A NEW SCLEROTIUM DISEASE OF BAMBOO-SHOOTS OF *PHYLLOSTACHYS RETICULATA* C. KOCH AND *PHYLLOSTACHYS NIGRA* MUNRO *VAR. HENONIS* STAFF., CAUSED BY *SCLEROTIUM JAPONICUM* n. sp.

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The Sclerotium disease of *Phyllostachys reticulata* C. Koch and *Phyllostachys nigra* Munro var. *Henonis* Staff. causes considerable damage to bamboo in cultivation. It was first noticed by the present writers is July 1933 at Simokita in the vicinity of Miyazaki.

The writers have investigated the disease carefully and come to the conclusion that the causal fungus is an undescribed species of *Sclerotium*.

The present paper deals with the morphology, the physiology, and the pathogenicity of the fungus.

Symptoms

The fungus attacks the leaf sheath and the culm of bamboo-shoots of *Phyllostachys reticulata* C. Koch and *Phyllostachys nigra* Munro var. *Henonis* Staff. The diseased leaf sheath of the bamboo-shoot forms a few spots. The diseased spots are at first brown water-soaked regions at the affected area and then become elliptical brown spots (Dusky Drab, Pl.XLV),(5) the central part of the spot changing into pale brown (Pale Ochraceous-Salmon, Pl.XV). The size of the spots of varies but they are commonly 1.0—1.5×0.5—1.0 cm.

The diseased culm of the bamboo-shoot at first shows water-soaked regions which become elongated water-soaked regions in darkish brown (Dusky Drab, Pl.XLV). The disease causes a soft rot of the shoot which eventually dries up.

Causal fungus

Mycelium

The hyphae are septated, branched, 4.65—9.5 (Commonly 6.2μ) in width in the host tissue and 6.6—9.9μ (Commonly 7.7μ) in the culture. The mycelium is at first hyaline, but later turns to pale yellowish brown.

Sclerotia

The Sclerotia are at first white, and then become reddish brown (Apricot Orange, Pl.XLV), round, elliptical or irregular, flat or concave at the under surface 108—936×72—720μ (Commonly 234×126μ). The results of the measurment of sclerotia produced on various culture media are as follows:

TABLE I. Size of sclerotia produced on various culture media

Culture media	Place of sclerotial formation	Length (μ)			Width (μ)		
		Range	Mode	Mean	Range	Mode	Mean
Onion decoction agar	A	180–639	315	328.41±14.283	126–423	234	124.56±10.224
	B	261–936	477	474.03±18.288	216–720	360	380.61±18.288
Apricot decoction agar	A	103–405	207	215.64± 8.964	72–315	153	153.00± 6.804
	B	198–792	450	453.78±16·551	180–531	342	337.63±10.341
Synthetic solution agar with asparagin	A	117–396	234	225.36± 7.380	99–234	153	163.80± 5.121
	B	198–351	261	255.06± 6.273	135–252	180	188.64± 3.861
Potato decoction agar	A	153–342	189	192.24± 6.057	108–216	153	158.94± 4.662

Remarks: A, in the medium; B, inside of the cover of Petri dish.

The Sclerotia consist of polygonal cells; a section of a sclerotium is pale reddish brown in the outer layer (the first layer) and white in the inner layers. The cells in the outer layer are 6.50—18.60μ (Mean 11.222±0.352μ) in length and 6.58—14.88μ (Mean 8.246±0.298μ) in width. The cell walls in the outer side of the first layer are very swollen 2.48—4.96μ (Commonly 3.1μ) in width and pale yellowish brown in color, while the inner side measures 0.91—2.17μ and is hyaline.

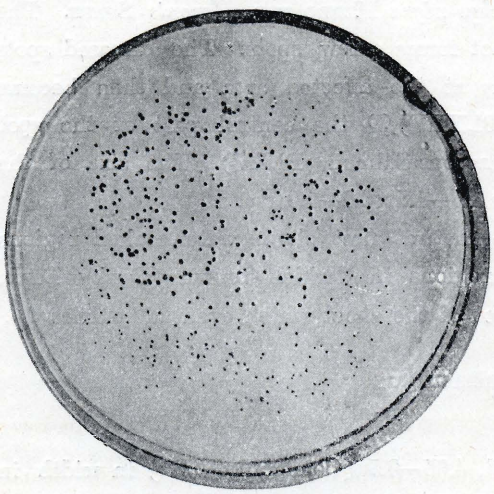

Fig. I. Sclerotia of *Sclerotium japonicum* ENDÔ et HIDAKA

The size of cells in the inner part differs somewhat according to the location, in general the cells in the second or third layer are smaller than those of the central part. The size of cells in the central part is 9.30—24.80μ (Mean 19.034±0.487μ) in length and 6.20—21.7μ (Mean 14.942±0.548μ) in width.

The results of the measurment of the cells forming sclerotia are as follows:

TABLE II. Size of cells forming sclerotia

		Range	Mode	Mean
Length (μ)	The cells in the outer layer (the first layer)	6.51—18.60	10.85	11.222±0.352
	The cells in the central part	9.30—24.80	18.60	19.034±0.487
Width (μ)	The cells in the outer layer	5.58—14.88	7.75	8.246±0.298
	The cells in the central part	6.20—21.70	15.50	14.942±0.548

In the writers' study of the literature of the subject up to date no fungus related to the present one is mentioned as found on bamboo-shoots of *Phyllostachys reticulata* C. KOCH and *P. nigra* MUNRO var. *Henonis* STAFF. or on other gramineous plants. The writers therefore treat it as a new species of *Sclerotium*.

The technical description of the fungus is as follows:

Sclerotium japonicum ENDÔ et HIDAKA n. sp.

Maculis in vagina-culminis ellipticis, pallide bruneis cum bruneis marginibus, 1.0—1.5 cm. long., 0.5—1.0 cm. crass., fructificatione ignotis, hyphis septatis, juvenile hyalinis, senescente pallide flavo-bruneis, 4.65—9.9μ, sclerotiis globosis, ellipticis, rarius irregularis, basis applanatis, planis, parvulis, 108—936μ (mediocris 234μ) long., 72—720μ (mediocris 126μ) crass., rufus-bruneis, cellulis cortice polygoniis, 6.51—18.60μ (mediocris 11.222μ) long., 6.58—14.88μ (mediocris 8.246μ) crass., intus albis, cellulis intus polygoniis, 9.3—24.8μ (mediocris 19.034μ) long., 6.2—21.948μ (mediocris 14.942μ) crass.

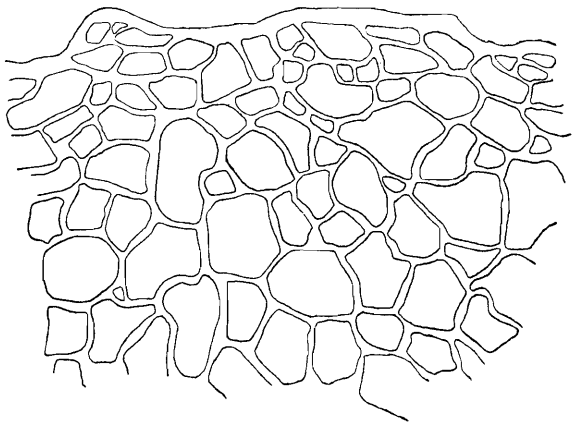

Fig. II. A section of sclerotium of *Sclerotium japonicum*

Hab. Parasiticum in culmis et vagina-culminis vivis *Phyllostacydis reticulatae* et *P. nigrae* var. *Henonidis*, Prov. Hiuga, Japoniae. (S. ENDÔ et Z. HIDAKA)

Cultural characteristics of the fungus on culture media were studied using four different agar media, prepared by the usual formulas. The fungus was cultured at 28°C. for 21 days and the following rusults were obtained.

TABLE III. Cultural characteristics of the fugus on agar media

Culture media	Mycelial growth		Color of colony	Rate of sclerotial formation
	Rate of growth	Thickness of colony		
Onion decoction agar	+++++	Thick	Pale Orange-Yellow	++++
Apricot decoction agar	++++	Thick	Pinkish Buff	+++++
Synthetic solution agar with asparagin	++	Thin	Pale Pinkish Cinnamon	+++
Potato decoction agar	++	Very thin	White	+

As shown in the above table, the mycelial growth was most prominent on onion decoction agar with apricot decoction agar, synthetic solution agar and potato decoction agar following in order. But the sclerotial formation was most vigorous on apricot decoction agar, with onion decoction agar and synthetic solution agar following in order, while the potato decoction agar was very poor. And, in the experiment, the most interesting fact is that sclerotia were produced not only on agar medium and inside of the cover of the dish, but also in the agar medium.

The influence of hydrogen-ion concentration of cultural media on the mycelial growth was tested. Potato decoction was prepared using redistilled water, and standardized with $\frac{N}{10}$-solution of hydrochloric acid and natrium hydroxide. In this experiment 100 cc. Erlenmyer's flasks were used, each containing 50 cc. of medium controlled in different pH values. A piece of mycelial colony (0.5 cm. diam.) of the fungus was inoculated and incubated at 28°C. After 2 days(3 days in the first experiment), the cultures were filtered through filter paper together with the contents of three flasks of the same pH value and the reaction of the filtrates was tested. These mycelial masses were then dried and their weight determined. The results obtained are as follows:

TABLE IV. Influence of hydrogen-ion concentrations on the mycelial growth of the fungus

Experiment	pH of medium prepared	pH of filtrate	Average dry weight of mycelia grown in a flask (gr.)	Experiment	pH of medium prepared	pH of filtrate	Average dry weight of mycelia grown in a flask (gr.)
1st experiment	4.033	3.790	0.1175	2nd experiment	3.860	3.790	0.0775
	4.224	4.033	0.1133		4.276	4.085	0.0700
	4.484	4.563	0.1650		4.433	4.259	0.0775
	4.657	4.709	0.1575		4.883	4.380	0.1055
	5.073	5.263	0.1725		5.020	4.675	0.0775
	5.333	5.117	0.1725		5.177	4.969	0.0825
	5.558	5.437	0.1875		5.263	4.969	0.1050
	5.610	5.783	0.1700		5.420	5.229	0.0875
	5.714	6.321	0.1950		5.506	5.055	0.1125
	6.095	5.939	0.1900		6.075	5.558	0.1125
	6.875	6.113	0.1875		6.338	5.732	0.0800
	7.534	6.373	0.1700		6.355	5.229	0.0700
	7.915	6.459	0.1175		7.205	6.303	0.0400
					7.239	6.893	0.0050

3rd experiment	3.028	3.028	0.0080	4th experiment	2.456	2.456	0.
	3.271	3.271	0.0145		2.699	2.699	0.0100
	3.686	3.531	0.0575		2.201	3.115	0.0425
	4.189	4.675	0.0950		4.414	4.345	0.1100
	4.484	5.090	0.1130		5.004	5.177	0.1500
	5.506	5.420	0.1150		5.939	5.749	0.1400
	5.749	5.749	0.0875		6.823	6.338	0.1300
	6.165	5.939	0.1180		7.153	5.350	0.1025
	6.737	6.165	0.1100		7.147	5.749	0.1000
	7.239	6.165	0.1105		7.759	6.425	0.1000
	7.309	6.390	0.0800		8.244	7.083	0.0975
	7.482	6.823	0.0800		8.640	7.326	0.0875
	7.551	6.563	0.0855		8.730	8.270	0.0157
	7.655	6.581	0.0770		9.010	8.340	0.0075

From the above data, it is clear that the hydrogen-ion concentrations for the mycelial growth of the fungus vary from pH 2.699 to pH 9.01, with the optimum concentration lying between pH 5.004—pH 6.615.

Inoculation experiments

In 1933 and 1934, some inoculation experiments on *Phyllostachys nigra* MUNRO var. *Henonis* STAFF., *P. reticulata* C. KOCK and *Oryza sativa* LINN. were made. In the experiments five methods of inoculation were employed: (a) the introduction of sclerotia into the tissue of the leaf sheath through punctures made with a sterilized needle, (b) the introduction of sclerotia on the leaf sheath, (c) sclerotia inserted between the leaf sheath and the culm, (d) the introduction of sclerotia into the tissue of the culm through punctures. (e) the introduction of sclerotia on the culm. The results obtained are as follows:

TABLE V. Results of inoculation experiments on bamboo-shoots of *Phyllostachys nigra* var. *Henonis*

Method of inoculation	Results
(a)	Elliptical pale brown spots (Cream Buff, Pl. XXX) with darkish brown (Dusky Drab, Pl. XLV) margin were formed on the inoculated parts. They are 0.9×0.8 cm. in size.
(b)	Darkish brown (Dusky Drab, Pl. XLV) regions were formed on the inoculated parts. They are about 1.8×1.2 cm. in size.
(c)	Darkish brown (Dusky Drab, Pl. XLV) regions appear on the inoculated parts. They are about 1.5×0.8 cm. in size.
(d)	Brown water-soaked regions (Dusky Drab, Pl. XLV) appers on the inoculated parts. They are about 1.5×0.5 cm. in size.
(e)	Inoculated parts show no change.

Remarks: The results were observed three days after inoculation at 27°—30°C.

TABLE VI. Results of inoculation experiments on bamboo-shoots of *Phyllostachys reticulata*

Experiment	Method of inoculation	Results
1st experiment	(b)	Elliptical spots appear on the inoculated parts. They are pale brown (Cream Buff, Pl. XXX) with brown (Natal Brown, Pl. XL) margin, 3.2-3.4×0.9-1.4 cm. in size.
	(e)	Irregular water-soaked regions appear on the inoculated parts. They are about 6.6×2.9 cm. in size.
2nd experiment	(a)	Elliptical water-soaked apots with brown (Natal Brown, Pl. XL) margin. They are about 1.8×0.5 cm. in size.
	(b)	Elliptical pale brown spots with brown (Natal Brown. Pl. XL) margin appear on the inoculated parts. They are about 1.7-1.0 cm. in size.
	(c)	Elliptical pale brown spots with brown (Natal Brown, Pl. XL) margin formed on the inoculated parts. They are about 1.8×1.0 cm. in size.
	(d)	Elliptical water-soaked regions (Olive Brown, Pl. XL) appear later causing soft rot.

Remarks: The results of the first experiment were observed four days after inoculation at 30°—32°C. and those of the second were observed two days after inoculation at 29°—33°C.

TABLE VII. Results of inoculation experiments on *Oryza sativa*

Method of inoculation	Results
(a)	Elongated water-soaked regions (Buffy Brown, Pl. XL) appear on the inoculated parts. They are 0.7-1.3×0.3-0.4 cm. in size.
(b)	Elongated water-soaked regions appear on the inoculated parts. They are 0.5-1.5×0.2-0.5 cm. in size.

Remarks: The results were observed four days after inoculation at 27°—30°C

From the above experiments, it is certain that the fungus attacks not only *Phyllostachys reticulata* and *Phyllostachys nigra* var. *Henonis*, but also *Oryza sativa*.

Summary

The present paper deals with a new Sclerotium disease of bamboo-shoots of *Phyllostachys reticulata* C. KOCH and *Phyllostachys nigra* MUNRO var. *Henonis* STAFF., which is caused by *Sclerotium japonicum* n. sp.

The fungus causes the rot of bamboo-shoots and forms brown spots with darkish brown margin on the leaf sheath.

When artificialy inoculated, the fungus attacks not only *Phyllostachys reticulata* C. KOCH and *P. nigra* MUNRO var. *Henonis* STAFF., but also *Oryza sativa* LINN.

The hydrogen-ion concentrations for the mycelial growth of the fungus vary from pH. 2.699 to pH 9.01, with the optimum concentration lying between pH 5.004 and pH 6.165.

Literature

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5 RIDGWAY, R. : Color standards and nomenclature, 1912.

Explanation of Plates

Plate I.

Fig. 1—2. A section of sclerotium of the fungus.
Fig. 3. A section of sclerotium of the fungus, showing the outer layer of sclerotium.
Fig. 4. A section of sclerotium of the fungus, showing the inner portion of sclerotium.

Plate II.

Fig. 1. Diseased spots on the leaf sheath of bamboo-shoot of *Phyllostachys nigra* MUNRO var. *Henonis* STAFF.
Fig. 2. Diseased region on the leaf sheath of bamboo-shoot of *P. nigra* MUNRO var. *Henonis*. STAFF.
Fig. 3. Diseased region on the leaf sheath of bamboo-shoot of *P. reticulata* C. KOCH.
Fig. 4. Diseased culm of *P. reticulata* C. KOCH, showing water-soaked region.

Plate III.

Fig. 1. Diseased culm of *P. reticulata* C. KOCH, showing the culm-rot.
Fig. 2. Diseased region on the leaf sheath of *Oryza sativa* L.
Fig. 3—4. Mycelia which have penetrated into the tissue of the culm of bamboo-shoot of *P. nigra* MUNRO var. *Henonis* STAFF.

MADAKE OYOBI HATIKU NO TAKENOKO NO ATARASII KINKAKUBYO

ENDÔ-SIGERU oyobi HIDAKA-ZYUN

(Résumé in Japonese)

Watakushidomo wa Madake (*Phyllostachys reticulata* C. KOGH) oyobi Hatiku (*Phyllosatachys nigra* MUNRO var. *Henonis* STAFF.) no Takenoko wo okasu Byôki wo sirabete sono Byôgenkin no Keitai oyobi Seisitu wo sirusita. Kono Byôgenkin wa imamade Hôkoku sarete inai *Sclerotium* ni zokusuru Kin de, kore ni *Sclerotium japonicum* ENDÔ et HIDAKA no Gakumei wo ataeta.

Sessyusiken dewa Madake oyobi Hatiku no hokani, Ine (*Oryza sativa* L.) omo okasu.

Kono Byôgenkin wa pH 2.699 kara pH 9.01 no aida de Hatuiku wo suruga, sono Saiteki-Nodo wa pH 5.004 kara pH 6.165 no aida ni aru.

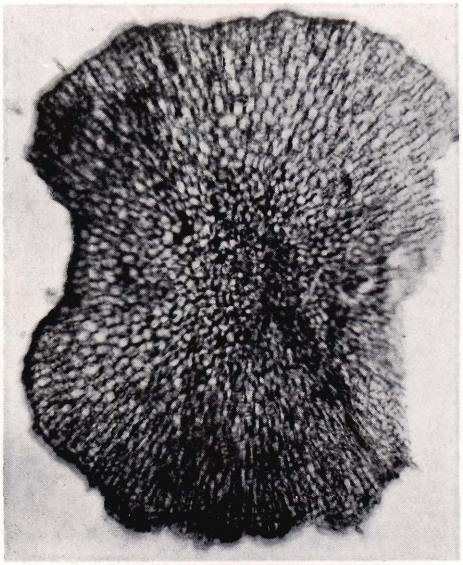


Fig. 1

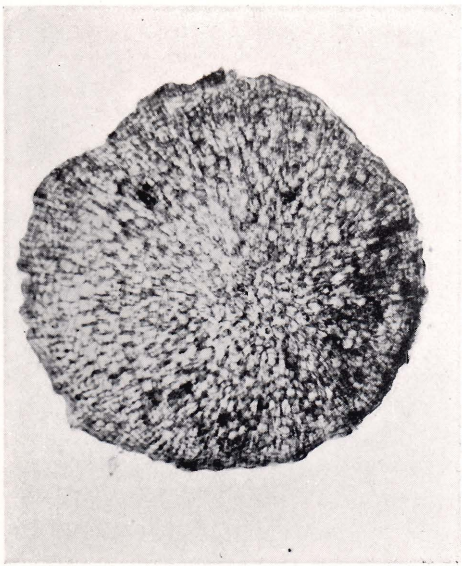


Fig. 2

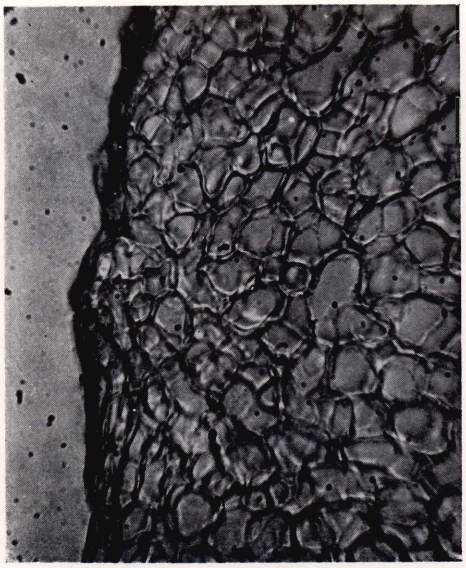


Fig. 3

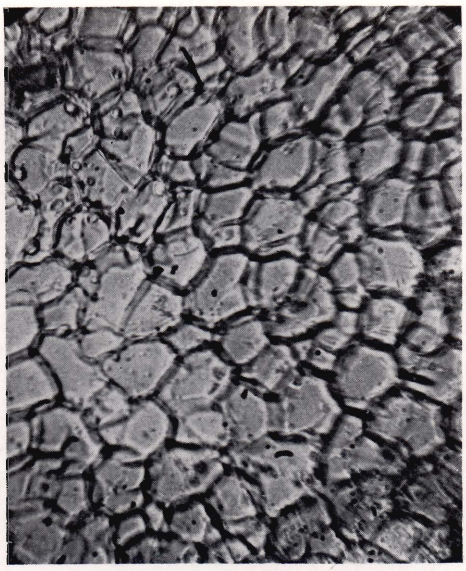


Fig. 4

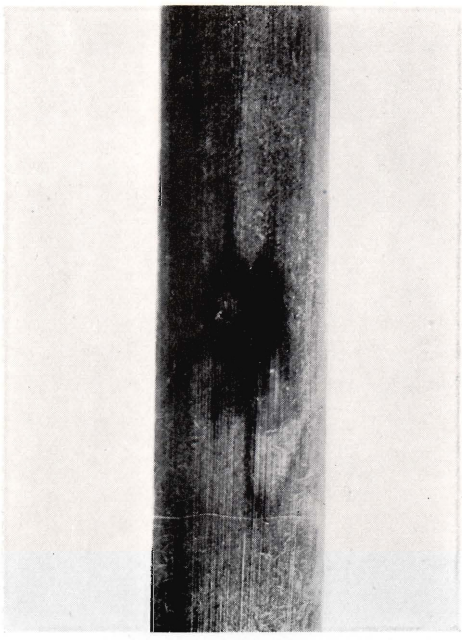


Fig. 1

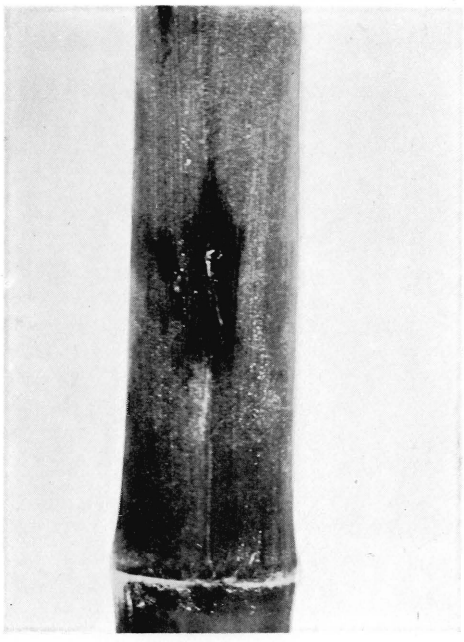
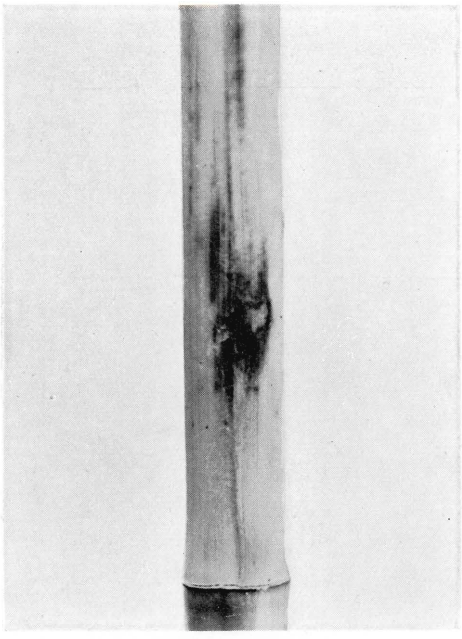


Fig. 2



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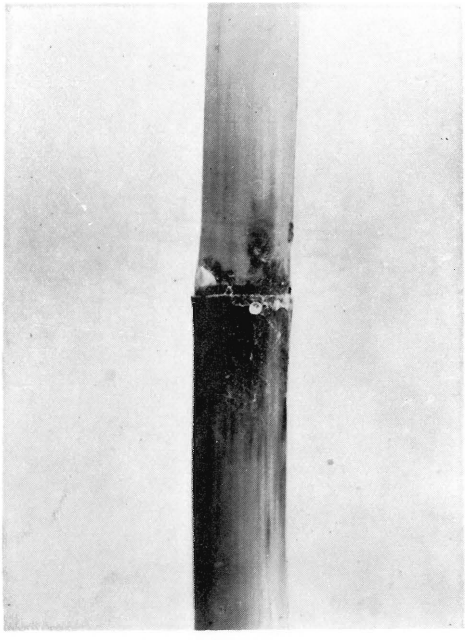

Fig. 4

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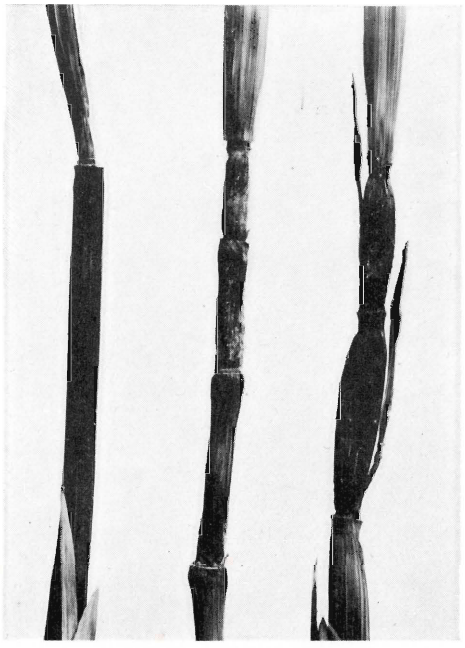

Fig. 1

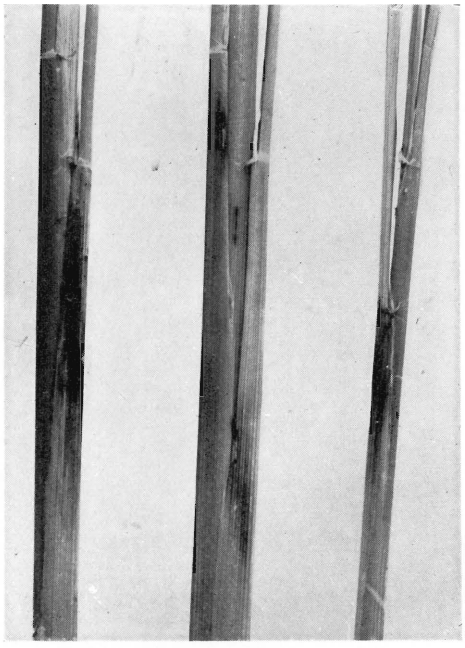

Fig. 2

Fig. 3

Fig. 4

ENDÔ and HIDAKA : Sclerotium disease