. Antagonistic action of various fungi on the growth of *Sclerotium Oryzae-sativae* at 32°C.

Name of fungi	Antagonistic action of the antagonist used	Growth of mycelium of the antagonist used	Growth of mycelium of <i>S. Oryzae-sativae</i>	
			Part of the colony facing the colony of antagonist	Counter part of the colony
None	—	—	+++++	+++++
<i>Asp. alliaceus</i>	++	++	(+)	++++
<i>Asp. amstelodami</i>	(+)	+	++++	+++++
<i>Asp. cinnamomeus</i>	+++	+++	—	(+)
<i>Asp. echinulatus</i>	+	++	+++	+++++
<i>Asp. flavus</i>	+++	+++	(+)	+++
<i>Asp. fumigatus</i>	+++	+++	—	(+)
<i>Asp. niger</i> (Stock No. 1)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 2)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 3)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 4)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 5)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 6)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 7)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 8)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 9)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 10)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 11)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 12)	+++	++++	—	+
<i>Asp. niger</i> (Stock No. 13)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 14)	+++	+++	—	+
<i>Asp. niger</i> (Stock No. 15)	+++	+++++	—	+
<i>Asp. niger</i> (Stock No. 16)	+++	+++	—	+
<i>Asp. parasiticus</i>	+++	+++	—	(+)
<i>Asp. quercinus</i>	+++	+	—	++
<i>Asp. sulphureus</i>	+	+	++	+++++
<i>Asp. Sydowi</i>	+++	+++	—	+++++
<i>Asp. Tamaritii</i>	+++	+++	—	(+)
<i>Asp. terreus</i>	+++	+++	—	+
<i>Asp. violaceo-fuscus</i>	+++	+++	—	+
<i>Pen. chrysogenum</i>	—	+	+++++	+++++
<i>Pen. citrinum</i>	++	++	+++	+++++
<i>Pen. commune</i>	(+)	+	++++	+++++
<i>Pen. granulatum</i>	—	(+)	+++++	+++++
<i>Pen. lilacinum</i>	—	(+)	+++++	+++++
<i>Pen. oxalicum</i>	—	+	+++++	+++++
<i>Pen. roseum</i>	++	++	++	+++++
<i>Mucor bedrechani</i>	+	+	+++	++++
<i>M. racemosus</i>	—	+	+++++	+++++
<i>Absidia coerulea</i>	++	++	+++	+++++

From the above results, it seems obvious that the antagonistic action of bacteria on the growth of *S. Oryzae-sativae* also differs greatly according to the species of bacteria. *Bac. aroideae*, *Bac. cereus*, *Bac. coli*, *Bac. corallinus*, *Bac. dendroides*, *Bac. fluorescens liquefaciens*, *Bac. mesentericus*, *Bac. mycoides*, *Bac. prodigiosus*, *Bac. subtilis*, *Bac. ureae*, *Bact. beticolum*, *Bact. Citri*, *Bact. medicaginis*, *Bact. michiganense*, *Bact. rossicum* and *Bact. Sojae* were highly antagonistic to the growth of *S. Oryzae-sativae*, but *Bac. fluorescens non-liquefaciens* showed no influence on it.

The antagonistic action of various fungi on the growth of *S. Oryzae-sativae* also differs greatly according to the species used. *Asp. alliaceus*, *Asp. amstelodami*, *Asp. cinnamomeus*, *Asp. echinulatus*, *Asp. flavus*, *Asp. fumigatus*, *Asp. niger* (Stock No. 1), *Asp. niger* (Stock No. 2), *Asp. niger* (Stock No. 3), *Asp. niger* (Stock No. 4), *Asp. niger* (Stock No. 5), *Asp. niger* (Stock No. 6), *Asp. niger* (Stock No. 7), *Asp. niger* (Stock No. 8), *Asp. niger* (Stock No. 9), *Asp. niger* (Stock No. 10), *Asp. niger* (Stock No. 11), *Asp. niger* (Stock No. 12), *Asp. niger* (Stock No. 13), *Asp. niger* (Stock No. 14), *Asp. niger* (Stock No. 15), *Asp. niger* (Stock No. 16), *Asp. parasiticus*, *Asp. quercinus*, *Asp. sulphureus*, *Asp. Sydowi*, *Asp. Tamarii*, *Asp. terreus*, *Asp. violaceo-fuscus*, *Pen. citrinum*, *Pen. commune*, *Pen. roseum*, *Mucor bedrghani* and *Absidia coerulea* were antagonistic to *S. Oryzae-sativae*. The mycelia of these fungi covered the colony of the latter retarding its growth.

Colonies of *Pen. chrysogenum*, *Pen. granulatum*, *Pen. lilacinum*, *Pen. oxalicum* and *Mucor ramosus* were all covered with the mycelia of *S. Orgzae-sativae*, thus showing that they exerted no antagonistic influence upon the growth of the fungus.

In the next series of experiments, an investigation was made on the antagonism of various microorganisms to the mycelial growth of *Corticium Rolfsii*, with the results shown in Tables 107-120.

TABLE 107. Antagonistic action of various bacteria on the growth of *Corticium Rolfsii* at 24°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	—	+
<i>Bac. butyricus</i>	+++	+++	—	+
<i>Bac. cereus</i>	++	++	—	(+)

TABLE 107. (Continued)

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
<i>Bac. corallinus</i>	—	(+)	+++++	+++++
<i>Bac. dendroides</i>	+++	+++	—	(+)
<i>Bac. fluorescens liquefaciens</i>	+++	+++	—	(+)
<i>Bac. fluorescens non-liquefaciens</i>	—	++	+++++	+++++
<i>Bac. megatherium</i>	++	+	—	+++++
<i>Bac. mesentericus</i>	+++	+++	—	+
<i>Bac. phytophthorus</i>	—	(+)	+++++	+++++
<i>Bac. prodigiosus</i>	+++	+++	—	—
<i>Bac. ureae</i>	+++	+++	—	—
<i>Bact. beticola</i>	++	+	—	+++++
<i>Bact. Cannae</i>	+++	+++	—	—
<i>Bact. Citri</i>	+	+++	—	+++++
<i>Bact. marginale</i>	—	+	+++++	+++++
<i>Bact. Martyniae</i>	+	++	—	+
<i>Bact. medicaginis</i>	+	+	—	+++++
<i>Bact. michiganense</i>	—	(+)	+++++	+++++
<i>Bact. Phaseoli</i>	—	+	+++++	+++++
<i>Bact. rossicum</i>	+++	+++	—	(+)
<i>Bact. Sojae</i>	+++	+++	—	(+)
<i>Bact. Siringae</i>	+	+	—	+++++
<i>Bact. tumefaciens</i>	++	+	—	+++++
<i>Bact. Vignae</i>	—	+	+++++	+++++
<i>Bact. vitans</i>	+++	+++	—	—

TABLE 108. Antagonistic action of various bacteria on the growth of *Corticium Rolfsii* at 24°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+	+	—	+++++
<i>Bac. butyricus</i>	+	+	—	+++++
<i>Bac. cereus</i>	++	++	—	+++++
<i>Bac. corallinus</i>	—	(+)	+++++	+++++
<i>Bac. dendroides</i>	+++	+++	—	+
<i>Bac. fluorescens liquefaciens</i>	++	++	—	+++++
<i>Bac. fluorescens non-liquefaciens</i>	—	+	+++++	+++++
<i>Bac. megatherium</i>	++	++	—	+++++
<i>Bac. mesentericus</i>	+	+	—	+++++

TABLE 108. (Continued)

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
<i>Bac. phytophthorus</i>	-	(+)	+++++	+++++
<i>Bac. prodigiosus</i>	+	(+)	-	+++++
<i>Bac. ureae</i>	+	+	-	(+)
<i>Bact. beticolum</i>	+	+	+++	+++++
<i>Bact. Cannae</i>	+	+	-	+++++
<i>Bact. Citri</i>	+	++	-	+++++
<i>Bact. marginale</i>	-	(+)	+++++	+++++
<i>Bact. Martyniae</i>	+	+	-	+++++
<i>Bact. medicaginis</i>	+	++	-	+++++
<i>Bact. michiganense</i>	-	+	+++++	+++++
<i>Bact. Phaseoli</i>	-	(+)	+++++	+++++
<i>Bact. rossicum</i>	+	+	-	+++++
<i>Bact. Sojae</i>	++	++	-	+++++
<i>Bact. Syringae</i>	+	(+)	+++++	-
<i>Bact. tumefaciens</i>	+	(+)	+++++	+++++
<i>Bact. Vignae</i>	-	(+)	+++++	+++++
<i>Bact. vitans</i>	++	++	-	+++++

Remarks: The fungus was first inoculated and allowed to develop to a diameter of 3 cm., and then the bacterium was inoculated on the opposite side of the dish.

TABLE 109. Antagonistic action of various bacteria on the growth of *Corticium Rolfsii* at 28°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
		Part of the colony facing the bacterium	Counter part of the colony
None	-	+++++	+++++
<i>Bac. aroideae</i>	+++	-	+
<i>Bac. butyricus</i>	+++	-	++
<i>Bac. cereus</i>	++	-	(+)
<i>Bac. corallinus</i>	-	+++++	+++++
<i>Bac. dendroides</i>	+++	-	-
<i>Bac. fluorescens liquefaciens</i>	++	-	+++++
<i>Bac. fluorescens non-liquefaciens</i>	-	+++++	+++++
<i>Bac. megatherium</i>	++	-	+++++
<i>Bac. mesentericus</i>	++	-	-
<i>Bac. phytophthorus</i>	-	+++++	+++++
<i>Bac. prodigiosus</i>	+++	-	-
<i>Bac. ureae</i>	+++	-	+++++
<i>Bact. beticolum</i>	++	-	+++++
<i>Bact. Cannae</i>	+++	-	+++++

TABLE 109. (Continued)

Name of bacteria	Antagonistic action of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
		Part of the colony facing the bacterium	Counter part of the colony
<i>Bact. Citri</i>	(+)	+++	+++++
<i>Bact. marginale</i>	-	+++++	+++++
<i>Bact. Martyniae</i>	+	-	+++++
<i>Bact. medicaginis</i>	+	+++	+++++
<i>Bact. michiganense</i>	-	+++++	+++++
<i>Bact. Phaseoli</i>	-	+++++	+++++
<i>Bact. rossicum</i>	+++	-	-
<i>Bact. Sojae</i>	+++	-	-
<i>Bact. Syringae</i>	+	-	+++++
<i>Bact. tumefaciens</i>	++	-	++++
<i>Bact. Vignae</i>	-	++++	+++++
<i>Bact. vitans</i>	+++	-	-

TABLE 110. Antagonistic action of various bacteria on the growth of *Corticium Rolfsii* at 28°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	-	-	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	-	++
<i>Bac. butyricus</i>	+++	+++	-	+++++
<i>Bac. corallinus</i>	-	(+)	+++++	+++++
<i>Bac. cereus</i>	++	++	-	++++
<i>Bac. dendroides</i>	+++	+++	-	+
<i>Bac. fluorescens liquefaciens</i>	++	+	-	+++++
<i>Bac. fluorescens non-liquefaciens</i>	-	+	+++++	+++++
<i>Bac. megatherium</i>	++	+	-	+++++
<i>Bac. mesentericus</i>	+	+	-	+
<i>Bac. phytophthorus</i>	-	(+)	+++++	+++++
<i>Bac. prodigiosus</i>	+	+	-	+++++
<i>Bac. ureae</i>	+++	+++	-	-
<i>Bact. beticolum</i>	+	+	-	+++
<i>Bact. Cannae</i>	+	+	-	+++++
<i>Bact. Citri</i>	+	++	-	++++
<i>Bact. marginale</i>	-	(+)	+++++	+++++
<i>Bact. Martyniae</i>	+	+	-	+++++
<i>Bact. medicaginis</i>	+	++	-	+++
<i>Bact. michiganense</i>	-	+	+++++	+++++
<i>Bact. Phaseoli</i>	-	(+)	+++++	+++++
<i>Bact. rossicum</i>	+++	+++	-	+

TABLE 110. (Continued)

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
<i>Bact. Sojae</i>	+++	+++	—	+
<i>Bact. Syringae</i>	+	+	—	+++++
<i>Bact. tumefaciens</i>	++	(+)	—	+++++
<i>Bact. Vignae</i>	—	(+)	+++++	+++++
<i>Bact. vitans</i>	++	++	—	+++++

Remarks: The fungus was first inoculated and allowed to develop to a diameter of 3 cm., and then the bacterium was inoculated on the opposite side of the dish.

TABLE 111. Antagonistic action of various bacteria on the growth of *Corticium Rolfsii* at 32°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	—	—	+++++	+++++
<i>Bac. aroideae</i>	+++	+++	—	(+)
<i>Bac. butyricus</i>	+++	+++	—	+++
<i>Bac. cereus</i>	++	+++	—	(+)
<i>Bac. corallinus</i>	—	(+)	+++++	+++++
<i>Bac. dendroides</i>	+++	+++	—	—
<i>Bac. fluorescens liquefaciens</i>	++	++	—	++++
<i>Bac. fluorescens non-liquefaciens</i>	—	++	+++++	+++++
<i>Bac. megatherium</i>	++	++	—	+++++
<i>Bac. mesentericus</i>	++	++	—	+++++
<i>Bac. phytophthorus</i>	—	(+)	+++++	+++++
<i>Bac. prodigiosus</i>	+++	+++	—	—
<i>Bac. ureae</i>	+++	+++	—	—
<i>Bact. beticolum</i>	+	(+)	—	+++++
<i>Bact. Cannae</i>	+++	+++	—	—
<i>Bact. Citri</i>	++	(+)	—	++++
<i>Bact. marginale</i>	—	(+)	+++++	+++++
<i>Bact. Martyniae</i>	+	++	—	+++++
<i>Bact. medicaginis</i>	+	(+)	—	+++++
<i>Bact. michiganense</i>	—	(+)	+++++	+++++
<i>Bact. Phaseoli</i>	—	(+)	+++++	+++++
<i>Bact. rossicum</i>	+++	+++	—	—
<i>Bact. Sojae</i>	+++	+++	—	—
<i>Bact. Syringae</i>	+	(+)	—	+++++
<i>Bact. tumefaciens</i>	++	+	—	+++++
<i>Bact. Vignae</i>	—	(+)	+++++	+++++
<i>Bact. vitans</i>	+++	+++	—	—

TABLE 112. Antagonistic action of various bacteria on the growth of *Corticium Rolfsii* at 32°C.

Name of bacteria	Antagonistic action of the bacterium used	Growth of the bacterium used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the bacterium	Counter part of the colony
None	--	—	+++++	+++++
<i>Bac. aroideae</i>	+	+	—	+++++
<i>Bac. butyricus</i>	+	+	—	+++++
<i>Bac. corallinus</i>	—	(+)	+++++	+++++
<i>Bac. cereus</i>	++	++	—	+++++
<i>Bac. dendroides</i>	+++	+++	—	+
<i>Bac. fluorescens liquefaciens</i>	++	++	—	+++++
<i>Bac. fluorescens non-liquefaciens</i>	—	+	+++++	+++++
<i>Bac. megatherium</i>	++	+	—	+++++
<i>Bac. mesentericus</i>	+	+	—	+++++
<i>Bac. phytophthorus</i>	—	(+)	+++++	+++++
<i>Bac. prodigiosus</i>	+	(+)	—	+++++
<i>Bac. ureae</i>	+	+	—	(+)
<i>Bact. beticolum</i>	+	+	—	+++++
<i>Bact. Cannae</i>	+	+	—	+++++
<i>Bact. Citri</i>	+	++	—	+++++
<i>Bact. marginale</i>	—	(+)	+++++	+++++
<i>Bact. Martyniae</i>	+	+	—	+++++
<i>Bact. medicaginis</i>	+	++	—	+++++
<i>Bact. michiganense</i>	—	+	+++++	+++++
<i>Bact. Phaseoli</i>	—	(+)	+++++	+++++
<i>Bact. rossicum</i>	+	+	—	+++++
<i>Bact. Sojae</i>	++	++	—	+++++
<i>Bact. Syringae</i>	+	(+)	—	+++++
<i>Bact. tumefaciens</i>	++	+	—	+++++
<i>Bact. Vignae</i>	—	(+)	+++++	+++++
<i>Bact. vitans</i>	++	++	—	+++++

Remarks: The fungus was first inoculated and allowed to develop to a diameter of 3 cm., and then the bacterium was inoculated on the opposite side of the dish.

TABLE 113. Antagonistic action of *Aspergillus niger* on the growth of *Corticium Rolfsii* at 24°C.

Strain number of the fungus	Antagonistic action of <i>A. niger</i> used	Growth of Mycelium of <i>A. niger</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>A. niger</i>	Counter part of the colony
None			+++++	+++++
<i>A. niger</i> (Stock No. 1)	--	+++	+++++	+++++
<i>A. niger</i> (Stock No. 2)	--	++	+++++	+++++

TABLE 113. (Continued)

Strain number of the fungus	Antagonistic action of <i>A. niger</i> used	Growth of mycelium of <i>A. niger</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>A. niger</i>	Counter part of the colony
<i>A. niger</i> (Stock No. 3)	(+)	++	+++++	+++++
<i>A. niger</i> (Stock No. 4)	(+)	++	+++++	+++++
<i>A. niger</i> (Stock No. 5)	-	++	+++++	+++++
<i>A. niger</i> (Stock No. 6)	-	++	+++++	+++++
<i>A. niger</i> (Stock No. 7)	(+)	++	++++	+++++
<i>A. niger</i> (Stock No. 8)	(+)	+++	++++	+++++
<i>A. niger</i> (Stock No. 9)	-	++	+++++	+++++
<i>A. niger</i> (Stock No. 10)	-	++	+++++	+++++
<i>A. niger</i> (Stock No. 11)	-	++	+++++	+++++
<i>A. niger</i> (Stock No. 12)	-	++	+++++	+++++
<i>A. niger</i> (Stock No. 13)	(+)	++	++++	+++++
<i>A. niger</i> (Stock No. 14)	(+)	++	++++	+++++
<i>A. niger</i> (Stock No. 15)	-	++	+++++	+++++
<i>A. niger</i> (Stock No. 16)	-	++	++++	+++++

TABLE 114. Antagonistic action of *Aspergillus* spp. on the growth of *Corticium Rolfsii* at 24°C.

Name of fungi	Antagonistic action of <i>Aspergillus</i> used	Growth of mycelium of <i>Aspergillus</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Aspergillus</i>	Counter part of the colony
None			+++++	+++++
<i>A. amstelodami</i>	-	(+)	+++++	+++++
<i>A. candidus</i>	-	(+)	+++++	+++++
<i>A. cellulosa</i>	-	+	+++++	+++++
<i>A. cinnamomeus</i>	-	++	+++++	+++++
<i>A. clavatus</i>	-	++	+++++	+++++
<i>A. echinulatus</i>	-	(+)	+++++	+++++
<i>A. Fischeri</i>	-	++	+++++	+++++
<i>A. flavipes</i>	-	+	+++++	+++++
<i>A. flavus</i>	-	++	+++++	+++++
<i>A. fumigatus</i>	-	(+)	+++++	+++++
<i>A. glaucus</i> (Stock No. 1)	-	(+)	+++++	+++++
<i>A. glaucus</i> (Stock No. 2)	-	(+)	+++++	+++++
<i>A. insuetus</i>	-	+	+++++	+++++
<i>A. japonicus</i>	-	+++	+++++	+++++
<i>A. medius</i>	-	+	+++++	+++++
<i>A. Oryzae</i>	-	+	+++++	+++++
<i>A. parasiticus</i>	(+)	++	++	+++++
<i>A. quercinus</i>	-	+	+++++	+++++
<i>A. repandus</i>	-	+	+++++	+++++
<i>A. repens</i>	-	++	+++++	+++++
<i>A. Schiemanni</i>	-	++	+++++	+++++

TABLE 114. (Continued)

Name of fungi	Antagonistic action of <i>Aspergillus</i> used	Growth of mycelium of <i>Aspergillus</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Aspergillus</i>	Counter part of the colony
<i>A. Sydowi</i>	—	+	+++++	+++++
<i>A. Tamarii</i>	(+)	++	++++	+++++
<i>A. terreus</i>	—	—	+++++	+++++
<i>A. terricola</i> var. <i>americana</i>	—	(+)	+++++	+++++
<i>A. ustus</i>	—	+	+++++	+++++
<i>A. versicolor</i>	—	(+)	+++++	+++++
<i>A. violaceo-fuscus</i>	(+)	++	++++	+++++

TABLE 115. Antagonistic action of *Penicillium* spp. on the growth of *Corticium Rolfsii* at 24°C.

Name of fungi	Antagonistic action of <i>Penicillium</i> used	Growth of mycelium of <i>Penicillium</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Penicillium</i>	Counter part of the colony
None			+++++	+++++
<i>P. avellaneum</i>	—	+	+++++	+++++
<i>P. brevicaulis</i>	—	+	+++++	+++++
<i>P. chrysogenum</i>	—	+	+++++	+++++
<i>P. citrinum</i>	—	+	+++++	+++++
<i>P. commune</i>	—	+	+++++	+++++
<i>P. divaricatum</i>	—	++	+++++	+++++
<i>P. granulatum</i>	—	++	+++++	+++++
<i>P. lilacinum</i>	—	(+)	+++++	+++++
<i>P. Olsoni</i>	—	+	+++++	+++++
<i>P. oxalicum</i>	—	++	+++++	+++++
<i>P. raseum</i>	—	+	+++++	+++++
<i>P. silvaticum</i>	—	+	+++++	+++++
<i>P. Thomii</i>	—	+++	+++++	+++++

TABLE 116. Antagonistic action of *Mucor* spp. and *Absidia* sp. on the growth of *Corticium Rolfsii* at 24°C.

Name of fungi	Antagonistic action of the antagonist used	Growth of mycelium of the antagonist used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of antagonist	Counter part of the colony
None			+++++	+++++
<i>M. bedrachani</i>	—	+++	+++++	+++++
<i>M. circinelloides</i>	—	+++	+++++	+++++
<i>M. racemosus</i>	—	+++	+++++	+++++
<i>A. coerulea</i>	—	+++	+++++	+++++

TABLE 117. Antagonistic action of *Aspergillus niger* on the growth of *Corticium Rolfsii* at 28°C.

Strain number of the fungus	Antagonistic action of <i>Asp. niger</i> used	Growth of mycelium of <i>Asp. niger</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>A. niger</i>	Counter part of the colony
None	—	—	+++++	+++++
<i>A. niger</i> (Stock No. 1)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 2)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 3)	(+)	++	++++	+++++
<i>A. niger</i> (Stock No. 4)	(+)	++	++++	+++++
<i>A. niger</i> (Stock No. 5)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 6)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 7)	(+)	+++	+++	+++++
<i>A. niger</i> (Stock No. 8)	(+)	+++	++++	+++++
<i>A. niger</i> (Stock No. 9)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 10)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 11)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 12)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 13)	(+)	++	++++	+++++
<i>A. niger</i> (Stock No. 14)	(+)	++	++++	+++++
<i>A. niger</i> (Stock No. 15)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 16)	—	+++	++++	+++++

TABLE 118. Antagonistic action of *Aspergillus* spp. on the growth of *Corticium Rolfsii* at 28°C.

Name of fungi	Antagonistic action of <i>Aspergillus</i> used	Growth of mycelium of <i>Aspergillus</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Aspergillus</i>	Counter part of the colony
None	—	—	+++++	+++++
<i>A. amstelodami</i>	—	(+)	+++++	+++++
<i>A. candidus</i>	—	(+)	+++++	+++++
<i>A. cellulosae</i>	—	++	+++++	+++++
<i>A. cinnamomeus</i>	—	++	+++++	+++++
<i>A. clavatus</i>	—	+	+++++	+++++
<i>A. echinulatus</i>	—	(+)	+++++	+++++
<i>A. Fischeri</i>	—	++	+++++	+++++
<i>A. flavipes</i>	—	++	+++++	+++++
<i>A. flavus</i>	—	++	+++++	+++++
<i>A. fumigatus</i>	—	+	+++++	+++++
<i>A. glaucus</i> (Stock No. 1)	—	(+)	+++++	+++++
<i>A. glaucus</i> (Stock No. 2)	—	(+)	+++++	+++++
<i>A. gracilis</i>	—	(+)	+++++	+++++
<i>A. insuetus</i>	—	++	+++++	+++++
<i>A. japonicus</i>	—	+++	+++++	+++++
<i>A. medius</i>	—	++	+++++	+++++
<i>A. Oryzae</i>	—	(+)	+++++	+++++
<i>A. parasiticus</i>	(+)	++	+++	+++++
<i>A. quercinus</i>	—	++	+++++	+++++
<i>A. repandus</i>	—	(+)	+++++	+++++

TABLE 118. (Continue)

Name of fungi	Antagonistic action of <i>Aspergillus</i> used	Growth of mycelium of <i>Aspergillus</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Aspergillus</i>	Counter part of the colony
<i>A. repens</i>	—	++	+++++	+++++
<i>A. Schiemanni</i>	(+)	++	+++++	+++++
<i>A. Sydowi</i>	—	(+)	+++++	+++++
<i>A. Tamarii</i>	(+)	+++	+++++	+++++
<i>A. terreus</i>	—	+	+++++	+++++
<i>A. terricola</i> var. <i>americana</i>	—	(+)	+++++	+++++
<i>A. ustus</i>	—	++	+++++	+++++
<i>A. versicolor</i>	—	(+)	+++++	+++++
<i>A. violaceo-fuscus</i>	(+)	++	+++++	+++++

TABLE 119. Antagonistic action of *Penicillium* spp. on the growth of *Corticium Rolfsii* at 28°C.

Name of fungi	Antagonistic action of <i>Penicillium</i> used	Growth of mycelium of <i>Penicillium</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Penicillium</i>	Counter part of the colony
None	—	—	+++++	+++++
<i>P. avellaneum</i>	—	++	+++++	+++++
<i>P. brevicaulis</i>	—	++	+++++	+++++
<i>P. chrysogenum</i>	—	++	+++++	+++++
<i>P. citrinum</i>	—	++	+++++	+++++
<i>P. commune</i>	—	++	+++++	+++++
<i>P. divaricatum</i>	—	++	+++++	+++++
<i>P. granulosum</i>	—	(+)	+++++	+++++
<i>P. lilacinum</i>	—	(+)	+++++	+++++
<i>P. Olsoni</i>	—	(+)	+++++	+++++
<i>P. oxalicum</i>	—	(+)	+++++	+++++
<i>P. roseum</i>	—	(+)	+++++	+++++
<i>P. silvaticum</i>	—	(+)	+++++	+++++
<i>P. Thomii</i>	—	++	+++++	+++++

TABLE 120. Antagonistic action of *Mucor* spp. and *Absidia* sp. on the growth of *Corticium Rolfsii* at 28°C.

Name of fungi	Antagonistic action of the antagonist used	Growth of mycelium of the antagonist used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of antagonist	Counter part of the colony
None	—	—	+++++	+++++
<i>M. bedrechani</i>	—	++	+++++	+++++
<i>M. circinelloides</i>	—	(+)	+++++	+++++
<i>M. racemosus</i>	—	+++	+++++	+++++
<i>A. coerulea</i>	—	++	+++++	+++++

TABLE 121. Antagonistic action of *Aspergillus niger* on the growth of *Corticium Rolfsii* at 32°C.

Strain number of the fungus	Antagonistic action of <i>Asp. niger</i> used	Growth of mycelium of <i>Asp. niger</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony
None	--	—	+++++	+++++
<i>A. niger</i> (Stock No. 1)	--	++	+++++	+++++
<i>A. niger</i> (Stock No. 2)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 3)	(+)	++	++++	++++
<i>A. niger</i> (Stock No. 4)	(+)	++	+++	++++
<i>A. niger</i> (Stock No. 5)	--	++	+++++	+++++
<i>A. niger</i> (Stock No. 6)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 7)	(+)	++	++++	+++++
<i>A. niger</i> (Stock No. 8)	(+)	+++	++++	+++++
<i>A. niger</i> (Stock No. 9)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 10)	—	+++	+++++	+++++
<i>A. niger</i> (Stock No. 11)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 12)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 13)	(+)	+++	++++	+++++
<i>A. niger</i> (Stock No. 14)	(+)	+++	++++	+++++
<i>A. niger</i> (Stock No. 15)	—	++	+++++	+++++
<i>A. niger</i> (Stock No. 16)	--	++	+++++	+++++

TABLE 122. Antagonistic action of *Aspergillus spp.* on the growth of *Corticium Rolfsii* at 32°C.

Name of fungi	Antagonistic action of <i>Aspergillus</i> used	Growth of mycelium of <i>Aspergillus</i> used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Aspergillus</i>	Counter part of the colony
None	—	—	+++++	+++++
<i>A. amstelodami</i>	--	(+)	+++++	+++++
<i>A. candidus</i>	--	(+)	+++++	+++++
<i>A. cellulosa</i>	--	++	+++++	+++++
<i>A. cinnamomeus</i>	--	++	+++++	+++++
<i>A. clavatus</i>	--	+	+++++	+++++
<i>A. echinulatus</i>	--	(+)	+++++	+++++
<i>A. Fischeri</i>	--	++	+++++	+++++
<i>A. flavipes</i>	--	(+)	+++++	+++++
<i>A. flavus</i>	--	++	+++++	+++++
<i>A. fumigatus</i>	--	+	+++++	+++++
<i>A. glaucus</i> (Stock No. 1)	--	(+)	+++++	+++++
<i>A. glaucus</i> (Stock No. 2)	--	—	+++++	+++++
<i>A. gracilis</i>	--	(+)	+++++	+++++
<i>A. insuetus</i>	--	—	+++++	+++++

TABLE 122. (Continued)

Name of fungi	Antagonistic action of Aspergillus used	Growth of mycelium of Aspergillus used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of used	Counter part of the colony
<i>A. japonicus</i>	—	+++	+++++	+++++
<i>A. medius</i>	—	+	+++++	+++++
<i>A. Oryzae</i>	—	(+)	+++++	+++++
<i>A. parasiticus</i>	(+)	+++	+++	+++++
<i>A. quercinus</i>	—	+	+++++	+++++
<i>A. repandus</i>	—	(+)	+++++	+++++
<i>A. repens</i>	—	++	+++++	+++++
<i>A. Schiemanni</i>	(+)	++	+++++	+++++
<i>A. Sydowi</i>	--	+	+++++	+++++
<i>A. Tamarii</i>	(+)	++	+++++	+++++
<i>A. terreus</i>	—	+	+++++	+++++
<i>A. terricola var. americana</i>	—	+	+++++	+++++
<i>A. ustus</i>	—	+	+++++	+++++
<i>A. versicolor</i>	—	+	+++++	+++++
<i>A. violaceo-fuscus</i>	(+)	++	+++	+++++

TABLE 123. Antagonistic action of *Penicillium spp.* on the growth of *Corticium Rolfsii* at 32°C.

Name of fungi	Antagonistic action of Penicillium used	Growth of mycelium of Penicillium used	Growth of mycelium of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of Penicillium	Counter part of the colony
None	—	—	+++++	+++++
<i>P. avellaneum</i>	—	++	+++++	+++++
<i>P. brevicaulis</i>	—	+	+++++	+++++
<i>P. chrysogenum</i>	—	+	+++++	+++++
<i>P. citrinum</i>	—	+	+++++	+++++
<i>P. commune</i>	—	(+)	+++++	+++++
<i>P. divaricatum</i>	—	++	+++++	+++++
<i>P. granulatum</i>	—	+	+++++	+++++
<i>P. lilacinum</i>	—	(+)	+++++	+++++
<i>P. Olsoni</i>	—	+	+++++	+++++
<i>P. oxalicum</i>	—	+++	+++++	+++++
<i>P. roseum</i>	—	(+)	+++++	+++++
<i>P. silvaticum</i>	—	(+)	+++++	+++++
<i>P. Thomii</i>	—	+	+++++	+++++

TABLE 124. Antagonistic action of *Mucor* spp. and *Absidia* sp. on the growth of *Corticium Rolfzii* at 32°C.

Name of fungi	Antagonistic action of the antagonist used	Growth of mycelium of the antagonist used	Growth of mycelium of <i>C. Rolfzii</i>	
			Part of the colony facing the colony of antagonist	Counter part of the colony
None	—	—	+++++	+++++
<i>M. bedrhami</i>	—	++	+++++	+++++
<i>M. circinelloides</i>	—	+++	+++++	+++++
<i>M. racemosus</i>	—	+++	+++++	+++++
<i>A. coerulea</i>	—	+++	+++++	+++++

Bac. aroideae, *Bac. butyricus*, *Bac. dendroides*, *Bac. ureae*, *Bac. prodigiosus*, *Bact. Cannae*, *Bact. medicaginis*, *Bact. rossicum*, *Bact. Sojæ*, *Bact. vitans* and *Bact. Martyniæ* were highly antagonistic to *Corticium Rolfzii*. These bacteria infested the colonies of the fungus, and inhibited the growth of its mycelium.

Bac. fluorescens liquefaciens, *Bac. mesentericus*, *Bac. cereus*, *Bact. Syringæ*, *Bact. Citri*, *Bact. beticolum* and *Bact. tumefaciens* are somewhat antagonistic to *Corticium Rolfzii*. These microorganisms stopped their growth leaving sterile regions along their boundary lines with the colonies of the latter.

Colonies of *Bac. corallinus*, *Bac. fluorescens non-liquefaciens*, *Bac. phytophthorus*, *Bac. Vignæ*, *Bact. Phaseoli*, *Bact. michiganense* and *Bact. marginale* were entirely covered by the mycelia of *C. Rolfzii*, showing that they exert no antagonistic effect upon the growth of the fungus.

Investigations on the same problem were then made at various temperatures using 46 species of fungi belonging to *Aspergillus*, *Penicillium*, *Mucor* and *Absidia*. Their colonies were all covered with the mycelia of *Corticium Rolfzii*, thus showing that they exert no distinct influence upon the growth of the latter. However, *Aspergillus niger* (Stock No. 3), *A. niger* (Stock No. 4), *A. niger* (Stock No. 7), *A. niger* (Stock No. 8), *A. niger* (Stock No. 13), *A. niger* (Stock No. 14), *A. parasiticus*, *A. Schiemanii*, *A. Tamaris* and *A. violaceo-fuscus* somewhat retarded the growth of *C. Rolfzii*.

From these results of experiments with three causal fungi of the Sclerotium diseases, it may be stated that the antagonistic action of various microorganisms toward the growth of their mycelia differs greatly according to the kinds of pathogens and of antagonists. In general, the antagonism of bacterial antagonists is stronger than that of fungous antagonists.

The viability of the sclerotia and mycelia of the fungi causing the Sclero-

tium diseases in mixed culture with certain bacteria was observed after the lapse of 21 days. The writer tested the viability of the fungus by staining with eosin or by culturing on sterilized rice straw. The results obtained are shown in Tables 125-130.

TABLE 125. Viability of the sclerotia of *Corticium Sasakii* in mixed cultures with various bacteria at 28°C.

Bacteria added	Total sclerotia tested	Number of living sclerotia	Remarks
None	3	3	Sclerotia were apparently healthy
<i>Bac. aroideae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. butyricus</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. cereus</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. coli</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. corallinus</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. dendroides</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. fluorescens liquefaciens</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. fluorescens non-liquefaciens</i>	3	3	Sclerotia were apparently healthy
<i>Bac. megatherium</i>	3	1	A sclerotium was apparently healthy
<i>Bac. mesentericus</i>	3	2	Sclerotia were infested with the bacterium
<i>Bac. mycoides</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. phytophthorus</i>	3	3	Sclerotia were apparently healthy
<i>Bac. prodigiosus</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. subtilis</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. ureae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. beticola</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. Cannae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. Citri</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. marginale</i>	3	1	A sclerotium was infested with the bacterium
<i>Bact. Martyniae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. medicaginis</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. michiganense</i>	3	3	Sclerotia were apparently healthy
<i>Bact. Phaseoli</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. rossicum</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. Sojae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. Syringae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. tumefaciens</i>	3	1	A sclerotium was apparently healthy
<i>Bact. Vignae</i>	3	3	Sclerotia were apparently healthy
<i>Bact. vitans</i>	3	0	Sclerotia were infested with the bacterium

TABLE 126. Viability of the mycelia of *Corticium Sasakii* in mixed cultures with various bacteria at 28°C.

Bacteria added	Total pieces of mycelia tested	Number of living pieces of mycelia	Remarks
None	10	10	Mycelia were apparently healthy
<i>Bac. aroidae</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. butyricus</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. cereus</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. coli</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. corallinus</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. dendroides</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. fluorescens liquefaciens</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. fluorescens non-liquefaciens</i>	10	10	Mycelia were apparently healthy
<i>Bac. megatherium</i>	10	6	Mycelia were infested with the bacterium
<i>Bac. mesentericus</i>	10	5	Mycelia were infested with the bacterium
<i>Bac. mycoides</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. phytophthorus</i>	10	10	Mycelia were apparently healthy
<i>Bac. prodigiosus</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. subtilis</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. ureae</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. beticola</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. Cannae</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. Citri</i>	10	2	Mycelia were infested with the bacterium
<i>Bact. marginale</i>	10	5	Mycelia were infested with the bacterium
<i>Bact. Martyniae</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. medicaginis</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. michiganense</i>	10	10	Mycelia were apparently healthy
<i>Bact. Phaseoli</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. rossium</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. Sojae</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. Syringae</i>	10	5	Mycelia were apparently healthy
<i>Bact. tumefaciens</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. Vignae</i>	10	8	Mycelia were apparently healthy
<i>Bact. vitans</i>	10	0	Mycelia were infested with the bacterium

 TABLE 127. Viability of the sclerotia of *Sclerotium Oryzae-sativae* in mixed cultures with various bacteria at 28°C.

Bacteria added	Total sclerotia tested	Number of living sclerotia	Remarks
None	3	3	Sclerotia were apparently healthy
<i>Bac. aroidae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. cereus</i>	3	0	Sclerotia were infested with the bacterium

TABLE 127. (Continued)

Bacteria added	Total sclerotia tested	Number of living sclerotia	Remarks
<i>Bac. coli</i>	3	1	A sclerotium was infested with the bacterium
<i>Bac. corallinus</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. dendroides</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. fluorescens liquefaciens</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. fluorescens non-liquefaciens</i>	3	3	Sclerotia were apparently healthy
<i>Bac. mesentericus</i>	3	1	A sclerotium was infested with the bacterium
<i>Bac. mycoides</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. prodigiosus</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. subtilis</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. ureae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. beticola</i>	3	1	A sclerotium was infested with the bacterium
<i>Bact. Citri</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. medicaginis</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. rossicum</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. Sojae</i>	3	0	Sclerotia were infested with the bacterium

TABLE 128. Viability of the mycelia of *Sclerotium Oryzae-sativae* in mixed cultures with various bacteria at 28°C.

Bacteria added	Total pieces of mycelia tested	Number of living pieces of mycelia	Remarks
None	10	10	Mycelia were apparently healthy
<i>Bac. aroideae</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. cereus</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. coli</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. corallinus</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. dendroides</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. fluorescens liquefaciens</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. fluorescens non-liquefaciens</i>	10	10	Mycelia were apparently healthy
<i>Bac. mesentericus</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. mycoides</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. prodigiosus</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. subtilis</i>	10	0	Mycelia were infested with the bacterium
<i>Bac. ureae</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. beticola</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. Citri</i>	10	2	Mycelia were infested with the bacterium
<i>Bact. medicaginis</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. rossicum</i>	10	0	Mycelia were infested with the bacterium
<i>Bact. Sojae</i>	10	0	Mycelia were infested with the bacterium

TABLE 129. Viability of the sclerotia of *Corticium Rolfsii* in mixed cultures with various bacteria at 28°C.

Bacteria added	Total sclerotia tested	Number of living sclerotia	Remarks
None	3	3	Sclerotia were apparently healthy
<i>Bac. aroideae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. butylicus</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. cereus</i>	3	3	Sclerotia were apparently healthy
<i>Bac. corallinus</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. dendroides</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. fluorescens liquefaciens</i>	3	3	Sclerotia were apparently healthy
<i>Bac. fluorescens non-liquefaciens</i>	3	3	Sclerotia were apparently healthy
<i>Bac. megatherium</i>	3	3	Sclerotia were apparently healthy
<i>Bac. mesentericus</i>	3	3	Sclerotia were apparently healthy
<i>Bac. phytophthorus</i>	3	3	Sclerotia were apparently healthy
<i>Bac. prodigiosus</i>	3	0	Sclerotia were infested with the bacterium
<i>Bac. ureae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. beticolum</i>	3	3	Sclerotia were apparently healthy
<i>Bact. Cannae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. Citri</i>	3	3	Sclerotia were apparently healthy
<i>Bact. marginale</i>	3	3	Sclerotia were apparently healthy
<i>Bact. Martyniae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. medicaginis</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. michiganense</i>	3	3	Sclerotia were apparently healthy
<i>Bact. Phaseoli</i>	3	3	Sclerotia were apparently healthy
<i>Bact. rossicum</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. Sojae</i>	3	0	Sclerotia were infested with the bacterium
<i>Bact. Syringae</i>	3	3	Sclerotia were apparently healthy
<i>Bact. tumefaciens</i>	3	3	Sclerotia were apparently healthy
<i>Bact. Vignae</i>	3	3	Sclerotia were apparently healthy
<i>Bact. vitans</i>	3	0	Sclerotia were infested with the bacterium

 TABLE 130. Viability of the mycelia of *Corticium Rolfsii* in mixed cultures with various bacteria at 28°C.

Bacteria added	Total pieces of mycelia tested	Number of living pieces of mycelia	Remarks
None	6	6	Mycelia were apparently healthy
<i>Bac. aroideae</i>	6	0	Mycelia were infested with the bacterium
<i>Bac. butyricus</i>	6	0	Mycelia were infested with the bacterium
<i>Bac. cereus</i>	6	6	Mycelia were apparently healthy
<i>Bac. corallinus</i>	6	6	Mycelia were apparently healthy
<i>Bac. dendroides</i>	6	0	Mycelia were infested with the bacterium

TABLE 130. (Continued)

Bacteria added	Total pieces of mycelia tested	Number of living pieces of mycelia	Remarks
<i>Bac. fluorescens liquefaciens</i>	6	4	Mycelia were apparently healthy
<i>Bac. fluorescens non-liquefaciens</i>	6	6	Mycelia were apparently healthy
<i>Bac. megatherium</i>	6	6	Mycelia were apparently healthy
<i>Bac. mesentericus</i>	6	6	Mycelia were apparently healthy
<i>Bac. phytophthorus</i>	6	6	Mycelia were apparently healthy
<i>Bac. prodigiosus</i>	6	0	Mycelia were infested with the bacterium
<i>Bac. ureae</i>	6	0	Mycelia were infested with the bacterium
<i>Bact. beticola</i>	6	6	Mycelia were apparently healthy
<i>Bact. Cannae</i>	6	0	Mycelia were infested with the bacterium
<i>Bact. Citri</i>	6	5	Mycelia were apparently healthy
<i>Bact. marginale</i>	6	6	Mycelia were apparently healthy
<i>Bact. Martyniae</i>	6	0	Mycelia were infested with the bacterium
<i>Bact. medicaginis</i>	6	3	Mycelia were infested with the bacterium
<i>Bact. michiganense</i>	6	6	Mycelia were apparently healthy
<i>Bact. Phaseoli</i>	6	6	Mycelia were apparently healthy
<i>Bact. rossicum</i>	6	0	Mycelia were infested with the bacterium
<i>Bact. Sojae</i>	6	0	Mycelia were infested with the bacterium
<i>Bact. Syringae</i>	6	6	Mycelia were apparently healthy
<i>Bact. tumefaciens</i>	6	6	Mycelia were apparently healthy
<i>Bact. Vignae</i>	6	6	Mycelia were apparently healthy
<i>Bact. vitans</i>	6	0	Mycelia were infested with the bacterium

From these results, it appears that the sclerotia and the mycelia of *Corticium Sasakii*, *Sclerotium Oryzae-sativae* and *Corticium Rolfsii* were all caused to die after 21 days at 28°C. if they were entirely covered by the colonies of the antagonistic bacteria.

(B) Antagonistic action of microorganisms on the growth of mycelia of the causal fungi of Sclerotium diseases in the soil

The antagonistic action of the bacteria toward the growth of *Corticium Rolfsii*, *Corticium Sasakii* and *Sclerotium Oryzae-sativae* in the soil was studied by adding various species of bacteria, previously proved to be antagonistic, to the soil. Each microorganism was first inoculated in a test tube containing 5 cc. of sand with 20% moisture, and was kept at 24°C. for 4 days, and then a number of sclerotia of the causal fungus were put in the culture. These cultures were kept at 24°C., 28°C. and 32°C., respectively for 21 days. The results obtained are briefly tabulated as follows:

TABLE 131. Vitality of the sclerotia of *Corticium Sasakii* in the soil infested with various microorganisms

Microorganisms added	24°C.		28°C.		32°C.	
	Total sclerotia tested	Number of living sclerotia	Total sclerotia tested	Number of living sclerotia	Total sclerotia tested	Number of living sclerotia
None	10	10	10	10	10	10
<i>Bac. butyricus</i>	10	4	10	6	10	8
<i>Bac. cereus</i>	10	4	10	5	10	6
<i>Bac. coli</i>	10	5	10	4	10	5
<i>Bac. corallinus</i>	10	5	10	6	10	2
<i>Bac. dendroides</i>	10	4	10	4	10	5
<i>Bac. fluorescens liquefaciens</i>	10	5	10	5	10	6
<i>Bac. mesentericus</i>	10	6	10	8	10	6
<i>Bac. mycoides</i>	10	3	10	4	10	3
<i>Bac. prodigiosus</i>	10	3	10	4	10	2
<i>Bac. subtilis</i>	10	5	10	4	10	4
<i>Bac. ureae</i>	10	6	10	6	10	3
<i>Bact. Cannae</i>	10	4	10	4	10	3
<i>Bact. medicaginis</i>	10	4	10	3	10	2
<i>Bact. rossicum</i>	10	5	10	5	10	7
<i>Bact. Vignae</i>	10	8	10	7	10	7
<i>Asp. flavus</i>	10	6	10	7	10	7
<i>Asp. niger</i> (Stock No. 7)	10	5	10	6	10	8
<i>Asp. parasiticus</i>	10	7	10	8	10	4
<i>Asp. Schiemanni</i>	10	6	10	7	10	8
<i>Asp. Tamarii</i>	10	5	10	8	10	5
<i>Tric. lignorum*</i>	10	0	10	0	10	0

Remarks: * The viability of sclerotia was tested after 35 days.

In the results tabulated above, it is shown that certain bacteria and fungi are not only antagonistic to the fungus on culture media but also to that in the soil. *Bacillus butyricus*, *Bac. cereus*, *Bac. coil*, *Bac. corallinus*, *Bac. dendroides*, *Bac. fluorescens liquefaciens*, *Bac. mesentericus*, *Bac. mycoides*, *Bac. prodigiosus*, *Bac. subtilis*, *Bac. ureae*, *Bacterium Cannae*, *Bact. medicaginis*, *Bact. rossicum*, *Bact. Vignae*, *Aspergillus flavus*, *Asp. niger* (Stock No. 7), *Asp. parasiticus*, *Asp. Schiemanni*, *Asp. Tamarii* and *Trichoderma lignorum* are antagonistic to *C. Sasakii* in the soil causing the death of its sclerotia after 21 days (35 days for *Trichoderma lignorum*) at 24°C. to 32°C.

From Table 132, it is evident that certain microorganisms are not only antagonistic to *S. Oryzae-sativae* on culture media but also to it in the soil. *Bac. cereus*, *Bac. dendroides*, *Bac. fluorescens liquefaciens*, *Bac. mesentericus*, *Bac.*

TABLE 132. Vitality of the sclerotia of *Sclerotium Oryzae-sativae* in the soil infested with various microorganisms

Microorganisms added	24°C.		28°C.		32°C.	
	Total sclerotia tested	Number of living sclerotia	Total sclerotia tested	Number of living sclerotia	Total sclerotia tested	Number of living sclerotia
None	10	10	10	10	10	10
<i>Bac. cereus</i>	10	5	10	3	10	4
<i>Bac. dendroides</i>	10	5	10	4	10	4
<i>Bac. fluorescens liquefaciens</i>	10	5	10	4	10	4
<i>Bac. mesentericus</i>	10	3	10	2	10	3
<i>Bac. mycoides</i>	10	3	10	3	10	4
<i>Bac. prodigiosus</i>	10	6	10	4	10	2
<i>Bac. subtilis</i>	10	6	10	5	10	4
<i>Bact. beticolum</i>	10	6	10	6	10	4
<i>Bact. medicaginis</i>	10	4	10	4	10	3
<i>Bact. rossicum</i>	10	6	10	4	10	4
<i>Asp. niger</i> (Stock No. 7)	10	6	10	6	10	6
<i>Asp. parasiticus</i>	10	6	10	8	10	7
<i>Asp. Tamarii</i>	10	8	10	7	10	7
<i>Tric. lignorum*</i>	10	0	10	0	10	0

Remarks: * The viability of sclerotia was tested after 35 days.

mycoides, *Bac. prodigiosus*, *Bac. subtilis*, *Bact. medicaginis*, *Bact. beticolum*, *Bact. rossicum*, *Asp. niger* (Stock No. 7), *Asp. parasiticus*, *Asp. Tamarii* and *Trichoderma lignorum* are antagonistic to *S. Oryzae-sativae* in the soil causing the death of the sclerotia of the fungus after 21 days (35 days for *Trichoderma lignorum*) at 24°C., 28°C. and 32°C.

TABLE 133. Vitality of the sclerotia *Corticium Rolfsii* in the soil infested with various microorganisms

Microorganisms added	24°C.		28°C.		32°C.	
	Total sclerotia tested	Number of living sclerotia	Total sclerotia tested	Number of living sclerotia	Total sclerotia tested	Number of living sclerotia
None	3	3	3	3	3	3
<i>Bac. aroideae</i>	3	2	3	2	3	2
<i>Bac. butyricus</i>	3	2	3	3	3	0
<i>Bac. cereus</i>	3	3	3	3	3	3
<i>Bac. dendroides</i>	3	0	3	0	3	0
<i>Bac. fluorescens liquefaciens</i>	3	0	3	0	3	1
<i>Bac. megatherium</i>	3	2	3	2	3	2
<i>Bac. mesentericus</i>	3	2	3	2	3	1

TABLE 133. (Continued)

Microorganisms added	24°C.		28°C.		32°C.	
	Total sclerotia tested	Number of living sclerotia	Total sclerotia tested	Number of living sclerotia	Total sclerotia tested	Number of living sclerotia
<i>Bac. prodigiosus</i>	3	2	3	2	3	1
<i>Bac. ureae</i>	3	1	3	0	3	1
<i>Bact. Cannae</i>	3	2	3	2	3	2
<i>Bact. Martyniae</i>	3	2	3	1	3	1
<i>Bact. medicaginis</i>	3	2	3	2	3	0
<i>Bact. rossicum</i>	3	1	3	1	3	0
<i>Bact. Sojae</i>	3	0	3	0	3	0
<i>Bact. vitans</i>	3	0	3	2	3	1
<i>Tric. lignorum*</i>	10	0	10	0	10	0

Remarks: * The viability of sclerotia was tested after 35 days.

From the above results it is obvious that certain microorganisms are not only antagonistic to the fungus on culture media but also to that in the soil. *Bac. aroideae*, *Bac. butyricus*, *Bac. dendroides*, *Bac. fluorescens liquefaciens*, *Bac. megatherium*, *Bac. mesentericus*, *Bac. prodigiosus*, *Bac. ureae*, *Bact. Cannae*, *Bact. Martyniae*, *Bact. medicaginis*, *Bact. rossicum*, *Bact. Sojae*, *Bact. vitans* and *Trichoderma lignorum* are antagonistic to *Corticium Rolfsii* in the soil, causing the death of the sclerotia of the fungus after 21 days (35 days for *Trichoderma lignorum*) at 24°C., 28°C. and 32°C.

(C) Antagonistic action of microorganisms on the growth of mycelia of the causal fungi of Sclerotium diseases on the plant body

In the previous section, it has been stated that the microorganisms tested retard the growth of mycelia of the causal fungi of Sclerotium diseases on culture media. Accordingly it was attempted to ascertain whether such is also the case for the fungus growing on the plant using *Bac. fluorescens liquefaciens*, *Bac. cereus*, *Bac. dendroides* and *Bac. mycoides* as the antagonistic bacteria.

Plant leaves such as those of Indian corn and camellia were washed with distilled water and then kept in distilled water in large Petri dishes. A sclerotium of the fungus to be tested and a bit of a colony of the antagonistic bacteria were inoculated on the leaf to confront each other. The results obtained are shown in Tables 134 and 135.

Antagonistic action of *Bac. cereus*, *Bac. dendroides*, *Bac. fluorescens liquefaciens* and *Bac. mycoides* toward *Corticium Sasakii* and *Corticium Rolfsii* is shown on the leaves. These fungi grow avoiding the bacterial antagonists. The diseased spots are formed on the part of the leaves away from the bacterial colony, although this relation was not clearly recognized in the case of *Corticium Rolfsii* and *Bac. cereus* growing on leaves of camellia.

TABLE 134. Effect of the antagonistic action of certain bacterial antagonists on the growth of mycelia of *Corticium Sasakii* on the plant body

Bacterial antagonists	Growth of <i>C. Sasakii</i> on—	
	Leaves of Indian corn.	Leaves of camellia
<i>Bac. cereus</i>	The fungus grew, avoiding the bacterial colony. Diseased spots appeared on the side of the fungus inoculated away from the bacterium.	The fungus developed avoiding the bacterial colony. No diseased spots were produced.
<i>Bac. dendroides</i>	The fungus developed avoiding the bacterial colony. Diseased spots appeared on the side of the fungus inoculated away from the bacterium.	The fungus grew, avoiding the bacterial colony. No diseased spots were produced.
<i>Bac. fluorescens liquefaciens</i>	The fungus grew, avoiding the bacterial colony. Diseased spots appeared on the side of the fungus inoculated away from the bacterium.	The fungus grew, avoiding the bacterial colony. No diseased spots were produced.
<i>Bac. mycoides</i>	The fungus developed, avoiding the bacterial colony. Diseased spots appeared on the side of the fungus inoculated away from the bacterium.	The fungus grew, avoiding the bacterial colony. No diseased spots were produced.

Remarks: These results were obtained after 3 days.

TABLE 135. Effect of the antagonistic action of certain bacterial antagonists on the growth of mycelia of *Corticium Rolfsii* on the plant body.

Bacterial antagonists	Growth of <i>C. Rolfsii</i> on—	
	Leaves of Indian corn	Leaves of camellia—
<i>Bac. cereus</i>	Mycelia developed, avoiding the bacterial colony. Diseased spots appeared on the side of the fungus inoculated away from the bacterium.	The phenomenon of avoiding the bacterial colony was not distinct. No diseased spots were produced.
<i>Bac. dendroides</i>	Mycelia developed, avoiding the bacterial colony. Diseased spots appeared on the side of the fungus inoculated away from the bacterium.	Mycelia developed, avoiding the bacterial colony. No diseased spots were produced.
<i>Bac. fluorescens liquefaciens</i>	The fungus developed, avoiding the bacterial colony. Diseased spots appeared on the side of the fungus inoculated away from the bacterium.	The fungus grew, avoiding the bacterial colony. Pale green diseased spots were produced on the part near the inocula.
<i>Bac. mycoides</i>	The fungus grew, avoiding the bacterial colony. Diseased spots appeared on the part away from the bacterial colony.	The fungus grew avoiding the bacterial colony. No diseased spots were produced.

Remarks: These results were obtained after 3 days.

2. Effect of the antagonistic action of microorganisms on the occurrence and severity of the diseases

In the preceding section, it was shown that the growth of the causal fungi of Sclerotium diseases on culture media or in the soil was greatly reduced by the antagonistic action of certain microorganisms. The present section deals with the results of the experiments on the occurrence and severity of Sclerotium diseases in the presence of other microorganisms.

Microorganisms known to be antagonistic to the pathogenes were used in these experiments. The causal fungus together with or without other microorganisms was inoculated in 250 cc. ERLLENMYER's flasks containing 100 cc. of sand. After one or two days some clean seeds of rice plant (Sinriki variety) were sown on the sand. The results obtained are tabulated as follows:

(A) Effect of the antagonistic action of microorganisms on the occurrence and severity of the disease caused by *Corticium Sasakii* (Tables 136-157)

TABLE 136. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of *Aspergillus niger*

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)
Control	40	40	4.0
<i>C. Sasakii</i>	40	36	3.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 1.)	40	40	3.5
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 2)	40	40	4.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 3)	40	40	3.1
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 4)	40	39	3.5
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 5)	40	40	4.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 6)	40	39	4.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 7)	40	38	3.7
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 8)	40	39	4.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 9)	40	40	4.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 10)	40	40	5.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 11)	40	36	3.7
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 12)	40	40	3.8
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 13)	40	36	3.2
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 14)	40	39	3.5
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 15)	40	37	3.2
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 16)	40	36	3.1

Remarks: The experiment was made at 24-30°C., May 24-30, 1930.

TABLE 137. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various fungi

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)
Control	40	40	6.0
<i>C. Sasakii</i>	40	36	3.5
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 4)	40	40	4.5
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 5)	40	39	5.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 7)	40	37	5.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 9)	40	40	6.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 12)	40	40	4.5
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 14)	40	40	6.0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 15)	40	37	4.0
<i>C. Sasakii</i> + <i>Asp. Schiemanii</i>	40	38	5.0
<i>C. Sasakii</i> + <i>Pen. lilacinum</i>	40	39	4.5
<i>C. Sasakii</i> + <i>Pen. oxalicum</i>	40	39	4.0
<i>C. Sasakii</i> + <i>Pen. Thomii</i>	40	40	5.5
<i>C. Sasakii</i> + <i>Pen. circinelloides</i>	40	38	4.5
<i>C. Sasakii</i> + <i>Mucor racemosus</i>	40	35	4.0

Remarks: The experiment was made at 28°-32°C., July 9-17, 1930.

TABLE 138. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various fungi

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	18	2.0	8.0-18.7	11.87	5.0-10.8	6.34	4-8	6.05
<i>C. Sasakii</i>	40	11	1.5	4.3-10.5	7.23	2.5- 7.5	5.17	4-7	5.67
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 1)	40	16	2.0	2.7-19.0	8.14	3.0-12.0	3.72	3-8	5.50
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 2)	40	15	1.9	4.5-15.1	9.85	4.5-15.0	8.53	4-8	6.27
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 4)	40	12	1.9	4.0-15.2	9.01	4.0-13.0	3.33	4-8	5.92
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 7)	40	13	2.0	3.5-16.0	8.02	3.0-10.5	7.46	4-8	5.69
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 13)	40	15	2.0	4.0-15.0	9.20	3.5-11.5	7.47	5-10	7.00

Remarks: The experiment was made at 28°-30.5°C., Sept. 26-Oct. 27, 1930.

TABLE 139. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various fungi

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	19	3.5	2.5-11.1	7.17	2.8-13.0	7.19	1-10	6
<i>C. Sasakii</i>	40	13	2.0	1.6-11.1	5.78	2.3-6.5	4.11	2-6	4
<i>C. Sasakii</i> + <i>Asp. gracilis</i>	40	16	3.3	3.2-11.3	7.38	3.5-13.0	7.32	4-8	6
<i>C. Sasakii</i> + <i>Asp. Sydowi</i>	40	16	3.0	3.5-12.0	7.76	1.5-14.0	6.49	1-8	6

Remarks: The experiment was made at 24°-30°C., Oct. 27-Dec. 8, 1930.

 TABLE 140. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of *Aspergillus niger*

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	40	5.5	7.5-15.5	12.41	7.0-26.0	14.17	4-8	6
<i>C. Sasakii</i>	40	40	2.5	3.0- 8.0	5.90	2.5- 8.0	5.13	1-5	3
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 4)	40	38	5.3	5.8-17.0	12.91	3.0-21.0	11.48	4-7	5
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 5)	40	39	4.0	10.0-14.5	12.92	6.0-23.0	13.00	4-7	6
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 6)	40	39	5.0	10.0-17.5	13.61	5.0-16.0	10.82	4-6	5
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 7)	40	40	4.4	6.5-16.0	12.75	5.0-14.5	8.26	4-8	6
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 9)	40	40	4.5	2.5-16.0	13.26	4.5-12.0	7.77	1-7	3
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 10)	40	40	5.0	8.0-16.0	12.47	5.0-15.0	9.94	4-8	6
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 11)	40	40	5.1	7.0-16.5	13.95	6.5-16.5	11.14	4-8	6
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 14)	40	40	5.4	8.5-16.0	13.38	5.0-22.0	12.39	4-8	5

Remarks: The experiment was made at 27.5°-31°C., June 9-29, 1931.

As shown in these tables (Nos. 136-140), *Asp. gracilis*, *Asp. niger* (Stock Nos. 1-16), *Asp. Schiemanni*, *Asp. Sydowi*, *Pen. lilacinum*, *Pen. oxalicum*, *Pen. Thomii*, *Mucor circinelloides* and *Mucor racemosus* are antagonistic to *C. Sasakii* and weaken the pathogenicity of the latter fungus in the soil.

Among bacteria *Bac. aroideae*, *Bac. butyricus*, *Bac. cereus*, *Bac. dendroides*, *Bac. fluorescens liquefaciens*, *Bac. mesentericus*, *Bac. mycoides*, *Bac. prodigiosus*, *Bac. subtilis*, *Bac. ureae*, *Bact. Cannae*, *Bact. Citri*, *Bact. medicaginis*, *Bact. Sojae* and *Bact. vitans* also proved to reduce the pathogenicity of *C. Sasakii*.

TABLE 141. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various bacteria

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)
Control (None inoculated)	40	40	5.7
<i>C. Sasakii</i>	40	36	5.0
<i>C. Sasakii</i> + <i>Bac. aroideae</i>	40	38	5.5
<i>C. Sasakii</i> + <i>Bac. ureae</i>	40	36	6.0
<i>C. Sasakii</i> + <i>Bact. Martyniae</i>	40	39	6.0
<i>C. Sasakii</i> + <i>Bact. michiganense</i>	40	36	5.0
<i>C. Sasakii</i> + <i>Bact. vitans</i>	40	36	5.0

Remarks: The experiment was made at 28.5°-32°C., Aug. 8-21, 1930.

TABLE 142. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various bacteria

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)
Control (None inoculated)	40	35	5.0
<i>C. Sasakii</i>	40	29	3.5
<i>C. Sasakii</i> + <i>Bac. aroideae</i>	40	30	5.0
<i>C. Sasakii</i> + <i>Bac. dendroides</i>	40	25	4.0
<i>C. Sasakii</i> + <i>Bac. mesentericus</i>	40	36	6.5
<i>C. Sasakii</i> + <i>Bac. subtilis</i>	40	33	5.0
<i>C. Sasakii</i> + <i>Bac. ureae</i>	40	30	5.0
<i>C. Sasakii</i> + <i>Bac. prodigiosus</i>	40	33	5.0
<i>C. Sasakii</i> + <i>Bact. Cannae</i>	40	34	4.0
<i>C. Sasakii</i> + <i>Bact. Citri</i>	40	32	5.5
<i>C. Sasakii</i> + <i>Bact. medicaginis</i>	40	30	5.0
<i>C. Sasakii</i> + <i>Bact. Sojae</i>	40	34	4.0
<i>C. Sasakii</i> + <i>Bact. vitans</i>	40	35	5.5

Remarks: The experiment was made at 28.3°-32.3°C., Aug. 22-Sept. 1, 1930.

TABLE 143. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	40	6.0	8.1-13.2	11.18	5.7-14.3	10.06	3-6	5.08
<i>C. Sasakii</i>	40	40	4.0	6.2-15.8	8.50	0.3-24.0	4.36	1-7	4.15
<i>C. Sasakii</i> + <i>Bac. cereus</i>	40	40	6.0	5.5-18.5	12.82	5.0-18.0	10.40	1-7	5.03
<i>C. Sasakii</i> + <i>Bac. fluorescens liquefaciens</i>	40	39	6.5	4.4-15.2	11.87	5.0-16.5	9.52	3-6	4.59
<i>C. Sasakii</i> + <i>Bac. prodigiosus</i>	40	40	6.0	7.0-15.7	12.19	3.5-15.5	10.99	2-7	4.85
<i>C. Sasakii</i> + <i>Bac. subtilis</i>	40	40	6.5	6.3-13.1	10.25	3.5-16.5	8.29	3-6	4.50

Remarks: The experiment was made at 27.5°-32.5°C., Feb. 25-Mar. 18, 1931.

TABLE 144. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	40	4.0	9.0-16.0	13.34	7.5-22.0	14.89	6-10	7
<i>C. Sasakii</i>	40	39	2.0	2.7-12.0	8.99	3.0-15.0	9.29	4-8	5
<i>C. Sasakii</i> + <i>Bac. cereus</i>	40	40	4.0	11.5-17.0	14.14	7.0-17.0	12.76	5-8	6
<i>C. Sasakii</i> + <i>Bac. fluorescens liquefaciens</i>	40	39	4.5	11.5-18.0	13.13	9.0-22.0	13.28	5-7	6
<i>C. Sasakii</i> + <i>Bac. prodigiosus</i>	40	40	5.0	7.5-17.0	14.83	5.0-20.0	12.24	5-8	6
<i>C. Sasakii</i> + <i>Bac. subtilis</i>	40	40	4.5	9.0-18.0	14.63	6.0-21.5	13.64	5-8	6

Remarks: The experiment was made at 27°-32.5°C., Jun. 29-Jul. 9, 1931.

TABLE 145. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	37	2.5	9.0-17.5	12.29	5.0-22.5	11.28	6-9	7
<i>C. Sasakii</i>	40	31	2.0	3.5-14.0	11.18	5.0-14.0	8.53	4-6	5
<i>C. Sasakii</i> + <i>Bac. butyricus</i>	40	36	2.8	2.5-14.5	10.77	7.7-16.5	11.56	4-7	5
<i>C. Sasakii</i> + <i>Bac. cereus</i>	40	38	3.0	7.5-15.5	13.16	2.0-19.5	11.39	3-6	5
<i>C. Sasakii</i> + <i>Bac. dendroides</i>	40	36	2.5	5.5-15.7	11.69	7.0-14.0	10.46	3-7	5
<i>C. Sasakii</i> + <i>Bac. fluorescens liquefaciens</i>	40	35	2.3	6.0-16.2	11.36	7.0-16.5	11.29	1-9	5
<i>C. Sasakii</i> + <i>Bac. prodigiosus</i>	40	34	2.1	9.0-18.0	14.24	4.5-15.5	10.56	4-9	7
<i>C. Sasakii</i> + <i>Bact. Cannae</i>	40	37	2.2	7.5-16.0	12.20	8.0-14.2	10.22	4-7	5

Remarks: The experiment was made at 28.5°-32.3°C., Jul. 7-17, 1931.

TABLE 146. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	36	3.0	11.0-15.7	13.16	4.5-16.0	9.54	6-11	9
<i>C. Sasakii</i>	40	34	2.4	8.0-14.5	10.36	4.3-15.0	6.51	4-9	7
<i>C. Sasakii</i> + <i>Bac. mycoides</i>	40	36	3.5	7.0-17.0	12.82	7.0-18.0	9.94	5-9	7
<i>C. Sasakii</i> + <i>Bac. prodigiosus</i>	40	38	4.0	9.2-16.0	13.27	6.5-19.0	12.26	6-10	8
<i>C. Sasakii</i> + <i>Bac. subtilis</i>	40	39	3.0	2.5-15.0	12.73	5.0-19.9	11.45	3-9	7
<i>C. Sasakii</i> + <i>Bact. rossicum</i>	40	35	3.0	8.0-15.0	12.25	7.0-16.0	8.85	5-9	7

Remarks: The experiment was made at 28.5°-32°C., Jul. 24-Aug. 11, 1931.

TABLE 147. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	37	3.5	10.0-16.0	14.43	4.5-15.0	9.34	6-11	9
<i>C. Sasakii</i>	40	37	2.6	5.5-15.1	11.27	2.0-9.0	5.53	4-11	7
<i>C. Sasakii</i> + <i>Bac. mycoides</i>	40	35	3.5	8.0-15.5	13.41	5.0-15.0	9.61	5-10	7
<i>C. Sasakii</i> + <i>Bac. prodigiosus</i>	40	40	3.0	10.0-14.5	13.01	5.0-14.0	8.85	4-12	7
<i>C. Sasakii</i> + <i>Bac. subtilis</i>	40	35	3.0	7.5-14.5	12.57	6.0-18.0	12.51	7-10	8
<i>C. Sasakii</i> + <i>Bact. rossicum</i>	40	34	3.0	10.0-19.0	14.20	2.5-13.0	8.49	3-10	7

Remarks: The experiment was made at 28°-32.5°C., Jul. 25-Aug. 13, 1931.

 TABLE 148. The pathogenicity of *Corticium Sasakii* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	40	5.0	15.0-21.0	17.92	9.0-30.0	14.16	5-9	6
<i>C. Sasakii</i>	40	38	3.5	9.5-18.0	15.20	8.0-18.0	11.31	4-8	6
<i>C. Sasakii</i> + <i>Bac. cereus</i>	40	40	5.5	13.5-19.0	17.43	8.2-21.5	14.59	4-9	6
<i>C. Sasakii</i> + <i>Bac. fluorescens liquefaciens</i>	40	39	5.0	12.0-20.0	17.47	8.0-20.0	13.53	4-9	6
<i>C. Sasakii</i> + <i>Bac. mycoides</i>	40	40	5.5	10.5-20.8	17.07	11.0-24.0	15.54	5-8	6
<i>C. Sasakii</i> + <i>Bac. prodigiosus</i>	40	40	4.5	13.7-21.0	17.53	6.0-23.0	14.52	3-9	6

Remarks: The experiment was made at 27.5°-32°C., Aug. 2-21, 1931.

The writer conducted similar experiments by inoculating the organisms on the stem of rice plant. A sclerotium of *Corticium Sasakii* smeared with

other microorganisms was inoculated on the ligule of the leaf sheath of each rice plant and covered with moistened cotton to keep the sclerotium from drying. The results obtained are summarized in Tables 149-155.

TABLE 149. Effect of *Aspergillus niger* on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Microorganisms inoculated	Number of plants treated	Number of diseased plants after—					
		1. day	2 days	3 days	4 days	5 days	6 days
Control	10	0	0	0	0	0	0
<i>C. Sasakii</i>	10	0	0	2(2)	4(6)	6(8)	6(8)
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 2)	10	0	0	0	1(1)	3(5)	3(7)
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 3)	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 4)	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 6)	10	0	0	0	3(5)	5(6)	5(6)
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 9)	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 12)	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 13)	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 14)	10	0	0	0	0	3(3)	3(4)
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 15)	10	0	0	0	0	0	0

Remarks: The experiment was made at 20°-25°C., Oct. 1-7, 1930. () indicates number of diseased spots on the stems.

TABLE 150. Effect of various fungi on the occurrence and severity the Sclerotium disease caused by *Corticium Sasakii*

Microorganisms inoculated	Number of plants treated	Number of diseased plants after—					
		1 day	2 days	3 days	4 days	5 days	6 days
Control	10	0	0	0	0	0	0
<i>C. Sasakii</i>	10	0	0	2(2)	2(6)	2(10)	2(18)
<i>C. Sasakii</i> + <i>Asp. terreus</i>	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. repens</i>	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. medius</i>	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. gracilis</i>	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. clavatus</i>	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. repandus</i>	10	0	0	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. cinnamomeus</i>	10	0	0	0	0	0	0

Remarks: The experiment was made at 20°-23°C., Oct. 7-13, 1930.

TABLE 151. Effect of various fungi on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Microorganisms inoculated	Number of plants treated	Number of diseased plants after—			
		1 day	2 days	3 days	4 days
Control	10	0	0	0	0
<i>C. Sasakii</i>	10	0	0	5 (7)	5 (9)
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 2)	10	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 3)	10	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 9)	10	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 13)	10	0	0	0	0
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 14)	10	0	0	0	0
<i>C. Sasakii</i> + <i>Pen. brevicaulis</i>	10	0	0	3 (6)	4 (7)
<i>C. Sasakii</i> + <i>Pen. oxalicum</i>	10	0	0	1 (2)	1 (2)
<i>C. Sasakii</i> + <i>Pen. Thomii</i>	10	0	0	0	0

Remarks: The experiment was made at 20°-23°C., Oct. 10-14, 1930.

 TABLE 152. Effect of various fungi on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*.

Microorganisms inoculated	Number of plants treated	Number of diseased plants after—	
		1 day	2 days
Control	10	0	0
<i>C. Sasakii</i>	10	0	10 (10)
<i>C. Sasakii</i> + <i>Asp. Tamarii</i>	10	0	1 (1)
<i>C. Sasakii</i> + <i>Asp. parasiticus</i>	10	0	3 (3)
<i>C. Sasakii</i> + <i>Asp. niger</i> (Stock No. 7)	10	0	0

Remarks: The experiment was made at 28°-31.5°C., Sept. 6-8, 1931.

 TABLE 153. Effect of various bacteria on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Microorganisms inoculated	Number of plants treated	Number of diseased plants after—	
		1 day	2 days
Control	10	0	0
<i>C. Sasakii</i>	10	0	10 (19)
<i>C. Sasakii</i> + <i>Bac. cereus</i>	10	0	10 (12)
<i>C. Sasakii</i> + <i>Bac. fluorescens liquefaciens</i>	10	0	7 (11)
<i>C. Sasakii</i> + <i>Bac. prodigiosus</i>	10	0	9 (14)
<i>C. Sasakii</i> + <i>Bac. mycoides</i>	10	0	7 (7)

Remarks: The experiment was made at 28°-33°C., Jul. 7-9, 1931.

TABLE 154. Effect of various bacteria on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Microorganisms inoculated	Number of plants treated	Number of diseased plants after—	
		1 day	2 days
Control	10	0	0
<i>C. Sasakii</i>	10	0	10 (29)
<i>C. Sasakii</i> + <i>Bac. corallinus</i>	10	0	8 (16)
<i>C. Sasakii</i> + <i>Bac. fluorescens liquefaciens</i>	10	0	9 (13)
<i>C. Sasakii</i> + <i>Bac. mycoides</i>	10	0	7 (12)

Remarks: The experiment was made at 28°-32°C., Jul. 8-10, 1931.

TABLE 155. Effect of various bacteria on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Microorganisms inoculated	Number of plants treated	Number of diseased plants after—	
		1 day	2 days
Control	10	0	0
<i>C. Sasakii</i>	10	0	10 (10)
<i>C. Sasakii</i> + <i>Bac. cereus</i>	10	0	1 (1)
<i>C. Sasakii</i> + <i>Bac. dendroides</i>	10	0	0
<i>C. Sasakii</i> + <i>Bac. mycoides</i>	10	0	0

Remarks: The experiment was made at 28°-32.5°C., Sept. 7-9, 1931.

A series of experiments were also made in the same manner using *Asp. niger* (Stock No.7) and *Bac. mycoides* as antagonists. In these experiments, however, the inoculated pathogens were removed from the host plant after a certain period, and allowed to dry. The experiments were repeated five times during a period from Aug. 5 to Aug. 15, 1931. The results are summarized in Tables 156-7.

TABLE 156. Effect of *Bac. mycoides* on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Microorganisms removed after—	Microorganisms inoculated	Number of plants treated	Number of diseased plants after—					
			1 day	2 days	3 days	4 days	5 days	6 days
6 hrs.	<i>C. Sasakii</i> + <i>Bac. mycoides</i>	50	0	0	0	0	0	0
	<i>C. Sasakii</i>	50	0	0	0	0	0	0

TABLE 156. (Continued)

Microor- ganisms removed after--	Microorganisms inoculated	Number of plants treated	Number of diseased plants after--					
			1 day	2 days	3 days	4 days	5 days	6 days
12 hrs.	<i>C. Sasakii</i> + <i>Bac. mycooides</i>	50	0	0	0	0	0	0
	<i>C. Sasakii</i>	50	0	0	0	0	0	0
18 hrs.	<i>C. Sasakii</i> + <i>Bac. mycooides</i>	50	0	0	0	0	0	0
	<i>C. Sasakii</i>	50	0	0	0	0	0	0
24 hrs.	<i>C. Sasakii</i> + <i>Bac. mycooides</i>	50	5(6)	8(13)	8(22)	8(24)	8(31)	8(35)
	<i>C. Sasakii</i>	50	17(17)	19(37)	21(57)	21(68)	21(85)	21(94)

TABLE 157. Effect of *Asp. niger* (Stock No. 7) on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Microor- ganisms removed after--	Microorganisms inoculated	Number of plants treated	Number of diseased plants after--					
			1 day	2 days	3 days	4 days	5 days	6 days
6 hrs.	<i>C. Sasakii</i> + <i>Asp. niger</i>	50	0	0	0	0	0	0
	<i>C. Sasakii</i>	50	0	0	0	0	0	0
12 hrs.	<i>C. Sasakii</i> + <i>Asp. niger</i>	50	0	0	0	0	0	0
	<i>C. Sasakii</i>	50	0	0	0	0	0	0
18 hrs.	<i>C. Sasakii</i> + <i>Asp. niger</i>	50	0	0	0	0	0	0
	<i>C. Sasakii</i>	50	0	0	0	0	0	0
24 hrs.	<i>C. Sasakii</i> + <i>Asp. niger</i>	50	0	0	0	0	0	0
	<i>C. Sasakii</i>	50	18(18)	19(32)	19(45)	19(46)	19(52)	19(52)

From the above results, it is obvious that the occurrence and severity of *C. Sasakii* was also decreased conspicuously by the presence of *Asp. niger* and *Bac. mycoides*.

(B) Effect of the antagonistic action of microorganisms on the occurrence and severity of the disease caused by *Sclerotium Oryzae-sativae* (Tables 158-169)

TABLE 158. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various fungi

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)
Control	40	35	9.0
<i>S. Oryzae-sativae</i>	40	31	6.0
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 2)	40	40	8.0
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 6)	40	40	7.0
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 12)	40	40	7.0
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 15)	40	40	7.0

Remarks: The experiment was made at 20°-30° C., Dec. 29, 1930-Jan. 7, 1931.

TABLE 159. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various fungi

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)
Control	40	40	9.5
<i>S. Oryzae-sativae</i>	40	34	6.5
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 8)	40	40	9.5
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 10)	40	40	9.0
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 13)	40	40	7.0
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 14)	40	40	7.5

Remarks: The experiment was made at 24°-32° C., Dec. 20, 1930-Jan. 8, 1931.

TABLE 160. The Pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various fungi

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	40	5.0	6.5-14.5	10.45	4.3-16.0	10.03	3-6	5
<i>S. Oryzae-sativae</i>	40	36	3.0	2.0-11.5	7.77	3.0-14.0	7.31	1-7	4
<i>S. Oryzae-sativae</i> + <i>Asp. cinnamomeus</i>	40	40	4.0	1.5-16.0	10.19	1.0-18.5	7.35	1-7	5
<i>S. Oryzae-sativae</i> + <i>Asp. flavus</i>	40	40	4.5	3.2-13.7	9.15	4.0-14.0	8.19	3-6	4
<i>S. Oryzae-sativae</i> + <i>Asp. fumigatus</i>	40	39	4.5	1.5-15.2	9.79	2.0-15.5	8.98	1-6	5
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 7)	40	39	5.0	5.5-14.2	10.40	5.0-14.0	10.69	3-7	5
<i>S. Oryzae-sativae</i> + <i>Asp. quercinus</i>	40	40	4.0	1.5-14.0	10.12	3.5-15.5	10.12	1-6	4
<i>S. Oryzae-sativae</i> + <i>Asp. terreus</i>	40	36	3.5	3.2-16.5	10.55	3.0-11.0	6.12	3-6	5

Remarks: The experiment was made at 17°-26° C., May 7-25, 1932.

 TABLE 161. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various fungi

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	38	4.5	2.5-12.5	8.29	4.0-12.0	8.09	1-6	4
<i>S. Oryzae-sativae</i>	40	28	2.5	2.1-12.3	6.20	1.5-12.3	5.55	1-6	3
<i>S. Oryzae-sativae</i> + <i>Asp. fumigatus</i>	40	35	4.5	2.0-13.0	7.36	2.3-16.5	7.83	2-5	4
<i>S. Oryzae-sativae</i> + <i>Asp. niger</i> (Stock No. 7)	40	38	5.0	1.5-12.0	7.32	0.3-12.2	6.76	1-6	4
<i>S. Oryzae-sativae</i> + <i>Asp. quercinus</i>	40	33	4.0	5.7-12.0	8.83	2.1-11.5	8.15	2-5	4
<i>S. Oryzae-sativae</i> + <i>Asp. Sydowi</i>	40	30	3.5	1.0-11.0	6.89	2.1-11.5	7.39	1-5	4

Remarks: The experiment was made at 23°-26° C., May 25-Jun. 11, 1932.

TABLE 162. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various fungi

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	38	4.0	7.0-19.0	12.83	7.5-25.5	12.92	4-7	6
<i>S. Oryzae-sativae</i>	40	39	2.0	4.3-15.0	8.23	3.5-13.0	8.08	4-7	5
<i>S. Oryzae-sativae</i> + <i>Asp. parasiticus</i>	40	38	2.5	1.5-16.0	8.60	2.0-25.0	10.42	1-7	5
<i>S. Oryzae-sativae</i> + <i>Asp. Tamarii</i>	40	39	3.5	5.0-18.0	11.89	3.3-15.0	6.96	4-7	6
<i>S. Oryzae-sativae</i> + <i>Pen. roseum</i>	40	38	3.5	3.0-15.0	9.67	4.0-15.5	5.73	3-7	5

Remarks: The experiment was made at 27°-32.5 C., Jul. 25-Aug. 15, 1932.

TABLE 163. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various fungi

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	40	4.5	1.5-18.5	13.90	1.5-24.3	14.00	1-8	6
<i>S. Oryzae-sativae</i>	40	38	2.0	2.7-15.3	8.77	2.6-12.0	7.24	4-7	5
<i>S. Oryzae-sativae</i> + <i>Asp. parasiticus</i>	40	40	4.0	4.2-17.1	10.88	3.5-25.0	12.43	4-7	6
<i>S. Oryzae-sativae</i> + <i>Asp. Tamarii</i>	40	38	4.0	7.0-18.5	13.84	4.5-14.5	8.74	4-7	6
<i>S. Oryzae-sativae</i> + <i>Pen. roseum</i>	40	35	3.8	2.5-16.5	11.82	5.2-16.5	8.60	4-7	6

Remarks: The experiment was made at 26°-32° C., Jul. 25-Aug. 16, 1932.

From the results shown in Tables 158-163, it is obvious that the pathogenicity of *S. Oryzae-sativae* was remarkably weakened by the presence of *Asp. cinnamomeus*, *Asp. flavus*, *Asp. fumigatus*, *Asp. niger* (Stock No. 2), *Asp. niger* (Stock No. 6), *Asp. niger* (Stock No. 7), *Asp. niger* (Stock No. 8), *Asp. niger* (Stock No. 10), *Asp. niger* (Stock No. 13), *Asp. niger* (Stock No. 15), *Asp. parasiticus*, *Asp. quercinus*, *Asp. Sydowi*, *Asp. Tamarii*, *Asp. terreus* and *Pen. roseum*.

Similar experiments were also made by using certain bacteria as antagonists, and gave similar results as shown in Tables 164-169.

TABLE 164. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	40	5.0	6.0-19.0	13.39	5.5-16.2	11.91	3-6	5
<i>S. Oryzae-sativae</i>	40	35	3.0	2.0-17.0	11.26	2.5-16.0	9.90	1-4	4
<i>S. Oryzae-sativae</i> + <i>Bac. aroides</i>	40	40	4.5	5.7-17.5	12.12	4.0-14.2	10.27	1-7	5
<i>S. Oryzae-sativae</i> + <i>Bac. cereus</i>	40	40	5.0	3.0-19.3	13.37	3.0-12.5	9.98	2-6	5
<i>S. Oryzae-sativae</i> + <i>Bac. fluorescens liquefaciens</i>	40	39	5.5	6.5-19.5	12.94	4.2-15.3	11.30	1-6	5
<i>S. Oryzae-sativae</i> + <i>Bac. mycoides</i>	40	37	4.0	8.0-20.0	12.64	4.2-15.5	9.54	3-6	5
<i>S. Oryzae-sativae</i> + <i>Bac. Prodigiosus</i>	40	40	5.5	9.7-16.5	13.27	4.5-15.0	11.21	4-7	5

Remarks: The experiment was made, at 23.5°-32.5°C., Jan. 27-Feb. 15, 1932.

TABLE 165. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	39	4.5	1.5-11.1	7.32	1.6-16.5	10.25	3-7	4
<i>S. Oryzae-sativae</i>	40	40	3.0	4.7-10.0	7.23	3.5-14.0	6.76	3-6	5
<i>S. Oryzae-sativae</i> + <i>Bac. cereus</i>	40	40	4.5	3.2-13.5	7.98	2.1-11.6	6.73	1-5	4
<i>S. Oryzae-sativae</i> + <i>Bac. mesentericus</i>	40	40	4.5	0.4-13.5	8.63	4.0-11.6	7.46	4-6	4
<i>S. Oryzae-sativae</i> + <i>Bac. mycoides</i>	40	36	4.0	5.5-16.5	7.54	0.4-10.0	5.63	1-6	4
<i>S. Oryzae-sativae</i> + <i>Bac. prodigiosus</i>	40	40	4.5	2.7-11.5	8.44	4.3-11.6	7.71	1-7	4

Remarks: The experiment was made at 24.5°-32° C., Feb. 16-Mar. 2, 1932.

TABLE 166. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	40	5.0	0.5-15.3	8.04	3.7-16.5	9.07	1-5	4
<i>S. Oryzae-sativae</i>	40	40	2.0	2.0-11.0	6.51	4.0-14.5	7.90	3-5	4
<i>S. Oryzae-sativae</i> + <i>Bac. cereus</i>	40	40	6.0	4.5-16.5	11.33	0.6-15.6	10.61	1-6	4
<i>S. Oryzae-sativae</i> + <i>Bac. fluorescens liquefaciens</i>	40	40	4.0	4.2-15.3	9.20	0.9-16.0	9.18	1-6	4
<i>S. Oryzae-sativae</i> + <i>Bac. mesentericus</i>	40	36	3.8	1.5-11.5	8.59	1.3-13.5	7.90	1-6	4
<i>S. Oryzae-sativae</i> + <i>Bac. mycoides</i>	40	40	5.0	4.3-19.2	12.45	0.3-16.0	8.38	4-5	4
<i>S. Oryzae-sativae</i> + <i>Bac. prodigiosus</i>	40	36	4.0	4.3-14.2	8.92	1.6-12.0	7.05	4-5	4

Remarks: The experiment was made at 15°-30°C., Feb. 16-Mar. 3, 1932.

TABLE 167. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	38	4.5	2.5-12.5	8.29	4.0-12.0	8.09	1-3	4
<i>S. Oryzae-sativae</i>	40	28	2.5	2.1-12.3	6.20	1.5-12.5	5.55	1-5	3
<i>S. Oryzae-sativae</i> + <i>Bac. cereus</i>	40	33	4.5	4.5-19.0	11.81	2.3-18.5	10.32	1-5	4

Remarks: The experiment was made at 23°-26°C., May 24-Jun. 11, 1932.

TABLE 168. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedlings in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	36	6.0	2.0-15.7	11.42	3.5-17.5	12.18	1-6	4
<i>S. Oryzae-sativae</i>	40	29	3.0	1.8-13.0	7.95	0.1-12.0	7.39	1-6	4
<i>S. Oryzae-sativae</i> + <i>Bac. fluorescens liquefaciens</i>	40	35	5.0	3.7-19.0	13.26	2.7-15.5	10.15	3-6	5
<i>S. Oryzae-sativae</i> + <i>Bac. dendroides</i>	40	38	4.0	1.5-19.0	11.45	2.0-19.0	9.33	1-6	4
<i>S. Oryzae-sativae</i> + <i>Bac. mesentericus</i>	40	35	4.2	1.5-18.0	12.67	0.5-15.0	9.74	1-6	4
<i>S. Oryzae-sativae</i> + <i>Bac. subtilis</i>	40	37	4.0	6.3-21.2	15.76	2.5-14.5	10.92	3-7	4
<i>S. Oryzae-sativae</i> + <i>Bac. ureae</i>	40	32	4.3	3.0-18.4	11.39	1.5-17.3	9.69	1-6	4
<i>S. Oryzae-sativae</i> + <i>Bact. rossicum</i>	40	37	4.5	3.5-21.5	15.01	1.0-13.5	8.76	1-7	4

Remarks: The experiment was made at 24°-27°C., Jun. 2-14, 1932.

TABLE 169. The pathogenicity of *Sclerotium Oryzae-sativae* on rice seedling in the presence of various bacteria

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	38	5.0	1.2-16.2	10.73	0.5-18.3	11.18	1-6	4
<i>S. Oryzae-sativae</i>	40	37	2.5	1.0-13.0	6.75	0.3- 7.0	3.85	1-6	4
<i>S. Oryzae-sativae</i> + <i>Bac. cereus</i>	40	38	4.0	3.5-14.5	10.21	5.0-17.0	10.35	3-6	5
<i>S. Oryzae-sativae</i> + <i>Bac. fluorescens liquefaciens</i>	40	40	3.5	2.5-17.0	8.86	3.5-13.5	9.54	2-7	5
<i>S. Oryzae-sativae</i> + <i>Bac. mycoides</i>	40	39	3.5	1.0-12.5	8.85	1.5-18.0	9.46	1-3	5
<i>S. Oryzae-sativae</i> + <i>Bac. ureae</i>	40	38	4.0	1.5-12.0	8.39	1.5-13.0	7.83	1-6	4

TABLE 169. (Continued)

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
<i>S. Oryzae-sativae</i> + <i>Bac. medicaginis</i>	40	38	3.8	2.2-14.2	8.69	5.0-20.5	12.27	2-6	5
<i>S. Oryzae-sativae</i> + <i>Bact. rossicum</i>	40	40	5.0	2.5-16.5	9.91	5.0-12.5	7.56	3-6	5

Remarks: The experiment was made at 27°-30° C., June 27-Jul. 8, 1932.

From the results of these experiments, it seems to be clear that *Bac. aroideae*, *Bac. cereus*, *Bac. dendroides*, *Bac. fluorescens liquefaciens*, *Bac. mesentericus*, *Bac. mycoides*, *Bac. prodigiosus*, *Bac. subtilis*, *Bac. ureae*, *Bact. medicaginis* and *Bact. rossicum* are highly antagonistic to *S. Oryzae-sativae* in the soil, affecting the pathogenicity of the latter fungus.

(C) Effect of the antagonistic action of various microorganisms on the occurrence and severity of the disease caused by *Corticium Rolfsii* (Tables 170-183)

From the results of these seven series of experiments (Tables 170-176), it is evident that the pathogenicity of *C. Rolfsii* on rice seedlings is weakened in the presence of *Asp. flavipes*, *Asp. flavus*, *Asp. niger* (Stock No. 3), *Asp. niger* (Stock No. 4), *Asp. niger* (Stock No. 7), *Asp. niger* (Stock No. 11), *Asp. niger* (Stock No. 13), *Asp. niger* (Stock No. 14), *Asp. parasiticus*, *Asp. Schiemanni* and *Asp. Tamaritii*.

TABLE 170. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various fungi

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)
Control	40	39	3.2
<i>C. Rolfsii</i>	40	30	1.8
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 4)	40	35	2.5
<i>C. Rolfsii</i> + <i>Asp. flavipes</i>	40	37	2.5
<i>C. Rolfsii</i> + <i>Asp. flavus</i>	40	38	2.4
<i>C. Rolfsii</i> + <i>Asp. parasiticus</i>	40	35	2.2
<i>C. Rolfsii</i> + <i>Asp. Schiemanni</i>	40	38	2.7
<i>C. Rolfsii</i> + <i>Asp. Tamaritii</i>	40	37	2.6

Remarks: The experiment was made at 22.8°-31.5°C., Jul. 14-21, 1930.

TABLE 171. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various fungi

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings	Weight of healthy seedlings (gm.)
Control	40	37	0	37	3.5
<i>C. Rolfsii</i>	40	37	2	35	3.0
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 1)	40	37	0	37	3.5
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 2)	40	38	0	38	3.7
<i>C. Rolfsii</i> + <i>Asp. repens</i>	40	34	0	34	3.5

Remarks: The experiment was made at 24.7°-32°C., Jul. 23-Aug. 7, 1930.

TABLE 172. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various fungi

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)
Control	40	34	4.0
<i>C. Rolfsii</i>	40	29	3.0
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 3)	40	33	3.5
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 13)	40	26	3.2
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 14)	40	36	3.5

Remarks: The experiment was made at 14°-27°C., Oct. 13-Nov. 5, 1930.

TABLE 173. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various fungi

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)
Control	40	35	4.5
<i>C. Rolfsii</i>	40	25	3.2
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 13)	40	34	3.4

Remarks: The experiment was made at 13°-27°C., Oct. 24-Nov. 18, 1930.

TABLE 174. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various fungi

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
						Range	Average	Range	Average	Range	Average
Control	40	38	0	38	4.0	4.2-12.0	7.21	2.2-12.5	7.33	1-7	4
<i>C. Rolfsii</i>	40	39	2	37	3.7	1.5-12.0	6.98	1.1- 7.2	4.02	1-5	3
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 3)	40	40	1	39	4.4	2.6-12.2	7.20	2.5- 8.0	5.04	1-6	4
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 4)	40	39	0	38	3.8	0.1-13.4	6.99	1.7- 8.0	4.13	1-6	4
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 8)	40	38	0	38	3.9	2.3-11.5	7.16	2.6-10.6	6.31	1-7	4
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 14)	40	40	0	40	4.0	1.9-14.0	6.75	1.8- 8.0	5.11	1-6	4

Remarks: The experiment was made at 18°-36°C., Nov. 18-Dec. 3, 1931.

TABLE 175. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various fungi

Micro-organisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
				Range	Average	Range	Average	Range	Average
Control	40	40	4.0	0.7-14.5	8.96	0.5-23.5	7.68	1-7	5
<i>C. Rolfsii</i>	40	38	3.9	0.9-16.2	8.15	0.3-18.5	5.93	1-7	5
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 3)	40	39	4.5	0.4-17.8	10.53	0.4-14.6	7.44	1-7	5
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 4)	40	40	5.0	2.1-15.5	10.22	1.5-16.8	8.07	1-8	6
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 7)	40	40	4.8	4.9-14.7	10.86	2.3- 7.9	5.02	4-7	5
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 8)	40	40	5.2	5.1-14.5	11.15	1.6-14.0	8.53	1-6	5
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 11)	40	39	4.9	5.3-15.2	10.97	5.0-14.5	8.74	3-7	5
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 14)	40	39	4.4	4.2-14.9	10.33	1.5- 9.9	4.93	3-8	6

Remarks: The experiment was made at 14°-35°C., Nov. 28-Dec. 17, 1930.

TABLE 176. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of *Aspergillus niger*

Microorganism inoculated	Number of seeds sown	Number of seeds germinated	Height of seedlings (cm.)	
			Range	Average
Control	20	20	4.8-8.9	6.30
<i>C. Rolfsii</i>	20	14	0.4-2.8	1.39
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 3)	20	18	0.8-5.7	3.05
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 4)	20	16	0.5-7.5	5.33
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 8)	20	20	1.1-6.5	2.81
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 13)	20	15	1.5-6.0	3.69

Remarks: The experiment was made at 15°-36°C., at Dec. 13-27, 1930.

Similar experiments were made using the broad bean (Otahuku variety) as host plants and gave similar results. In these experiments, 500 cc. flasks containing 200 cc. of clean sand were used.

TABLE 177. The pathogenicity of *Corticium Rolfsii* on broad bean in the presence of *Aspergillus niger*

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings	Weight of stems (gm.)	Weight of roots (gm.)	Average length of seedlings (cm.)
Control	20	20	0	20	21.0	30.8	8.56
<i>C. Rolfsii</i>	20	16	16	0	0	0	0
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 3)	20	15	6	9	3.0	0.7	4.54
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 7)	20	19	4	15	17.0	20.0	12.02
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 8)	20•	18	11	7	7.5	2.5	10.94
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 13)	20	19	2	17	9.0	11.0	6.24
<i>C. Rolfsii</i> + <i>Asp. niger</i> (Stock No. 14)	20	20	2	18	14.0	19.0	9.16

Remarks: The experiment was made at 15°-36°C., Dec. 23, 1930-Jan. 6, 1931.

Experiments made with various bacterial antagonists also gave similar results, which are shown in Tables 178-181.

TABLE 178. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various bacteria

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)
Control	40	34	4.0
<i>C. Rolfsii</i>	40	29	3.0
<i>C. Rolfsii</i> + <i>Bac. cereus</i>	40	26	3.5
<i>C. Rolfsii</i> + <i>Bac. prodigiosus</i>	40	32	3.5

Remarks: The experiment was made at 8°-27°C., Oct. 10-Nov. 5, 1930.

TABLE 179. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various bacteria

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Weight of healthy seedlings (gm.)
Control	40	15	1.8
<i>C. Rolfsii</i>	40	14	1.5
<i>C. Rolfsii</i> + <i>Bac. dendroides</i>	40	16	2.0

Remarks: The experiment was made at 15°-27°C., Nov. 14-Dec. 2, 1930.

TABLE 179. (Continued)

Microorganisms inoculated	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
	Range	Average	Range	Average	Range	Average
Control	0.8-12.5	6.03	1.1-11.9	5.71	1-9	5.51
<i>C. Rolfsii</i>	1.3-11.4	5.21	1.7-11.4	5.81	1-7	4.36
<i>C. Rolfsii</i> + <i>Bac. dendroides</i>	1.3-14.0	8.27	1.3- 9.5	5.68	1-8	5.75

TABLE 181. The pathogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various bacteria

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Height of seedlings (cm.)	
			Range	Average
Control	40	40	3.2-13.6	9.37
<i>C. Rolfsii</i>	40	39	4.6-12.8	9.27
<i>C. Rolfsii</i> + <i>Bac. coli</i>	40	40	5.2-11.7	9.34
<i>C. Rolfsii</i> + <i>Bac. dendroides</i>	40	39	4.9-14.0	10.05
<i>C. Rolfsii</i> + <i>Bac. prodigiosus</i>	40	40	5.3-12.2	9.76
<i>C. Rolfsii</i> + <i>Bac. subtilis</i>	40	39	3.2-13.2	9.78

Remarks: The experiment was made at 14°-36°C., Dec. 24, 1930-Jan. 10, 1931.

From the results shown in Tables 178-181, it is evident that *Bacillus cereus*, *Bac. coli*, *Bac. dendroides*, *Bac. fluorescens liquefaciens*, *Bac. prodigiosus* and *Bac. subtilis* have unfavorable influence on the pathogenicity of *C. Rolfsii* to rice seedlings.

TABLE 180. The patnogenicity of *Corticium Rolfsii* on rice seedlings in the presence of various bacteria

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings	Weight of healthy seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling	
						Range	Average	Range	Average	Range	Average
Control	40	40	0	40	5.8	0.9-15.5	9.49	7.2-22.8	13.15	2-8	5
<i>C. Rolfsii</i>	40	38	2	36	4.3	1.8-10.5	7.59	0.2- 9.2	4.92	1-8	5
<i>C. Rolfsii</i> + <i>Bac. dendroides</i>	40	40	0	40	5.9	5.5-14.1	11.67	3.6-14.6	8.10	1-8	6
<i>C. Rolfsii</i> + <i>Bac. fluorescens liquefaciens</i>	40	40	1	39	6.0	2.2-14.8	10.14	1.2-12.4	8.82	1-8	6
<i>C. Rolfsii</i> + <i>Bac. prodigiosus</i>	40	40	1	39	5.7	7.5-14.5	10.58	4.7-20.6	9.51	4-8	6
<i>C. Rolfsii</i> + <i>Bac. subtilis</i>	40	40	0	40	5.3	3.8-13.5	9.95	2.2-11.3	6.41	3-7	6

Remarks: The experiment was made at 14°-36°. Dec. 20, 1930-Jan., 8, 1931.

Similar experiments made with broad beans also gave similar results. The pathogenicity of *C. Rolfsii* to the broad bean was markedly weakened in the presence of *Bac. aroideae*, *Bac. dendroides*, *Bac. prodigiosus*, *Bac. ureae*, *Bac. mesentericus*, *Bact. Cannae*, *Bact. Sojae*, *Bact. medicaginis* and *Bact. vitans*. The detailed data are given in the following two tables:

TABLE 182. The pathogenicity of *Corticium Rolfsii* on broad beans in the presence of various bacteria

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Number of healthy seedlings	Weight of healthy seedlings (gm.)
Control	10	10	10	4.5
<i>C. Rolfsii</i>	10	0	0	0
<i>C. Rolfsii</i> + <i>Bac. aroideae</i>	10	2	1	0.5
<i>C. Rolfsii</i> + <i>Bac. dendroides</i>	10	0	0	0
<i>C. Rolfsii</i> + <i>Bac. prodigiosus</i>	10	4	4	1.0
<i>C. Rolfsii</i> + <i>Bac. ureae</i>	10	2	2	1.5
<i>C. Rolfsii</i> + <i>Bact. Cannae</i>	10	6	6	2.0
<i>C. Rolfsii</i> + <i>Bact. Sojae</i>	10	2	2	1.5
<i>C. Rolfsii</i> + <i>Bact. vitans</i>	10	3	3	0.5

Remarks: The experiment was made at 10°-30°C., Mar. 28-Apr. 10, 1930.

TABLE 183. The pathogenicity of *Corticium Rolfsii* on broad beans in the presence of various bacteria

Microorganisms inoculated	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings	Weight of healthy seedlings (gm.)
Control	10	5	0	5	1.0
<i>C. Rolfsii</i>	10	1	1	0	0
<i>C. Rolfsii</i> + <i>Bac. cereus</i>	10	4	0	4	0.4
<i>C. Rolfsii</i> + <i>Bac. mesentericus</i>	10	1	0	1	0.4
<i>C. Rolfsii</i> + <i>Bac. prodigiosus</i>	10	2	0	2	0.2
<i>C. Rolfsii</i> + <i>Bac. medicaginis</i>	10	4	0	4	0.8

Remarks: The experiment was made at 24°-33°C., Jul. 5-16, 1930.

These results show that *Bacillus aroideae*, *Bac. cereus*, *Bac. coli*, *Bac. dendroides*, *Bac. fluorescens liquefaciens*, *Bac. mesentericus*, *Bac. prodigiosus*, *Bac. ureae*, *Bacterium Cannae*, *Bact. medicaginis*, *Bact. Sojae*, *Bact. vitans*, *Aspergillus flavipes*, *Asp. niger* (Stock No. 3), *Asp. niger* (Stock No. 4), *Asp. niger* (Stock No. 7), *Asp. niger* (Stock No. 8), *Asp. niger* (Stock No. 11), *Asp. niger* (Stock No. 13), *Asp. niger* (Stock No. 14), *Asp. parasiticus*, *Asp. Schiemanni* and *Asp. Tamarii* are highly antagonistic to *Corticium Rolfsii* in the soil and that they all reduce the pathogenicity of the latter fungus.

From the results shown in the above three series of experiments, the writer came to the conclusion that certain microorganisms antagonistic to the growth of mycelia of the causal fungi are also capable of influencing the occurrence and the severity of these diseases, although their actions differ from each other according to the kind of antagonists.

3. Effect of the filtrates of the cultures of certain fungous antagonists on the occurrence and severity of the diseases

The direct antagonistic action of living microorganisms on plant pathogenes has been studied by many authorities^(4, 5, 6, 7, 18, 20, 21, 22, 39, 72, 85, 91, 92, 105), but the influence of the filtrates of the cultures of these antagonists on the occurrence and severity of the disease has not been fully investigated, though some investigators^(91, 106) have already touched on this problem.

In the writer's experiments, the fungous antagonists were cultured on SAITO's soy medium in ERLENMYER's flasks for 21 days at 28°C., and then the culture solutions were filtered through a Chamberland filter (F). Fifty cc. of each of the filtrates were poured into 250 cc. ERLENMYER's flasks containing 100 cc. of clean sand, and then the pathogene was transplanted in the flask. One to three days later several clean seeds of rice (Sinriki variety) were sown on the sand. Experiments were repeated five times for *Corticium Sasakii*, and four times each for *Sclerotium Oryzae-sativae* and *Corticium Rolfsii*. The results obtained are summarized in Tables 184-186.

From the above experiments with three different pathogenes, it may be stated that the filtrates of the solutions, upon which *Asp. niger*, *Asp. parasiticus* or *Asp. Tamarii* were previously cultured, are antagonistic and affect the occurrence and severity of the diseases caused by *Corticium Sasakii*, *Corticium Rolfsii* and *Sclerotium Oryzae-sativae*, while these filtrates were shown to be somewhat toxic to rice seedlings.

A similar experiment was undertaken in order to ascertain the toxic

TABLE 184. Effect of the filtrates of the cultures of certain fungous antagonists on the occurrence and severity of the Sclerotium disease caused by *Corticium Sasakii*

Medium used	Inoculated pathogene	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Weight of healthy seedlings (gm.)	Height of healthy seedlings (cm.)		Length of roots of the healthy seedlings (cm.)		Number of roots per seedling	
						Range	Average	Range	Average	Range	Average
Water	<i>C. Sasakii</i>	200	177	152	2.2	1.0-17.4	7.93	0-14.0	6.14	0-7	4
	None inoculated	200	193	0	21.4	1.6-24.7	16.61	0-21.5	11.51	0-9	6
Culture solution	<i>C. Sasakii</i>	200	16	0	0.9	0.1-3.4	2.03	0-0.4	0.60	0-4	1
	None inoculated	200	32	0	1.9	0.1-5.7	2.28	0-2.4	0.53	0-5	1
Filtrate of the culture of <i>Asp. niger</i>	<i>C. Sasakii</i>	200	72	3	2.8	0.1-9.7	4.78	0-0.8	0.12	0-6	3
	None inoculated	200	62	0	3.4	0.1-6.7	2.49	0-0.4	0.10	0-1	3
Filtrate of the culture of <i>Asp. parasiticus</i>	<i>C. Sasakii</i>	200	120	7	7.0	0.4-17.1	7.33	0-3.7	0.69	0-9	5
	None inoculated	200	123	0	6.3	0.2-16.8	7.04	0-4.5	0.45	0-12	4
Filtrate of the culture of <i>Asp. Tamaritii</i>	<i>C. Sasakii</i>	200	149	2	7.4	0.5-15.0	6.54	0-2.6	0.59	0-13	6
	None inoculated	200	138	0	7.9	0.4-13.8	6.12	0-1.5	0.47	0-11	6

TABLE 185. Effect of the filtrates of the cultures of certain fungous antagonists on the occurrence and the severity of the Sclerotium disease caused by *Sclerotium Oryzae-sativae*

Medium used	Inoculated pathogene	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Weight of healthy seedlings (gm.)	Height of healthy seedlings (cm.)		Length of roots of the healthy seedlings (cm.)		Number of roots per seedling	
						Range	Average	Range	Average	Range	Average
Water	<i>S. Oryzae-sativae</i>	160	143	29	9.1	7.2-19.7	14.87	1.0-19.6	9.36	4-10	7
	None inoculated	160	156	0	11.9	1.0-20.1	15.17	3.5-19.3	8.49	3-9	6
Culture solution	<i>S. Oryzae-sativae</i>	160	0								
	None inoculated	160	29	0	1.0	0.1-3.5	1.53	0-0.5	0.07	0-3	1
Filtrate of the culture of <i>Asp. niger</i>	<i>S. Oryzae-sativae</i>	160	57	8	2.7	0.1-4.3	1.73	*			
	None inoculated	160	54	0	2.2	0.1-5.8	1.97	0-0.1	0.01	0-5	1
Filtrate of the culture of <i>Asp. parasiticus</i>	<i>S. Oryzae-sativae</i>	160	102	2	5.2	0.2-12.7	4.90	0-3.6	1.32	0-9	4
	None inoculated	160	118	0	6.2	0.2-13.3	5.16	0-5.1	1.46	0-9	4
Filtrate of the culture of <i>Asp. Tamaritii</i>	<i>S. Oryzae-sativae</i>	160	86	1	2.6	0.1-9.1	2.68	0-1.2	0.12	0-13	2
	None inoculated	160	65	0	2.7	0.2-10.6	3.10	0-1.0	0.16	0-15	2

Remarks: * No root developed.

TABLE 186. Effect of the filtrates of the cultures of certain fungous antagonists on the occurrence and the severity of the Sclerotium disease caused by *Corticium Rolfsii*

Medium used	Inoculated pathogene	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Weight of healthy seedlings (gm.)	Height of healthy seedlings (cm.)		Length of roots of the healthy seedlings (cm.)		Number of roots per seedling	
						Range	Average	Range	Average	Range	Average
Water	<i>C. Rolfsii</i>	160	123	45	9.0	5.0-29.5	19.09	5.5-18.4	10.55	4-9	6
	None inoculated	160	141	0	14.4	3.0-26.8	10.64	2.5-24.0	9.53	3-11	6
Culture solution	<i>C. Rolfsii</i>	160	37	34	0.2	0.1-15.5	12.63	0-4.0	3.50	0-7	6
	None inoculated	160	28	0	1.6	0.1-16.0	5.95	0-7.5	1.62	0-8	3
Filtrate of the culture of <i>Asp. niger</i>	<i>C. Rolfsii</i>	160	53	8	3.1	0.1-22.4	10.62	0-3.0	1.27	0-10	5
	None inoculated	160	53	0	2.5	0.2-17.0	5.54	0-5.0	1.00	0-10	4
Filtrate of the culture of <i>Asp. parasiticus</i>	<i>C. Rolfsii</i>	160	37	5	1.8	0.3-18.0	6.59	0-2.0	7.90	0-10	4
	None inoculated	160	57	0	3.2	0.2-18.5	7.56	0-4.0	3.06	0-12	5
Filtrate of the culture of <i>Asp. Tamaritii</i>	<i>C. Rolfsii</i>	160	68	0	3.7	0.2-18.5	9.95	0-3.7	1.27	0-12	7
	None inoculated	160	66	0	3.2	0.1-22.0	9.28	0-4.2	2.05	0-13	6

action of the filtrates of the cultures of the antagonists on the fungus affecting the stem of rice plant. A sclerotium of *Corticium Sasakii* was inoculated at the ligule of the leaf sheath, and then the treated portion was covered with a piece of cotton moistened with the above mentioned filtrate. The experiments were repeated five times. The results obtained are summarized in Table 187.

TABLE 187. Effect of the filtrates of the cultures on the appearance of the Sclerotium disease on the stem of the rice plant

Medium used	Inoculated pathogene	Number of plants tested	Number of diseased plants
Water	<i>C. Sasakii</i>	50	33 (78)*
	None inoculated	50	0
Culture solution	<i>C. Sasakii</i>	50	36 (108)
	None inoculated	50	0
Filtrate of the culture of <i>Asp. niger</i>	<i>C. Sasakii</i>	50	15 (24)
	None inoculated	50	0
Filtrate of the culture of <i>Asp. parasiticus</i>	<i>C. Sasakii</i>	50	16 (24)
	None inoculated	50	0
Filtrate of the culture of <i>Asp. Tamaraii</i>	<i>C. Sasakii</i>	50	22 (24)
	None inoculated	50	0

Remarks: ()* Number of diseased spots.

From these results, it is evident that the filtrates of the aged culture solutions of *Asp. niger*, *Asp. parasiticus* or *Asp. Tamaraii* affect the occurrence and the severity of the disease caused by *Corticium Sasakii* on the stem of rice plant. In no case the toxic influence of these filtrates on the plant surface was recognized.

4. Morphological changes of the causal fungi caused by the antagonists

The retarded growth of *Corticium Sasakii*, *Corticium Rolfsii* or *Sclerotium Oryzae-sativae* in mixed cultures with various antagonists has been stated in the previous sections of this chapter. In the present section, experiments which aimed to ascertain the morphological changes of the mycelia of these

causal fungi are described^(18,34). The method to secure the mixed culture is just the same as described already.

(A) Morphological changes of the hyphae of *Corticium Sasakii*

The hyphae of *Corticium Sasakii* in a mixed culture with *Bac. cereus* were remarkably different from the normal hyphae. Their apical cells were subject to plasmolysis, while the septa became as thick as 1-2 μ . The width of such hyphae varied with their portions. The apical cells were globose and 4-7 μ in diameter, while the second was 5 μ and the third 5-7 μ .

When *Corticium Sasakii* was cultured with *Bact. rossicum*, plasmolysis occurred in the hyphae in the part facing the bacterium, but morphologically they did not show any remarkable changes. The hyphae branched, at obtuse angles. The size of the cell was 20 \times 5-7 μ in the apical cells, and 30-55 \times 6-10 μ in the second and 30 \times 6 μ in the third. The hyphae of the fungus infested by *Bac. subtilis* became strikingly swollen at the apex attaining 13 μ in width, in comparison with healthy hyphae which are 6-8 μ in width. The affected hyphae became jagged only 2 μ in width at the narrowest part.

The fungus was greatly affected by *Bac. prodigiosus*; the colony of the fungus, therefore, remained small or almost undeveloped: plasmolysis occurred in the apical cells of the hyphae at the part of the colony facing the bacterium. The size of the cell was 35 \times 6-7 μ in the apex of hyphae and 40 \times 7-8 μ in the second cells. Generally the hyphae became swollen and were 2-3 μ in width showing jagged edges.

The hyphae of fungus in a mixed culture with *Bac. mycoides* showed a great morphological change: the hyphae at the part facing the bacterium became jagged and plasmolysis took place therein, but no special change was found in the hyphae in the central part of the colony. The hyphae branched at an obtuse angle and the size of the apical cell was 25-70 \times 5-19 μ .

The hyphae of *Corticium Sasakii* affected by *Bac. dendroides* was subject to a remarkable change and became jagged measuring only 2 μ wide at their narrowest part, while the healthy part was 5-6 μ wide. The apical cell became globose, measuring 25-40 \times 4-12 μ in size and often showing plasmolysis, while the second cells were 30-45 \times 4-7 μ , and the third 35-60 \times 3-8 μ . Their staining reaction differed greatly according to the affected parts of the mycelia. By fuchsin they were stained "Rosolane Pink" when normal, but when the cytoplasm was lost they became "Cameo Pink", and "Paris Blue" when plasmolysis occurred.

In a mixed culture of *Corticium Sasakii* with *Bac. fluorescens liquefaciens*, the part of the colony of the former facing the bacterium changed greatly

in morphological characters, but the central parts did not show any remarkable change. The apical cells of the hyphae facing the bacterium became somewhat swollen and turning into hyaline as plasmolysis occurred. In general, the hyphae became greatly indented, and branched at irregular angles. The size was $25-80 \times 4-10 \mu$ in the apical cells, $25-75 \times 2-20 \mu$ in the second, and $35 \times 68 \mu$ in the third. The hyphae infested by *Bac. ureae* became jagged and plasmolysis occurred therein. They branched at acute angles and the apical cells were globose and 15μ in diameter.

In the case of *Corticium Sasakii* infested by *Bac. mesentericus*, some parts of the hyphae of the former became very thin and were only $2-3 \mu$ wide. The apical cells became swollen to $9-10 \mu$ in width and their walls thickened. The staining reaction of the hyphae was remarkably different according to their part. The wide part showed "La France Pink" by fuchsin and the narrow part "Cameo Pink." The infected parts became "Light Methyl Blue" and the apparently healthy part was "Sky Blue" by methylene blue.

Corticium Sasakii in a mixed culture with *Bac. collarinus* grew rather vigorously, but morphological changes were observed. The narrow parts were $2-3 \mu$ wide, while the apical cells became swollen to a width $12-15 \mu$, and their walls thickened. The length of the cell was only 25μ , while that of the normal cells was $55-70 \mu$. The staining reaction of the hyphae differed according to the degree of infection by the bacterium. The most severely infected parts were stained "Spinel Pink" by fuchsin, and the healthy parts "Rosolane Pink" or "Grenadine" by safranin.

Plasmolysis occurred in the hyphae of *Corticium Sasakii* infected by *Bact. michiganens*. The apical cells were shorter than the basal one, and the width was in the contrary relation. The sizes were $30-45 \times 7 \mu$ in the apical cells and $100-120 \times 5 \mu$ in the basal ones. The staining reactions varied according to the parts of the cells. The parts showing plasmolysis were stained "Deep Rose Pink" by fuchsin and "Cameo Pink" at the vacuole, but "Mazarine Blue" or "Pallid Methyl Bule" by methylene blue and "Light Salmon Orange" or "Orient Pink" by safranin.

(B) Morphological changes of the hyphae of *Sclerotium Oryzae-sativae*

When *Sclerotium Oryzae-sativae* was affected by *Bac. fluorescens liquefaciens*, plasmolysis of the hyphae occurred at the apical cells of the colony facing the bacterium. The hyphae often became jagged, and their narrow parts were only 1μ in width. The size was $20-25 \times 4-6 \mu$ in the apical cells, $40-60 \times 1-5 \mu$ in the second, and $35-40 \times 3-6 \mu$ in the third.

In the case of *Bact. rossicum*, plasmolysis of the hyphae occurred at the apical part facing the bacterium. In severe cases, the cell membranes were often destroyed, inducing the cell 100 μ in length, the width of the hyphae was variable and their narrow parts were only 2-3 μ in width as against 5-7 μ in normal parts.

The hyphae of the fungus in a mixed culture with *Bac. corallinus* show some morphological changes at the apical part facing the colony of the bacterium, while no change occurred at the inner part of the colony. Plasmolysis was only found at the apical cells, the hyphae became jagged, and the cell membrane was often destroyed. The size was 20-65 \times 5-7 μ in the apical cells, 35-75 \times 3-9 μ in the second and 32-60 \times 4-8 μ in the third.

The hyphae of the fungus affected by *Bac. dendroides* changed their shape and size greatly, causing plasmolysis and the destruction of septa. The apical cells became globose and 7 μ in diameter, while the normal cells were 3-4 μ in width: the size was 60-80 \times 4-5 μ in the second and 60-100 \times 4-6 μ in the third.

In mixed cultures with *Bac. mycooides* the apical cells became globose and 8 μ in diameter as compared with 6 μ in other cells. Plasmolysis did not take place.

When *Sclerotium Oryzae-sativae* was affected by *Bac. subtilis*, the apical cells became somewhat swollen, but no plasmolysis occurred. The hyphae often became jagged and the narrow parts were only 3-4 μ wide, in comparison with 7-10 μ in normal parts. The size was 25-45 \times 4-6 μ in the apical cells, 20-65 \times 3-6 μ in the second, and 30 \times 2-5 μ in the third. The branching of the hyphae was mostly at an acute angle.

In *Sclerotium Oryzae-sativae* affected by *Bac. prodigiosus*, plasmolysis often occurred in the cells and the hyphae became jagged as the cells were all swollen to more than 15 μ in width and their membranes were frequently destroyed. The size was 13-75 \times 1-6 μ in the apical cells, 30-80 \times 2-6 μ in the second and 30-65 \times 2-5 μ in the third. The branching of the hyphae was the same as normal.

The hyphae of *Sclerotium Oryzae-sativae* affected by *Bact. michiganense* also became jagged. The size was 25-35 \times 4-7 μ in the apical cells, and 10-65 \times 5-8 μ in the second and 25-38 \times 4-5 μ in the third. The hyphae at the apical part branched at acute angles, and those at the basal part at obtuse angles.

(C) Morphological change of the hyphae of *Corticium Rolfsii*

Corticium Rolfsii in a mixed culture with *Bac. fluorescens liquefaciens* was much depressed in its mycelial growth. The apical cells of the branches of

hyphae became globose and $15 \times 10\text{--}12 \mu$ in size, while two or three slender hyphae developed from the globose cells. The hyphae were $3\text{--}4.5 \mu$ wide and showed plasmolysis at the apical parts. When the fungus was affected by *Bac. megatherium*, the apical cells of the branches of hyphae became globose, plasmolysis occurred, and one or two slender hyphae developed from the globose cells. In the case of *Bac. mycooides*, the hyphae of the fungus in the margin of the colony facing the bacterium changed greatly in their morphological characters, but no change took place in the central part of the colony. The hyphae were 5μ in width, and plasmolysis was observed. The apical cells became jagged, and the cell membrane as well as the cell contents disappeared. The size was $35\text{--}100 \times 3\text{--}6 \mu$ in the apical cells, $65\text{--}75 \times 3\text{--}6 \mu$ in the second, and $75\text{--}80 \times 5\text{--}7 \mu$ in the third.

In a mixed culture with *Bac. prodigiosus*, the hyphae of the fungus were only $1\text{--}3 \mu$ in width and plasmolysis often occurred. The size was $13\text{--}35 \times 3\text{--}5 \mu$ in the apical cells, $42\text{--}62 \times 2\text{--}4 \mu$ in the second, and $16\text{--}35 \times 3\text{--}5 \mu$ in the third. The staining reactions of the hyphae were widely variable. The swollen parts were stained "Spinal Pink" by fuchsin, "Pallid Methyl Blue" by methylene blue and "Orient Pink" by safranin, while the fibrous parts were stained "Rose Pink" by fuchsin, "Methyl Blue" by methylene blue and "Light Salmon" by safranin.

The morphological characters of the hyphae of the fungus affected by *Bac. mesentericus* differed very remarkably from normal, especially at the part of the colony facing the bacterium. Plasmolysis occurred in the apical cells, and not only their septa but also the cytoplasm were injured. The hyphae branched at obtuse angles at the parts facing the bacterium, and at acute angles at the central part of the colony. The size was $15\text{--}55 \times 2\text{--}6 \mu$ in the apical cells, $10\text{--}105 \times 3\text{--}5 \mu$ in the second, and $18\text{--}35 \times 3\text{--}6 \mu$ in the third.

The hyphae of the fungus in a mixed culture with *Bact. rossicum* were commonly $5\text{--}6 \mu$ wide (in rare cases very slender, and often only 2μ in width). The branching of hyphae was found to be the same as normal. The sizes of the cells differed according to the part of the mycelium. They were $40\text{--}55 \times 2\text{--}8 \mu$ in the apical cells, $20\text{--}45 \times 2\text{--}7 \mu$ in the second, and $22\text{--}30 \times 5\text{--}8 \mu$ in the third.

In a mixed culture with *Bac. dendroides*, the bacterium made a very rapid growth on culture media, and engirdled the colony of the fungus, so that the fungus colony was almost unable to develop. The hyphae became jagged with a width of $1\text{--}2 \mu$, plasmolysis was often observed, and frequently the cell membrane was injured. The staining reaction of the hyphae differed

greatly according to the degree of the destruction; the destroyed parts showed "Berlin Blue" by methylene blue, "Liseran Purple" by safranin, and "Deep Rose Pink" by fuchsin, while the external healthy parts were paler than those of the injured parts, being stained "Pallid Methyl Blue" by methylene blue, and "Magenta" by safranin.

According to the results above described, the morphological change of the mycelia affected by other microorganisms is to be divided into six types.

Type 1: Loss of septa and cytoplasm in the hyphal cell.

Type 2: Plasmolysis of hyphal cell.

Type 3: Change of color of hyphae into brown.

Type 4: Formation of jagged edges in the hyphal cell.

Type 5: Formation of globose cell at the apices of hyphae.

Type 6: Development of one or two slender hyphae from the globose-cell at the apex.

To compare the above described morphological changes of the mycelia with those caused by certain chemicals, the following experiments were conducted using *Corticium Sasakii*, *Sclerotium Oryzae-sativae* and *Corticium Rolfsii*. A sclerotium and a small dose of chemicals were put on potato decoction agar to confront each other. At least three dishes were used for a series. The results obtained are summarized in Tables 188-190.

Among the chemicals tested, ammonium carbonate, copper sulphate and tannic acid were extremely toxic to the growth of the mycelium, while ammonium citrate, ammonium chloride and ammonium phosphate in the case of *Corticium Sasakii* and ammonium citrate in the case of *Corticium Rolfsii* promoted their growth. The morphological changes of the mycelia were also observed. In these cases, the changes were very similar to those found in mixed cultures with antagonists.

TABLE 188. Effect of certain chemicals on the morphological characters of the mycelium of *Corticium Sasakii*

Chemicals	Morphological change of the mycelium	Average radius of the mycelial colony after 3 days (mm.)	
		Part of the colony facing the chemical	Counter part of the colony
Control (No chemical added)	No change observed.	39.0	39.0
Ammonium acetate	Plasmolysis observed.	33.0	38.5
Ammonium carbonate	The mycelium never developed.	0	0

TABLE 188. (Continued)

Chemicals	Morphological change of the mycelium	Average radius of the mycelial colony after 3 days (mm.)	
		Part of the colony facing the chemical	Counter part of the colony
Ammonium chloride	No morphological change of the hyphae observed.	63.3	49.3
Ammonium citrate	The hyphae near the chemical slightly destroyed.	45.0	44.0
Ammonium phosphate	The hyphae facing the chemical deformed at apical cells and plasmolysis often occurred.	39.7	36.0
Ammonium sulphate	The hyphae did not change so remarkably, but some swelling at the apical cell was observed.	35.0	43.3
Calcium carbonate	The apical cells of the hyphae facing the chemical shortened slightly.	55.0	55.0
Copper carbonate	No morphological change of the hyphae was observed.	61.0	65.0
Copper sulphate	The apical cells of the hyphae became globose and 15.4-24.8 μ (average 18.8 μ) in width while 3.7-7.5 μ (average 5.0 μ) in the normal cells. Plasmolysis often occurred; and the affected parts were 1.1-4.4 μ , while the normal cells 3.3-7.7 μ in width.	7.0	52.5
Ferrous sulphate	The apical cells of the hyphae globose, and 10-26.4 μ wide, while the normal cells 4.0-11.0 μ in width. Plasmolysis occurred not only at the apical parts but also in other parts.	3.75	10.5
Nitrolime	The hyphae facing the chemical branched at right angles and plasmolysis occurred.	12.0	29.5
Oxalic acid	Plasmolysis and deformation at the apical cells facing the chemical occurred.	2.5	2.5
Sulphur flour	No morphological change occurred.	38.0	7.0
Tannic acid	Plasmolysis of the hyphae observed in the part facing the chemical. The apical cells were often deformed into a globose shape.	5.7	39.5
Uric acid	Plasmolysis occurred to a slight extent at the apical cells facing the chemical.	40.0	44.0

TABLE 189. Effect of certain chemicals on the morphological characters
the mycelium of *Sclerotium Oryzae-sativae*

Chemicals	Morphological change of the mycelium	Average radius of the mycelial colony after 3 days (mm.)	
		Part of the colony facing the chemical	Counter part of the colony
Control (No chemicals added)	No change observed.	30.0	30.0
Ammonium acetate	Two hyphal branches developed from the apical cell showing "T"-shape.	6.0	20.0
Ammonium carbonate	Mycelium did not develop.	0	0
Ammonium citrate	The hyphae were $64.2 \times 7-13 \mu$ and plasmolysis observed.	22.0	27.0
Ammonium phosphate	The cells of the hyphae facing the chemical swelled somewhat at the apical cells and plasmolysis occurred.	46.5	48.5
Ammonium sulphate	The apical cells of the hyphae facing the chemical shortened to $13.0-19.5 \mu$, rarely 7.4μ in length. Plasmolysis occurred also in the cells affected by the chemical.	46.5	48.5
Calcium carbonate	Plasmolysis occurred and all the hyphae were destroyed.	27.0	29.0
*Copper carbonate	The hyphae facing the chemical often swelled, and became $3.8-16.5 \mu$ in width (Average 15.7μ), while 9.6μ in the normal cells.	35.3	53.3
Copper sulphate	The cells of the hyphae swelled, and measured $8-14 \mu$ in width, while $4-6 \mu$ in the normal cells. The cell membrane of the apical cells became very thick and brown in color.	0	6.75
Ferrous sulphate	The mycelium did not develop.	0	0
Nitrolime	Plasmolysis occurred.	35.3	37.0
Oxalic acid	The mycelium did not develop.	0	0
*Sulphur flour	The cells of the hyphae facing the chemical often swelled, plasmolysis occurred, and cells became $11.6-16.7 \mu$ in width, while the normal cells were 9.0μ wide.	45.6	51.3

TABLE 189. (Continued)

Chemicals	Morphological change of the mycelium	Average radius of the mycelial colony after 3 days (mm.)	
		Part of the colony facing the chemical	Counter part of the colony
Tannic acid	Plasmolysis often occurred, and destroyed the hyphae which were 4.1-5.2 μ in width, while the normal cells were 9.6-10.3 μ wide.	38.0	43.3
*Uric acid	Plasmolysis occurred at the apical cells of the hyphae facing the chemical.	40.2	44.5

Remarks: * The results were observed after 4 days.

 TABLE 190. Effect of the chemicals on the morphological characters of the mycelium of *Corticium Rolfsii*.

Chemicals	Morphological change of the mycelium	Average radius of the mycelial colony after 3 days (mm.)	
		Part of the colony facing the chemical	Counter part of the colony
Control (No chemicals added)	No change observed.	32.5	32.5
*Ammonium acetate	Plasmolysis occurred and the apical cells often became globose.	18.0	36.0
Ammonium carbonate	The mycelium did not develop.	0	0
*Ammonium chloride	No change observed.	19.5	21.0
Ammonium citrate	Occasionally plasmolysis occurred slightly in the hyphae facing the chemical.	31.8	30.6
*Ammonium phosphate	Mostly no change observed, but occasionally in the apical cells changed slightly.	22.3	22.3
Calcium carbonate	The hyphae were 4 μ in width, and plasmolysis often occurred.	23.0	27.0
Copper carbonate	No change observed.	31.2	31.3
Copper sulphate	The hyphae often bifurcated at the apical cells, where plasmolysis was observed.	29.6	32.6
Ferrous sulphate	The apical cells became globose and 6.0-9.0 μ (average 7.5 μ) while normal cells 1.5-3.5 μ (average 2.5 μ) in width.	30.2	37.0

TABLE 190. (Continued)

Chemicals	Morphological change of the mycelium	Average radius of the mycelial colony after 3 days (mm.)	
		Part of the colony facing the chemical	Counter part of the colony
Nitrolime	The apical cells of the hyphae facing the chemical somewhat swelled and became 4.4-5.5 μ while the normal cells 3.3 μ in width. Plasmolysis occurred in the hyphae affected by the chemical, where loss of cytoplasm was often observed.	24.7	27.0
Oxalic acid	The hyphae swelled, and 4.1-6.1 μ (average 1.6 μ) in width at the apical cells, while the normal cells, 1.1-2.8 μ (average 1.6 μ). Plasmolysis also was observed.	40.0	45.0
Sulphur flour	The apical cells of the hyphae became globose, and plasmolysis often occurred, but some cells showed no change.	37.0	40.0
Tannic acid	The apical cells became globose and plasmolysis occurred in the hyphae.	10.4	40.0

Remarks: * The results were observed after 4 days.

5. Effect of environmental factors on the antagonistic action of microorganisms

There is no doubt for the fact that the antagonistic action of microorganisms is often influenced by environmental factors. The writer conducted the following experiments on some factors which may affect the antagonistic action.

(A) Effect of nutriments

As to the nutriments which may affect the antagonism, carbohydrates and organic nitrogen compounds were considered in these experiments. First the effect of organic nitrogen compounds was investigated. As the source of organic nitrogen, albumen, ammonia, alanine, asparagin, fibrin, legmin, peptone, salicin, tyrosin and urealic acid (1% each) were used in the experiments. The fundamental medium consisted of potassium biphosphate 5 gm., magnesium sulphate 2.5 gm., cane sugar 50 gm., distilled water 1000 cc., and agar 20 gm. The experiments were carried out in the same way as that described in the previous section. In all series, the cultures were kept at 28°C. in a incubator for 21 days. The results obtained are given in Table 191.

TABLE 191. Effect of organic nitrogen compounds on the antagonistic action of *Aspergillus niger* to *Corticium Rolfsii*

Organic nitrogen compounds added	Antagonistic action of <i>Asp. niger</i>	Growth of mycelium of <i>Asp. niger</i>	Growth of mycelium of <i>C. Rolfsii</i>		Formation of sclerotia of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony	Number	Weight (gm.)
Albumen	++	++	+++	++++	64	0.04
Ammonium citrate	+++	+++	+	+++	11	0.02
Alanine	+++	+++	++	+++++	42	0.02
Asparagin	++	++	+++	+++++	21	0.06
Fibrin	(+)	++++	+++	+++++	0	0
Legumin	++	++	+++	+++++	32	0.06
Peptone	+++	++++	++	+++++	21	0.02
Salicin	++	++	+++	+++++	9	0.03
Tyrosin	++++	++++	-	++	0	0
Urealic acid	++	+++	+++	+++++	24	0.03

TABLE 192. Effect of organic nitrogen compounds on the antagonistic action of *Aspergillus Tamarisii* to *Corticium Rolfsii*

Organic nitrogen compounds added	Antagonistic action of <i>Asp. Tamarisii</i>	Growth of mycelium of <i>Asp. Tamarisii</i>	Growth of mycelium of <i>C. Rolfsii</i>		Formation of sclerotia of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Asp. Tamarisii</i>	Counter part of the colony	Number	Weight (gm.)
Albumen	(+)	+++	++++	+++++	46	0.11
Ammonium citrate	+++	+++	++	+++	7	0.01
Alanine	++	++	++	+++	17	0.02
Asparagin	+++	+++	(+)	+++++	24	0.07
Fibrin	(+)	++	++++	+++++	42	0.06
Legumin	++	++	+++	+++++	15	0.03
Peptone	++	+++	++	+++	20	0.03
Salicin	(+)	++	++++	+++++	7	0.01
Tyrosin	++	+++	+++	+++++	37	0.04
Urealic acid	(+)	++	++++	+++++	16	0.02

The results given in these tables show that the nutriment added to the culture media affected the antagonistic action of the antagonists, and that tyrosin, alanine, peptone and ammonium citrate strengthen the antagonistic action of *Aspergillus niger* and *Aspergillus Tamarisii* on *Corticium Rolfsii* in the highest degree.

To ascertain the effect of carbohydrates on the antagonistic action of

antagonists, experiments were carried out on the same line, using a fundamental medium containing 1% of each carbohydrate. But in these experiments, 2.5 gm. of asparagin was used instead of cane sugar in the fundamental medium previously described. The results obtained are tabulated as follows :

TABLE 193. Effect of carbohydrates on the antagonistic action of *Aspergillus niger* to *Corticium Sasakii*

Carbohydrates added	Antagonistic action of <i>Asp. niger</i>	Growth of mycelium of <i>Asp. niger</i>	Growth of mycelium of <i>C. Sasakii</i>		Formation of sclerotia of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony	Number	Weight (gm.)
Corn starch	+	+	++++	+++++	2	trace
Galactose	+	+	+++	+++++	2	trace
Glucose	+++	+++	+	+++++	29	0.03
Glycerin	++	++	+	+++++	5	0.01
Glycogen	++	++	+++	+++++	39	0.13
Inulin	+++	+++	+	+++++	2	trace
Maltose	++	++	+	+++++	7	0.06
Mannose	++	++	+	+++++	23	0.09
Lactose	++	++	+++	+++++	10	trace
Levulose	++	++	+	++++	14	0.09
Raffinose	+++	+++	+	++++	12	0.02
Sucrose	+++	+++	+	+++++	78	0.10

TABLE 194. Effect of carbohydrates on the antagonistic action of *Aspergillus parasiticus* to *Corticium Sasakii*

Carbohydrates added	Antagonistic action of <i>Asp. parasiticus</i>	Growth of mycelium of <i>Asp. parasiticus</i>	Growth of mycelium of <i>C. Sasakii</i>		Formation of sclerotia of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Asp. parasiticus</i>	Counter part of the colony	Number	Weight (gm.)
Corn starch	+	++	+++	+++++	1	trace
Galactose	+++	+++	++	+++++	3	trace
Glucose	++++	++++	++	+++++	2	trace
Glycerin	++	++	++	++++	0	0
Glycogen	+++	+++	+	+++++	1	trace
Inulin	++	+++	+	+++++	5	0.03
Maltose	+++	+++	+	+++++	1	trace
Mannose	++++	++++	++	+++++	4	trace
Lactose	+++	+++	++	+++++	0	0
Levulose	++++	++++	++	+++++	0	0
Raffinose	++++	++++	++	+++++	0	0
Sucrose	++++	++++	++	+++++	9	0.08

TABLE 195. Effect of carbohydrates on the antagonistic action of *Aspergillus Tamarii* to *Corticium Sasakii*

Carbohydrates added	Antagonistic action of <i>Asp. Tamarii</i>	Growth of mycelium of <i>Asp. Tamarii</i>	Growth of mycelium of <i>C. Sasakii</i>		Formation of sclerotia of <i>C. Sasakii</i>	
			Part of the colony facing the colony of <i>Asp. Tamarii</i>	Counter part of the colony	Number	Weight (gm.)
Corn starch	+	++	++++	+++++	4	trace
Galactose	+	++	++++	+++++	2	trace
Glucose	++	+++	+	+++++	13	0.09
Glycerin	++	++	+++	+++++	0	0
Glycogen	+	++	++++	+++++	6	0.05
Inulin	++	++	+	+++++	3	0.05
Maltose	++	++	+	+++++	45	0.08
Lactose	++	++	++	+++++	0	0
Levulose	++	++	+	+++++	12	0.11
Raffinose	++	++	++	+++++	7	0.02
Sucrose	+++	++	-	+++++	16	0.15

TABLE 196. Effect of carbohydrates on the antagonistic action of *Aspergillus niger* to *Corticium Rolfsii*

Carbohydrates added	Antagonistic action of <i>Asp. niger</i>	Growth of mycelium of <i>Asp. niger</i>	Growth of mycelium of <i>C. Rolfsii</i>		Formation of sclerotia of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Asp. niger</i>	Counter part of the colony	Number	Weight (gm.)
Corn starch	+++	+++	+	+++++	38	0.09
Galactose	++	+++	+++	+++++	30	0.07
Glucose	++	+++	+++	+++++	79	0.01
Glycerin	+++	+++	+	+++++	13	0.03
Glycogen	++	+++	+++	+++++	3	trace
Inulin	++	+++	+++	++++	48	0.15
Lactose	+++	+++	-	+++	1	trace
Levulose	++	+++	+++	+++++	22	0.05
Maltose	++	+++	+++	++++	71	0.13
Mannose	+	+++	++++	++++	37	0.08
Raffinose	++	++	+++	+++++	33	0.09
Sucrose	++	+++	+++	+++++	74	0.16

TABLE 197. Effect of carbohydrates on the antagonistic action of *Aspergillus parasiticus* to *Corticium Rolfsii*

Carbohydrates added	Antagonistic action of <i>Asp. parasiticus</i>	Growth of mycelium of <i>Asp. parasiticus</i>	Growth of mycelium of <i>C. Rolfsii</i>		Formation of sclerotia of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Asp. parasiticus</i>	Counter part of the colony	Number	Weight (gm.)
Corn starch	++	++	+++	+++++	19	0.05
Galactose	++++	++++	—	++	7	0.01
Glucose	+	++	++++	++++	47	0.16
Glycerin	++	+++	++	+++	15	0.01
Glycogen	++	++	+++	+++++	14	0.05
Inulin	+++	+++	+	+++++	24	0.06
Lactose	+++	++++	+	+++	0	0
Levulose	+	++	++++	+++++	51	0.18
Maltose	++	++	+++	+++++	21	0.05
Mannose	+	++	++++	+++++	31	0.11
Raffinose	+++	+++	+	+++	38	0.07
Sucrose	++	+++	+++	+++++	84	0.15

TABLE 198. Effect of carbohydrates on the antagonistic action of *Aspergillus Tamaris* to *Corticium Rolfsii*

Carbohydrates added	Antagonistic action of <i>Asp. Tamaris</i>	Growth of mycelium of <i>Asp. Tamaris</i>	Growth of mycelium of <i>C. Rolfsii</i>		Formation of sclerotia of <i>C. Rolfsii</i>	
			Part of the colony facing the colony of <i>Asp. Tamaris</i>	Counter Part of the colony	Number	Weight (gm.)
Corn starch	+++	+++	++	+++	16	0.05
Galactose	+++	++	+++	++++	66	0.17
Glucose	++	++	+++	++++	13	0.02
Glycerin	+++	+++	+++	+++++	19	0.08
Glycogen	++	++	++++	+++++	40	0.11
Inulin	+++	+++	++	+++++	16	0.06
Lactose	+++	++++	++	++++	31	0.05
Levulose	++	+++	++++	+++++	38	0.13
Maltose	++	++	++++	+++++	16	0.06
Mannose	++	+++	+++	+++++	9	0.06
Raffinose	+++	++	++	+++++	3	trace
Sucrose	++	++	+++	+++++	66	0.25

C/N ratio of the nutriment added in the culture media is also one of the important factors affecting the antagonistic action of the antagonists. The writer has made some experiments on this line using *Corticium Sasakii* as the pathogene and *Aspergillus niger*, *Aspergillus parasiticus* and *Aspergillus Tamaris* as the antagonists. In these experiments, the fundamental culture

medium consisted of potassium biphosphate 5 gm., magnesium sulphate 0.2 gm., distilled water 1000 cc., and agar 20 gm., with sucrose as the carbohydrate source and peptone as the nitrogen source added to the medium in different ratios. The results obtained are summarized as follows:

TABLE 199. Effect of C/N ratio in culture media on the antagonistic action of fungous antagonists to *Corticium Sasakii*

Fungous antagonists	C:N	Antagonistic action of the antagonist	Growth of the antagonist	Growth of mycelium of <i>C. Sasakii</i>		Formation of sclerotia of <i>C. Sasakii</i>
				Part of the colony facing the colony of antagonist	Counter part of the colony	
<i>Asp. niger</i>	Control (Carbohydrate and nitrogen absent)	(+)	(+)	++++	+++++	-
	1:5	++	+++	-	+++++	-
	1:4	++	++	-	+++++	-
	1:3	+++	+++	-	+++++	-
	1:2	++	++	-	+++++	-
	1:1	++	++	-	+++++	-
	2:1	++	++	-	+++++	-
	3:1	+++	+++	-	+++++	-
	4:1	++	++	-	+++++	-
	5:1	++	++	-	+++++	-
<i>Asp. parasiticus</i>	Control	(+)	(+)	++++	+++++	+
	1:5	+	+	-	+++++	-
	1:4	+	+	-	+++++	-
	1:3	+	+	-	+++++	-
	1:2	+	+	-	+++++	-
	1:1	+	+	-	+++++	-
	2:1	+	+	-	+++++	+
	3:1	++	++	-	+++++	+
	4:1	+++	+++	-	+++++	+
	5:1	++	++	-	+++++	+
<i>Asp. Tamarii</i>	Control	(+)	(+)	++++	+++++	+
	1:5	+	+	-	+++++	-
	1:4	+	+	-	+++++	-
	1:3	+	+	-	+++++	-
	1:2	++	++	-	+++++	-
	1:1	++	++	-	++++	-
	2:1	++	++	-	+++++	+
	3:1	+++	+++	-	+++++	+
	4:1	+++	+++	-	+++++	+
	5:1	+++	+++	-	+++++	+

As shown in the table, C/N ratio in the culture media has also an influence on the antagonism. The ratio, at which the action is the greatest, varies according to the species of the antagonists.

(B) Influence of water content of soil

The influence of water content of soil on the antagonistic action of soil

microorganisms was investigated using *Corticium Sasakii*. In the experiments glass pots, 10 cm. in diam. and 10.5 cm. in height, containing 400 cc. of sandy loam were used. Sandy loam (46.75% water holding capacity in weight) were prepared to have different water contents such as 10%, 20%, 30% and 40% (by weight). The fungus was inoculated in the soil and after one or two days clean rice seeds (Mii-sinriki variety) were sown. The experiments were repeated three times in the same way with the results shown in Table 200.

TABLE 200. Influence of water content of the soil on the antagonistic action of some fungous antagonists upon *Corticium Sasakii*

Water content (%)		<i>C. Sasakii</i>	<i>C. Sasakii</i> + <i>Asp. niger</i>	<i>C. Sasakii</i> + <i>Asp. Tamarii</i>
10	Number of seeds sown	150	150	150
	Number of seeds germinated	20	21	14
	Diseased seedlings			
	Number	10	9	7
	Ratio (%)	100	90	70
20	Number of seeds sown	150	150	150
	Number of seeds germinated	135	133	132
	Diseased seedlings			
	Number	60	50	40
	Ratio (%)	100	83	67
30	Number of seeds sown	150	150	150
	Number of seeds germinated	148	144	142
	Diseased seedlings			
	Number	46	29	33
	Ratio (%)	100	63	77
40	Number of seeds sown	150	150	150
	Number of seeds germinated	99	144	81
	Diseased seedlings			
	Number	23	12	11
	Ratio (%)	100	48	48

As indicated in Table 200, the water content of the soil has an influence on the antagonism. The antagonistic action of *Aspergillus niger* and *Aspergillus Tamarii* to *Corticium Sasakii* is the greatest at 40% water content at least as far as this experiment is concerned.

(C) Effect of a combination of antagonists in the soil

It is naturally considered that both phenomena, symbiosis and antagonism, may be observed in a mixed inoculation of some antagonists. The mixed inoculation of two antagonists, *Aspergillus niger* and *Aspergillus Tamarii*, together with *Corticium Sasakii* was investigated. The experiments were made

at the constant soil temperatures of 20°C., 24°C. and 28°C.

TABLE 201. Effect of a combination of antagonists on their antagonistic action in the soil.

Soil temperature	Fungi inoculated	Number of seeds sown	Number of seeds germinated	Number of diseased seedlings	Number of healthy seedlings	Weight of healthy seedlings (gm.)
20°	<i>C. Sasakii</i>	50	45	18	27	2.5
	<i>C. Sasakii</i> + <i>Asp. niger</i>	50	50	13	37	3.0
	<i>C. Sasakii</i> + <i>Asp. Tamaritii</i>	50	50	8	42	3.5
	<i>C. Sasakii</i> + <i>Asp. niger</i> + <i>Asp. Tamaritii</i>	50	49	11	38	3.0
24°	<i>C. Sasakii</i>	50	44	19	25	2.5
	<i>C. Sasakii</i> + <i>Asp. niger</i>	50	47	14	33	3.5
	<i>C. Sasakii</i> + <i>Asp. Tamaritii</i>	50	49	14	35	3.5
	<i>C. Sasakii</i> + <i>Asp. niger</i> + <i>Asp. Tamaritii</i>	50	46	9	37	4.0
28°	<i>C. Sasakii</i>	50	50	24	26	2.0
	<i>C. Sasakii</i> + <i>Asp. niger</i>	50	50	19	31	3.5
	<i>C. Sasakii</i> + <i>Asp. Tamaritii</i>	50	50	15	35	4.0
	<i>C. Sasakii</i> + <i>Asp. niger</i> + <i>Asp. Tamaritii</i>	50	47	18	29	2.5
Total	<i>C. Sasakii</i>	150	139	61	78	7.0
	<i>C. Sasakii</i> + <i>Asp. niger</i>	150	147	46	101	10.0
	<i>C. Sasakii</i> + <i>Asp. Tamaritii</i>	150	149	37	112	11.0
	<i>C. Sasakii</i> + <i>Asp. niger</i> + <i>Asp. Tamaritii</i>	150	142	38	104	9.5

These results show that *Aspergillus Tamaritii* was reduced in its antagonistic action when mixed with *Aspergillus niger*.

6. Influence upon rice seedlings of the microorganisms antagonistic to the causal fungi of Sclerotium diseases

In an earlier section of this chapter, it was shown that *Bacillus cereus*, *Bacillus dendroides*, *Bacillus fluorescens liquefaciens*, *Bacillus mycoides*, *Bacillus prodigiosus*, *Bacillus subtilis*, *Aspergillus niger*, *Aspergillus Tamaritii*, *Trichoderma lignorum*, etc., are antagonistic to *Corticium Sasakii*, *Sclerotium Oryzae-sativae* and *Corticium Rolfsii*, and also that they inhibit the mycelial growth of these

TABLE 202. Effect of some antagonistic microorganisms on rice seedlings.

Microorganisms	Number of seeds sown	Number of seeds germinated	Weight of seedlings (gm.)	Height of seedlings (cm.)		Length of roots (cm.)		Number of roots per seedling		
				Range	Average	Range	Average	Range	Average	
<i>Bac. cereus</i>	200	193	20.3	3.1-25.0	13.76	3.5-20.7	14.04	3-8	6	
	200	190	20.3	1.6-28.0	15.23	3.0-18.5	12.37	1-7	5	
<i>Bac. fluorescens</i>	200	183	19.0	1.5-21.7	13.17	3.0-21.5	10.15	1-13	7	
	200	179	20.0	4.0-21.5	15.84	4.5-30.0	12.39	4-12	7	
<i>Bac. mycoides</i>	200	199	12.3	5.2-17.0	11.16	3.7-18.2	10.03	1-9	5	
	200	199	11.9	1.0-18.5	11.49	2.5-20.0	10.52	2-8	5	
* <i>Bac. prodigiosus</i>	120	117	14.9	6.0-26.3	17.37	8.0-25.0	14.57	4-11	6	
	120	120	15.0	8.5-24.5	18.74	6.3-21.2	12.88	4-8	6	
Control	200	191	17.5	0.5-14.0	7.75	0.5-26.7	10.47	1-7	5	
	Inoculated									
<i>Asp. niger</i>	200	193	20.8	1.5-17.5	7.62	1.0-22.0	11.41	1-8	5	
	200	192	19.0	1.0-14.5	8.24	1.5-18.0	9.87	1-7	5	
	160	151	16.0	0.8-17.0	8.75	1.0-14.5	10.09	1-7	5	
	160	156	16.0	2.0-15.2	7.95	2.5-18.0	9.38	1-8	5	
	200	190	19.6	0-14.0	7.54	0.4-17.0	8.57	1-7	6	
	200	193	19.7	1.5-14.0	8.14	3.0-16.0	10.02	1-9	5	
	120	120	12.5	4.0-11.0	7.53	2.0-18.5	9.15	2-9	5	
	200	196	19.0	0.4-12.7	7.58	1.0-23.5	9.02	1-9	5	
	200	191	19.5	0-14.0	7.97	0.5-19.0	8.28	1-7	5	
	200	185	18.0	1.0-14.0	8.51	0.5-26.5	10.21	1-8	5	
	160	153	14.4	2.5-15.0	7.52	2.3-17.5	9.14	1-8	5	
	160	146	14.4	2.0-13.5	7.76	1.2-15.0	7.82	1-9	5	
	** <i>Trichoderma lignorum</i>	160	157	17.3	1.5-22.2	14.19	0.1-20.2	10.09	1-8	6
		160	152	17.1	1.0-21.0	11.78	0.3-13.7	7.41	1-9	6

Remarks: * and ** respectively indicate the results of the experiments repeated three times and four times.

pathogenes and the severity of the diseases. The writer, therefore, investigated the effect of these antagonists on the growth of rice seedlings. The antagonist was inoculated in the sand (100 cc.) put in a 250 cc. ERLENMYER'S flask, and the flask was moistened with 50 cc. of water. After one or two days clean rice seeds (Miisinriki variety) were sown in the sand. The experiments were mostly repeated five times for each organism. The results obtained are summarized in Table 202.

These results show that the microorganisms tested have no harmful effect on rice seedlings. This fact seems to suggest the possibility of the practical application of the antagonism of the microorganisms for the disease control.

VII Summary

1. Physiological studies on the causal fungi of the Sclerotium diseases of rice plant were carried out with special reference to some factors affecting the disease occurrence. The present report deals with the results obtained from 1926 to 1936.

2. The pathogenicity of the causal fungi on seedlings and fully grown plants was discussed, especially on their effect upon the roots of rice seedlings. *Corticium Sasakii* (SHIRAI) MATSUMOTO, *Sclerotium Oryzae-sativae* SAWADA and *Leptosphaeria Salvini* CAVARA are strong in the pathogenicity but *Sclerotium hydrophilum* SACC. seems to be very weak.

3. In the vicinity of Kyoto, both the sclerotia and the mycelia of *Corticium Sasakii*, *Sclerotium Oryzae-sativae*, *Sclerotium hydrophilum*, *Leptosphaeria Salvini* and *Corticium Rolfsii* are capable of overwintering in the soil.

4. *Leptosphaeria Salvini*, *Helminthosporium sigmoideum* var. *irregulare*, *Sclerotium Oryzae-sativae*, *Sclerotium hydrophilum* and *Sclerotium fumigatum* have the ability to overwinter in the stubble or in the straw by means of sclerotia.

5. The growth of mycelia of the causal fungi is remarkably influenced by the hydrogen-ion concentration of the culture media. *Corticium Sasakii* is able to grow between pH 2.57 and pH 7.76 and most vigorously in the medium ranging from pH 5.44 to pH 6.67. *Sclerotium Oryzae-sativae* grows at the concentrations ranging from pH 2.67 to pH 8.26 and best in the medium ranging from pH 4.17 to pH 4.41. *Sclerotium hydrophilum* grows slightly at pH 2.67 and pH 8.52 and vigorously at the concentrations from pH 5.99 to pH 6.13. *Leptosphaeria Salvini* grows between pH 3.20 and pH 9.01, and its

vigorous growth was obtained at the concentrations between pH 5.07 and pH 5.94. The growth of mycelia of *Sclerotium fumigatum* occurs slightly at pH 2.70 and also at pH 8.73, showing vigorous growth on the medium from pH 5.51 to pH 5.75. *Corticium Rolfsii* is able to grow between pH 2.21 and pH 7.92, and its most vigorous growth was observed at the concentrations between pH 3.29 and pH 5.63. The growth of mycelia of *Sclerotium japonicum* also occurs between pH 2.70 and pH 9.01, showing the most vigorous growth on the medium ranging from pH 5.00 to pH 6.17.

6. The growth of mycelia of the causal fungi is influenced by temperature. Little or no growth of *Corticium Sasakii*, *Sclerotium Oryzae-sativae* and *Corticium Rolfsii* occurs at about 10°C., while the most vigorous is obtained at 28° to 32°C., especially at 32°C. for *Corticium Sasakii* and *Corticium Rolfsii* and at 28°C. for *Sclerotium Oryzae-sativae*.

7. The sunlight retards the growth of mycelia of *Corticium Sasakii*, *Sclerotium Oryzae-sativae*, *Sclerotium hydrophilum*, *Leptosphaeria Salvinii*, *Sclerotium japonicum* and *Corticium Rolfsii*.

8. The growth of mycelia of the causal fungi is greatly affected by the water content of the soil. In sand *Corticium Sasakii* begins to grow at 5% water content and continues to grow up to 50%, showing vigorous growth at 10 to 40%. In sandy loam the same fungus also develops at 5% water contents, and grows vigorously at 20 to 50%, showing the most vigorous growth at 50%. The growth of mycelia of *Sclerotium Oryzae-sativae* in sand occurs at 20% water content and continues to grow up to 50%, showing the vigorous growth at 40 to 50%, while in sandy loam the fungus shows the vigorous growth at 30 to 50%, especially most vigorous at 50%.

9. The formation of sclerotia of the causal fungi is remarkably affected by some environmental factors. The sclerotia of *Corticium Sasakii* are formed more abundantly in the light than in the dark. The formation of sclerotia of *Corticium Sasakii*, *Sclerotium Oryzae-sativae* and *Sclerotium hydrophilum* seems to be accelerated by a temporary fall of temperature. The formation of sclerotia of *Corticium Rolfsii* seems to be accelerated by a temporary rise of temperature, and also by temporary dipping of its mycelia in water. The presence of other microorganisms is also a factor affecting the formation of sclerotia.

10. The viability of the causal fungi is greatly influenced by temperature. The thermal death points of the sclerotia under dry condition are indicated below: 90°C. for 50 minutes or 95°C. for 40 minutes in *Corticium Sasakii*; 90°C. for 30 minutes or 95°C. for 20 minutes in *Sclerotium Oryzae-*

sativae; 95°C. for 80 minutes in *Sclerotium hydrophilum*; 90°C. for 40 minutes or 95°C. for 30 minutes in *Corticium Rolfsii*. The thermal death points of the sclerotia in water are as follows: 50°C. for 40 minutes or above 55°C. for 5 minutes in *Corticium Sasakii*; above 50°C. for 5 minutes in *Sclerotium Oryzae-sativae*; 55°C. for 5 minutes in *Sclerotium hydrophilum*; 50°C. for 30 minutes or 55°C. for 5 minutes in *Corticium Rolfsii*. The thermal death points of the mycelia are lower than those of the sclerotia. The thermal death points of the mycelia under dry condition are as follows: 65°C. for 70 minutes in *Corticium Sasakii*; 70°C. for 40 minutes or 75°C. for 5 minutes in *Sclerotium Oryzae-sativae*; 55°C. for 40 minutes, 60°C., 70°C and 75°C. for 20 minutes or 80°C. for 5 minutes in *Corticium Rolfsii*. Their thermal death points in water are as follows: 50°C. for 5 minutes in *Corticium Sasakii*, 50°C. for 5 minutes in *Sclerotium Oryzae-sativae*, 45°C. for 80 minutes, 50°C. for 10 minutes or 55°C. for 5 minutes in *Corticium Rolfsii*.

11. The viability of the causal fungi is affected by drying. The sclerotia of *Corticium Sasakii*, *Sclerotium Oryzae-sativae* and *Sclerotium hydrophilum* as well as the mycelia of *Corticium Sasakii* and *Corticium Rolfsii* keep their viability in a desiccator for twenty-one months under laboratory conditions.

The sclerotia of *Corticium Sasakii* kept in dry soil seem to lose their viability after twenty-one months, and the mycelia of the same fungus often after seven months. The sclerotia of *Corticium Rolfsii* kept in dry soil seem to lose their viability after twenty-one months under laboratory conditions. The sclerotia of *Sclerotium Oryzae-sativae* and *Sclerotium hydrophilum* kept in dry soil for nine months still remained alive.

12. The viability of the causal fungi is affected by several chemicals. Among various acids, arsenic, butyric, carbolic, chromic, hydrochloric, nitric, oxalic, picric, pyrogallic and salicylic acids are extremely harmful to the viability of the sclerotia. Among alkalis, potassium hydroxide, sodium carbonate and sodium nitrate are very destructive to the viability of the sclerotia.

13. The infection of the rice plant by *Corticium Sasakii* is affected by moisture and temperature. The minimum period of continuous wetting necessary for the infection is about 18 hours at 32°C. and 24 hours at 28°C. So far as the present experiments indicate, infection seems hardly possible at 36° or 24°C. and the optimum temperature for the infection is ranging from 28°C. to 32°C. The writer was led to the conclusion that the effect of temperature on the infection is proportional to its direct effect on the fungus.

14. The Sclerotium disease caused by *Corticium Sasakii* occurs at a soil

temperature of 16°C., and the percentage of infected seedlings increases with a rise of soil temperature up to 32°C., when the greatest infection occurred, but it decreases with a rise of soil temperature above 32°C. At 40°C. no infection was secured. The rice seedlings made a most vigorous growth at 28°C., 32°C. and 36°C., especially at 32°C. where as the growth of mycelia and the development of hyphae from the sclerotia were most vigorous at 32°C. Therefore, the writer considers the effect of soil temperature to the disease occurrence to be the results of its influence to the fungus.

15. The disease caused by *Sclerotium Oryzae-sativae* occurs at soil temperatures from 16°C. to 36°C. and is most vigorous at 28°C. The optimum temperature for the disease occurrence by *Sclerotium Oryzae-sativae* is somewhat lower than that by *Corticium Sasakii*. This fact may explain why the former is found farther north than *Corticium Sasakii*.

16. The occurrence and severity of the Sclerotium diseases is affected by soil moisture, but this effect differs according to the kind of pathogenes. The disease caused by *Corticium Sasakii* occurred at soil moistures ranging from 22.5% to 42.9%, and the greatest percentage of infection was obtained at 38.9-42.9%. On the other hand the disease caused by *Sclerotium Oryzae-sativae* occurred at soil moisture ranging from 23.5% to 52.2%, and the greatest percentage of infection was found at 45.2-52.2%.

17. Generally speaking, the disease caused by *Corticium Sasakii* occurs at soil reaction ranging from pH 2.61 to pH 7.85, showing the greatest development within the limit from pH 4.81 to pH 6.60, where the fungus makes the most vigorous growth. The writer considers that the soil reaction seems to affect directly the growth of the fungus.

18. The sunlight greatly affects the infection of rice plant by *Corticium Sasakii*. It tends to inhibit the infection. The reduction of infection by the sunlight seems to be due to its direct effect upon the fungus.

19. The development of the diseased spots caused by *Corticium Sasakii* after the penetration of the fungus is more vigorous in the light than in the dark.

20. The infection by *Corticium Sasakii* is greatly affected by the amount of sodium chloride in the soil. The severity of the disease decreases rapidly with the increase of sodium chloride in the soil and the disease is not found when its content becomes more than 1%.

21. The causal fungi of the Sclerotium diseases do not grow well in the presence of various other microorganisms on Saito's soy agar or the bouillon agar.

22. Similar antagonistic action of certain microorganisms was experimentally proved on living leaf-sheaths of rice plants and leaf-blades of Indian corns.

23. The antagonism of microorganisms in the soil to the causal fungi was experimentally proved. These fungi were killed in three weeks at 24°C., 28°C. and 32°C. by the presence of other microorganisms. Their pathogenicity was also proved to be lowered by the antagonistic action of these antagonists.

24. The filtrates of the solutions, upon which *Aspergillus niger*, *Asp. parasiticus* or *Asp. Tamaritii* were previously cultured, are antagonistic and affect the occurrence and severity of Sclerotium diseases.

25. The morphological change of mycelia of the causal fungi in the presence of antagonistic microorganisms is very distinct and somewhat specific to the kinds of antagonists. Such hyphal deformations are similar to those observed in the presence of various chemicals.

26. The nutriment affects the antagonism. Among various nitrogen compounds tyrosin, alanine, peptone and ammonium citrate strengthen the antagonistic action of *Aspergillus niger* and others on *Corticium Sasakii* to the highest degree. Among carbohydrates lactose, glycerin and corn starch favor the antagonism to the highest degree. The C/N ratio, at which the action is the greatest, varies according to the species of the antagonists. The soil moisture has also great influence upon the action. The soil moisture, at which the antagonism is the greatest, vary with the kind of pathogenes and antagonists. The action of the antagonists is greatly affect by mixing them. The antagonism of *Aspergillus Tamaritii* is lowered by mixing with *Aspergillus niger*.

27. *Bacillus cereus*, *Bacillus fluorescens liquefaciens*, *Bacillus mycoides*, *Bacillus prodigiosus*, *Aspergillus niger* and *Trichoderma lignorum* have no harmful effect on rice seedlings. The practical application of the principle of antagonism to the problem of the disease control seems to be quite possible by applying these microorganisms in the soil.

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VIII. Explanation of plates

Plate I.

1. Symptoms of a disease caused by *Corticium Sasakii* (SHIRAI) MATSUMOTO.
2. Symptoms of a disease caused by *Sclerotium Oryzae-sativae* SAWADA.
- 3-4. Symptoms of a disease caused by *Sclerotium fumigatum* NAKATA.

Plate II. Symptoms of a disease caused by *Leptosphaeria Salvini* CAVARA.

- 1-2. Diseased stems.
3. Diseased stem showing sclerotia in the tissue.
4. Diseased spots produced by artificial inoculation with the fungus.

Plate III.

1. Symptoms of a disease caused by *Sclerotium hydrophilum* SACC.
2. Rice plant showing diseased spots produced by artificial inoculation with *Sclerotium japonicum* ENDÔ ET HIDAHA.
3. Paddy rice field with the remained stubbles where various fungi causing Sclerotium diseases can overwinter.
4. A heap of rice straws where diseased straws were often found.

Plate IV. Effect of temperature on the mycelial growth of *Corticium Sasakii* on apricot decoction agar.

1. Philippine strain

Above, left to right
 10°C. 16°C. 20°C. 24-25°C.
 Below, left to right
 36°C. 32°C. 28°C.

2. Japanese strain

Above, left to right
 10°C. 16°C. 20°C. 24-25°C.
 Below, left to right
 36°C. 32°C. 28°C.

Plate V. Effect of temperature on the mycelial growth of *Corticium Sasakii* on SARTO's soy agar.

1. Philippine strain

Above, left to right
 10°C. 16°C. 20°C. 24-25°C.
 Below, left to right
 36°C. 32°C. 28°C.

2. Japanese strain

Above, left to right
 10°C. 16°C. 20°C. 24-25°C.
 Below, left to right
 36°C. 32°C. 28°C.

Plate VI.

1. *Corticium Rolfsii* on bouillon agar at 32°C.
- 2-3. *Corticium Rolfsii* and *Bacillus megatherium* on bouillon agar at 28°C.
4. *Corticium Rolfsii* and *Bacillus cereus* on bouillon agar at 32°C.
5. *Corticium Rolfsii* and *Bacillus mesentericus* on bouillon agar at 32°C.
6. *Corticium Rolfsii* and *Bacterium Caninae* on bouillon agar at 32°C.

Plate VII.

- 1-2. Hyphae of *Corticium Rolfsii* affected by copper sulphate.
3. Hyphae of *Corticium Rolfsii* affected by oxalic acid.
4. Mycelial colony of *Corticium Rolfsii* affected by oxalic acid.

Plate VIII. Hyphae of *Corticium Sasakii* affected by copper sulphate.

Plate IX.

1. Mycelial colony of *Corticium Sasakii* affected by copper sulphate.
2. Mycelial colony of *Corticium Sasakii* affected by oxalic acid.
3. Mycelial colony of *Corticium Sasakii* affected by tannic acid.
4. Mycelial colony of *Corticium Sasakii*.
- 5-6. Hyphae of *Corticium Sasakii*.

Plate X.

1. Hypha of *Corticium Sasakii*.

- 2-4. Hyphae of *Corticium Sasakii* affected by *Bacillus cereus*.
- 5-7. Hyphae of *Corticium Sasakii* affected by *Bacillus corallinus*.
- 8-9. Hyphae of *Corticium Sasakii* affected by *Bacillus dendroides*.
- 10-12. Hyphae of *Corticium Sasakii* affected by *Bacillus fluorescens liquefaciens*.

Plate. XI.

- 1-3. Hyphae of *Corticium Sasakii* affected by *Bacillus mesentericus*.
- 4-7. Hyphae of *Corticium Sasakii* affected by *Bacillus mycoïdes*.
- 8-10. Hyphae of *Corticium Sasakii* affected by *Bacillus prodigiosus*.
- 11-15. Hyphae of *Corticium Sasakii* affected by *Bacillus subtilis*.

Plate XII.

- 1. Hypha of *Corticium Sasakii* affected by *Bacillus ureae*.
- 2-3. Hyphae of *Corticium Sasakii* affected by *Bacterium rossicum*.
- 4-5. Hyphae of *Corticium Rolfsii*.
- 6. Hypha of *Corticium Rolfsii* affected by *Bacillus cereus*.
- 7-10. Hyphae of *Corticium Rolfsii* affected by *Bacillus dendroides*.
- 11-14. Hyphae of *Corticium Rolfsii* affected by *Bacillus fluorescens liquefaciens*.

Plate XIII.

- 1. Hyphae of *Corticium Rolfsii* affected by *Bacillus mesentericus*.
- 2-6. Hyphae of *Corticium Rolfsii* affected by *Bacillus megatherium*.
- 7. Hyphae of *Corticium Rolfsii* affected by *Bacillus mycoïdes*.
- 8-12. Hyphae of *Corticium Rolfsii* affected by *Bacillus prodigiosus*.
- 13-16. Hyphae of *Corticium Rolfsii* affected by *Bacterium rossicum*.

Plate XIV.

- 1. Hypha of *Corticium Rolfsii* affected by *Bacterium tumefaciens*.
- 2-3. Hyphae of *Sclerotium Oryzae-sativae*.
- 4-5. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacillus aroïdeae*.
- 6-7. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacillus cereus*.
- 8-12. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacillus corallinus*.
- 13-15. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacillus dendroides*.
- 16-17. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacillus fluorescens liquefaciens*.

Plate XV.

- 1. Hypha of *Sclerotium Oryzae-sativae* affected by *Bacillus mesentericus*.
- 2-3. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacillus mycoïdes*.
- 4-6. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacillus prodigiosus*.
- 7-10. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacillus subtilis*.
- 11-13. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacterium michiganense*.

Plate XVI.

- 1-2. Hyphae of *Sclerotium Oryzae-sativae* affected by *Bacterium michiganense*.
- 3. Hypha of *Corticium Sasakii*.
- 4-6. Hyphae of *Corticium Sasakii* affected by oxalic acid.
- 7-19. Hyphae of *Corticium Sasakii* affected by copper sulphate.

Plate XVII.

1. Hypha of *Corticium Sasakii* affected by copper carbonate.
- 2-5. Hyphae of *Corticium Sasakii* affected by ferrous sulphate.
- 6-7. Hyphae of *Corticium Sasakii* affected by ammonium acetate.
8. Hypha of *Corticium Sasakii* affected by ammonium citrate.
- 9-10. Hyphae of *Corticium Sasakii* affected by ammonium chloride.
- 11-12. Hyphae of *Corticium Sasakii* affected by ammonium sulphate.
13. Hypha of *Corticium Sasakii* affected by nitrolime.
- 14-16. Hyphae of *Corticium Sasakii* affected by ammonium phosphate.
17. Hypha of *Corticium Sasakii* affected by sulphur flour.
- 19-23. Hyphae of *Corticium Sasakii* affected by tannic acid.

Plate XVIII.

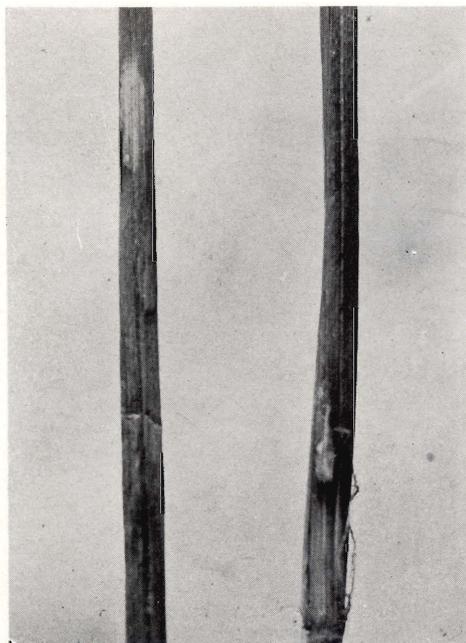
1. Hypha of *Corticium Sasakii* affected by tannic acid.
2. Hyphae of *Corticium Sasakii* affected by nitrolime.
- 3-4. Hyphae of *Corticium Rolfsii*.
- 5-13. Hyphae of *Corticium Rolfsii* affected by copper sulphate.
- 14-18. Hyphae of *Corticium Rolfsii* affected by ferrous sulphate.
- 19-20. Hyphae of *Corticium Rolfsii* affected by ammonium phosphate.

Plate XIX.

- 1-4. Hyphae of *Corticium Rolfsii* affected by oxalic acid.
- 5-8. Hyphae of *Corticium Rolfsii* affected by tannic acid.
- 9-10. Hyphae of *Corticium Rolfsii* affected by ferrous sulphate.
11. Hypha of *Corticium Rolfsii* affected by calcium carbonate.
- 12-13. Hyphae of *Corticium Rolfsii* affected by nitrolime.
- 14-15. Hyphae of *Sclerotium Oryzae-sativae*.
- 16-20. Hyphae of *Sclerotium Oryzae-sativae* affected by copper sulphate.
- 21-22. Hyphae of *Sclerotium Oryzae-sativae* affected by copper carbonate.

Plate XX.

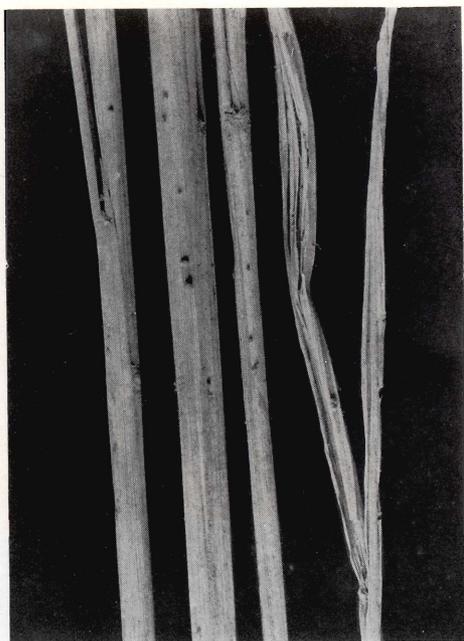
1. Hypha of *Sclerotium Oryzae-sativae* affected by ammonium acetate.
- 2-3. Hyphae of *Sclerotium Oryzae-sativae* affected by ammonium citrate.
- 4-5. Hyphae of *Sclerotium Oryzae-sativae* affected by ammonium phosphate.
- 6-8. Hyphae of *Sclerotium Oryzae-sativae* affected by ammonium sulphate.
- 9-12. Hyphae of *Sclerotium Oryzae-sativae* affected by tannic acid.
- 13-16. Hyphae of *Sclerotium Oryzae-sativae* affected by sulphur flour.
17. Hyphae of *Sclerotium Oryzae-sativae* affected by calcium carbonate.
- 18-19. Hyphae of *Sclerotium Oryzae-sativae* affected by nitrolime.
- 20-21. Hyphae of *Sclerotium Oryzae-sativae* affected by uric acid.



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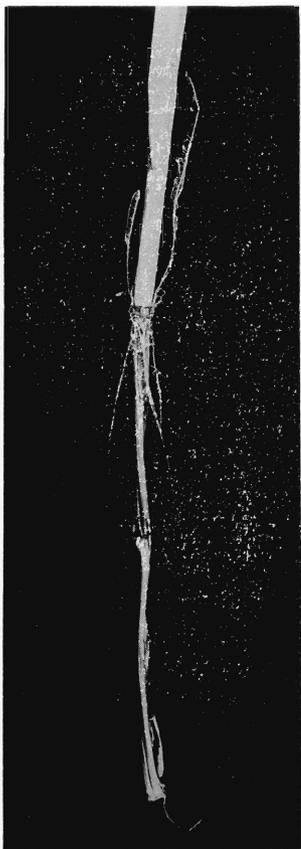
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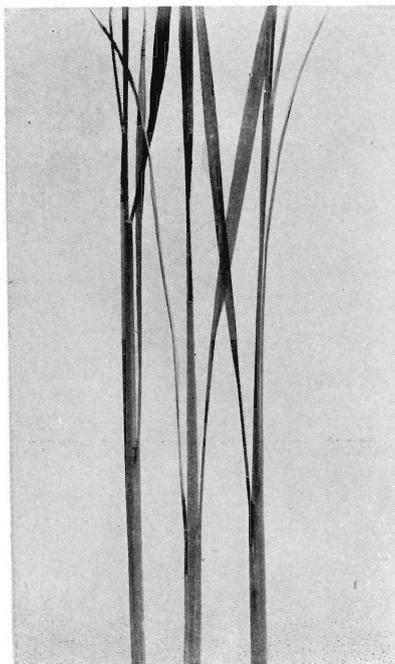
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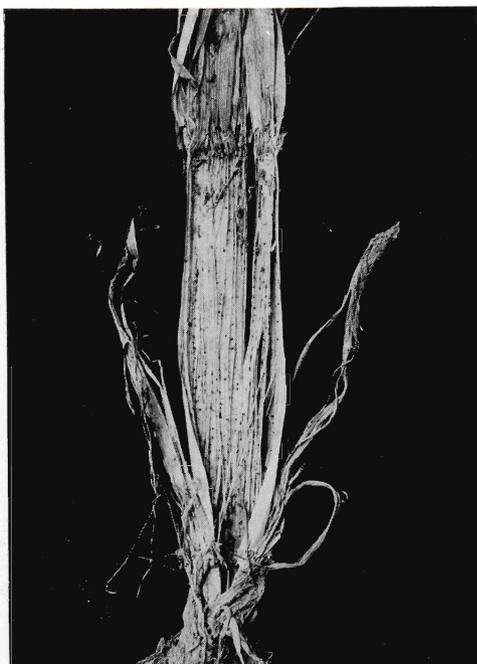
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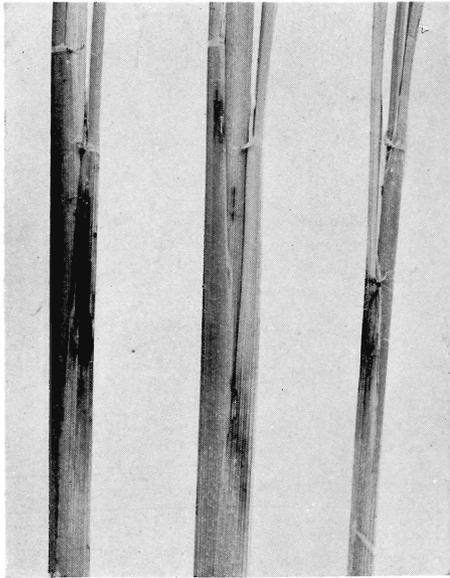
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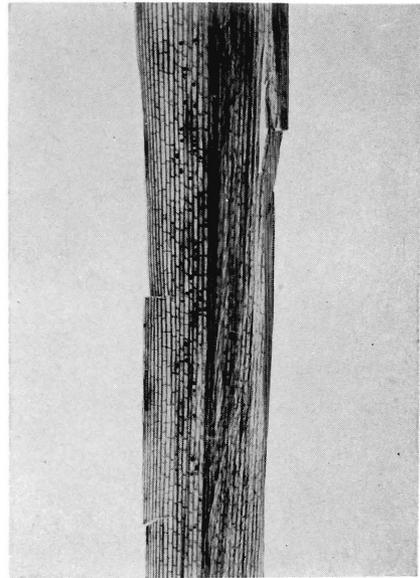
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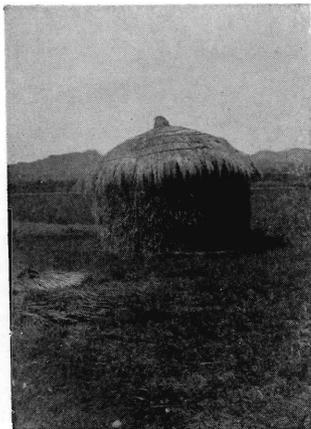
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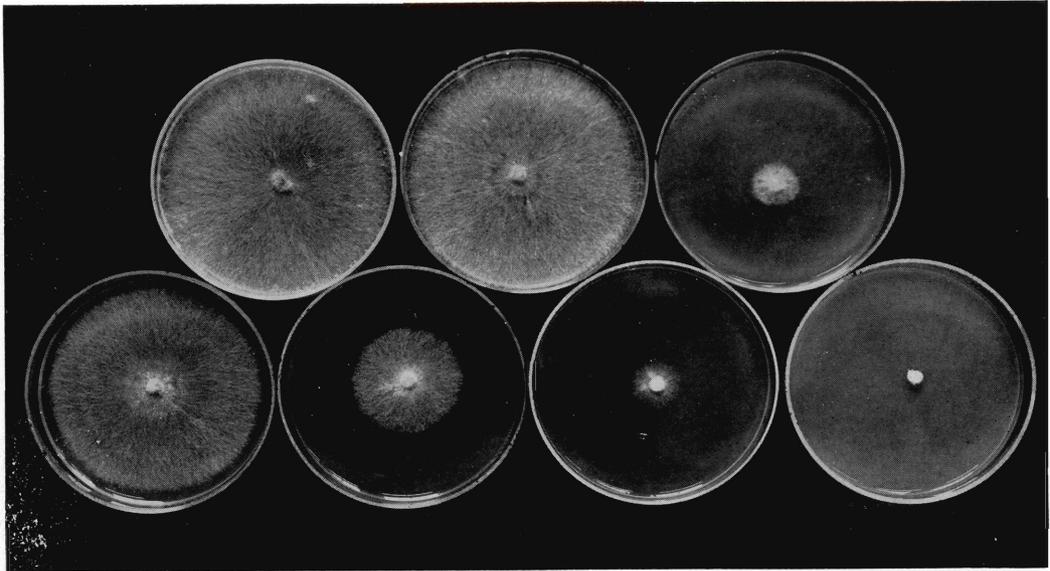
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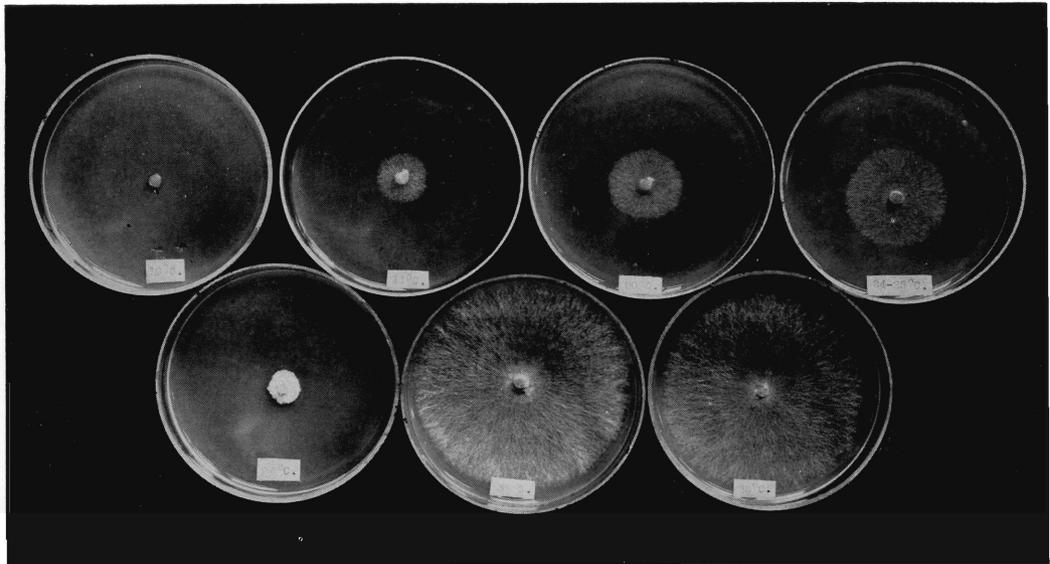
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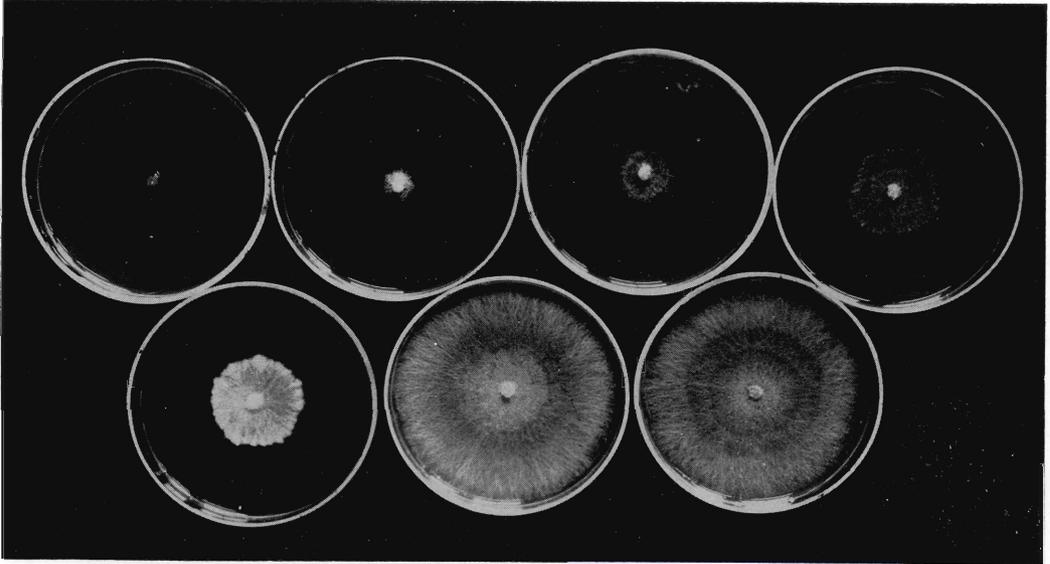
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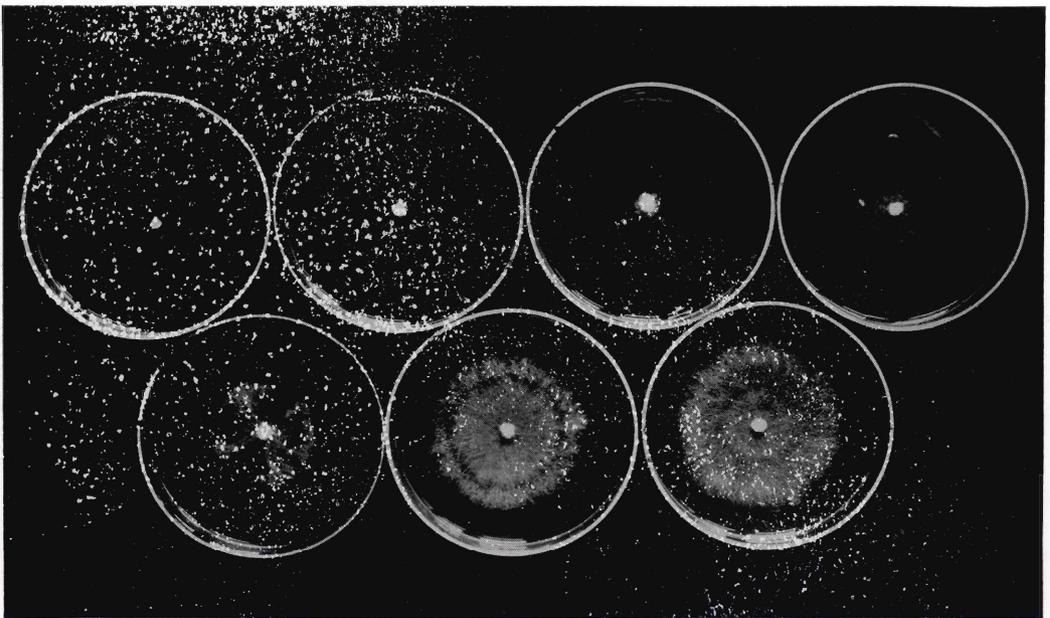
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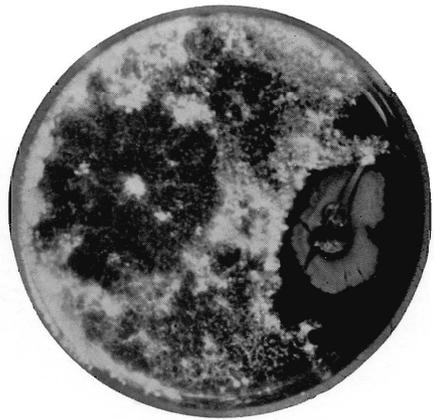
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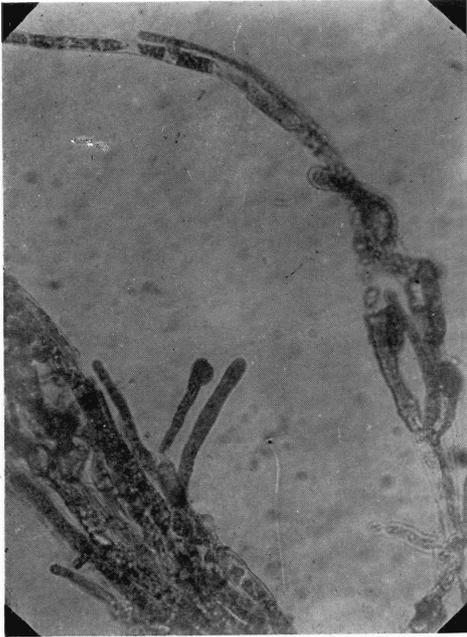
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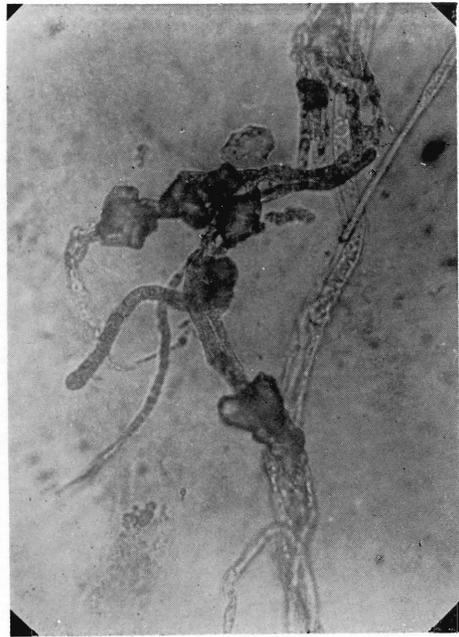
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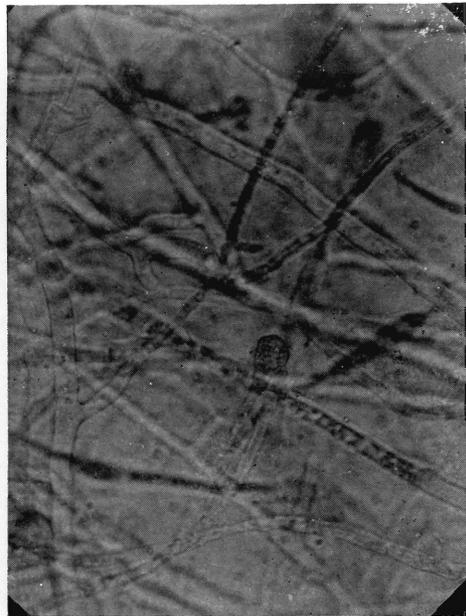
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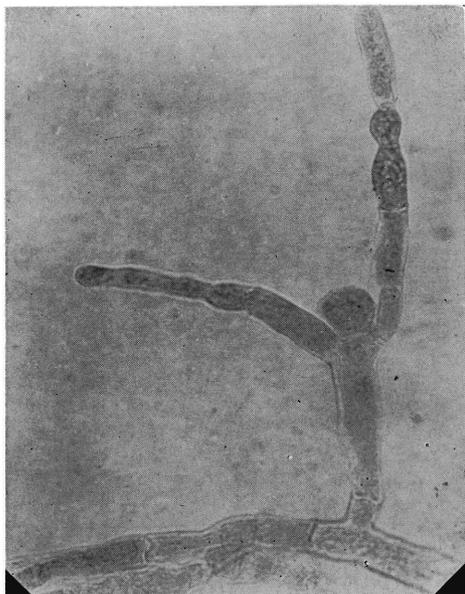
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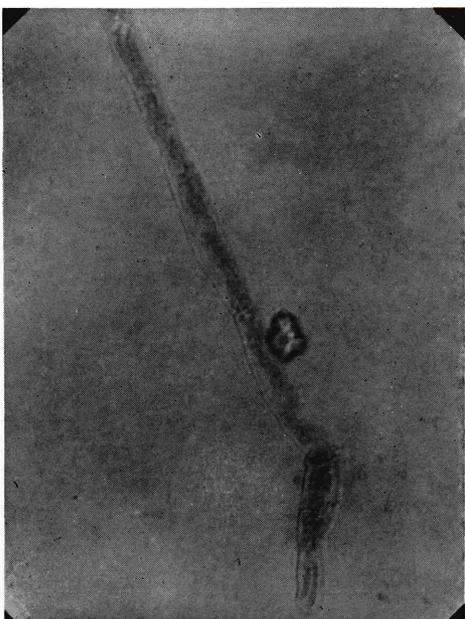
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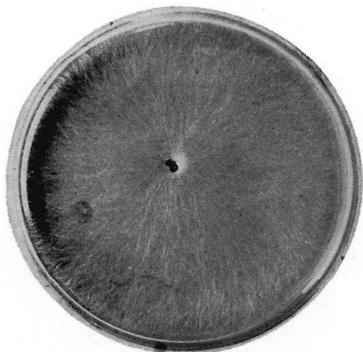
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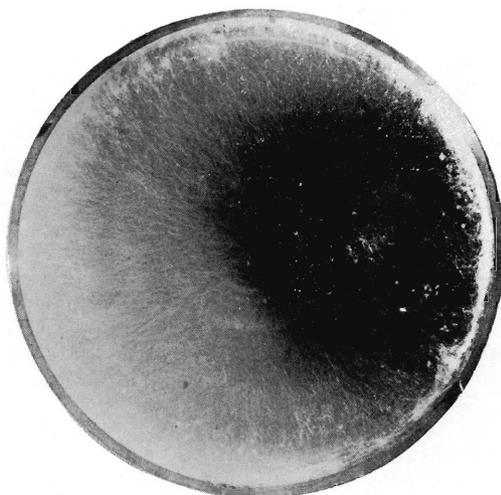
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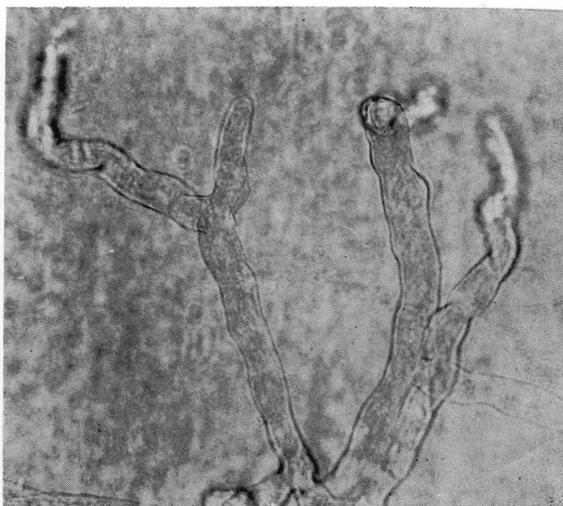
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