STUDIES ON THE FLAX RUST.

BY

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亜麻銹病の研究

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I. Introduction.

It has been a well-known fact in the flax cultivating regions of Europe, North America and other countries, that a rust disease generally recognized to be caused by *Melampsora Lini* TUL. has seriously damaged its culture.

The flax rust not only hinders the growth of the plant by attacking its leaves, bracts, pods and stems, but also attacks the fibro-vascular system of the flax-stem and renders it liable to break at the attacked spots. Moreover the black fungus-tissues remain in most cases adhering to the fibers even after the scutching and hackling operations have been carried out. By careful observations, we can trace the black fungus masses (its teleutosori) in the form of very minute fragments attacked to the end of fine strands of hackled fibers. In Japan, the rust disease at present spreads over the whole flax regions and its damage is very serious.

Numerous papers concerning the flax rust disease have been published by many authors in Europe and North America with reference to its causal fungus and preventive methods. Some important points concerning the life-history, the morphology and physiology of the causal fungus however remain to be solved.

At the suggestion of Profs. K. MIYABE and S. ITÔ, the author has taken up the study of the flax rust, since the fall of 1924, and the present paper is merely a preliminary report of his investigations. The writer wishes to express here his sincere thanks to Profs. MIYABE and ITÔ who have helped him throghout the study with useful suggestions and to Assistant Prof. Y. TOCHINAI, Miss

Y. HOMMA and Mr. S. IMAI for their kind advice and constant encouragement. The writer is also indebted to Dr. A. W. HENRY, pathologist, University Farm, University of Minnesota, St. Paul, Minn.; Mr. L. H. DEWEY, botanist in Charge of Fiber Investigations, U. S. Department of Agriculture, Washington; Mr. R. L. DAVIS, plant-breeder, U. S. Department of Agriculture, Washington; Miss HELEN HART, University Farm, University of Minnesota, St. Paul, Minn. and to Messrs. T. AKINO and Y. SANTÔ, experts of the Teikoku Seima Kaisha for their kindness in sending us many valuable specimens and papers.

II. Historical Review of the Flax Rust.

The rust of flax caused by *Melampsora* was first described by C. H. PERSOON[1] in 1801 as *Uredo miniata* PERS. var. *Lini* PERS. Important studies were made by J. C. ARTHUR[2], F. D. FROMME[3], A. BUCHHEIM[4], F. KÖRNICKE[5], F. TOBLER[6], A. W. HENRY[7], H. HART[8] and others.

In Europe, BUCHHEIM[4] reported in 1912 on the specialization between *Melampsora* parasitic on different species of *Linum*. G. H. PETHYBRIDGE and H. A. LAFFERTY[9] published in 1920 a detailed report on the flax rust. In the next year, TOBLER[6] reported especially the anatomical study of the affected tissues of the host plant. In 1923, J. C. DORST[10] was successful in selecting a rust resistant variety from the Frisian flax.

In North America, ARTHUR[2] first proved the autoecious formation of the aecidium in 1906, and FROMME[3] reported on physiological and cytological studies of the fungns in 1912. Recently, HART[8] also has made studies concerning the physiology of the fungus. In 1925, HENRY[7] reported that there are several

1) Synopsis methodica fungorum, p. 216 (1801).
2) Jour. of Myc. XIII, p. 201-202 (1907).
3) Bull. Torr. Bot. Club, XXXIX, p. 113-131 (1912).
4) Ber. Deutsch. bot. Ges. XXXIII, p. 73-75 (1915).
5) Land- u. Forstw. Zeit. Preussen (1865), p. 42 (1865).
6) Faserforsch. I, p. 223-229 (1921).
7) Phytopath. XV, p. 52 (1925).
8) Phytopath. XV, p. 52-53 (1925); *Ibid.* XVI, p. 185-205 (1926).
9) Jour. Dept. Agric. & Techn. Instr. Ireland, XX, p. 334-337 (1920).
10) Rept. Internat. Conf. Phytopath. & Econ. Entomol. Holland (1923), p. 33-34 (1924).

highly resistant or immune varieties of the cultivated flax.

In Japan, *Melampsora* parasitic on *Linum* was first collected in 1906 by Prof. G. YAMADA on *Linum stelleroides* PLANCH. growing wild in the neighborhood of Morioka and almost at the same time by Mr. M. MIURA in Aomori Prefecture. The rust of the cultivated flax was found in 1911 in the neighborhood of Sapporo, but did not cause very serious damage at that time to flax growers. In 1914 and the following year, the disease spread suddenly and resulted in a serious loss to the flax cultivators. Dr. NAOHARU HIRATSUKA, the then expert of the Teikoku Seima Kaisha, began to study the disease in 1914, and he published a preliminary report of the flax rust in the report of the Teikoku Seima Kaisha, No. 9 (Japanese). After this, the late Mr. KENJI MIYABE undertook important studies on the same problem, especially on the effect of the rust fungi on the bast-fibers, but his work remained unpublished on account of his lamented death.

III. Geographical Distribution of the Flax Rust.

The flax rust causing *Melampsora liniperda* (KÖRN.) PALM like other species of rust fungus such as *Puccinia graminis* PERS., etc., has almost world-wide distribution.

In Japan, it has been found almost throughout the northern districts, including Saghalien, Hokkaidô and the northern part of Honshû. The materials were obtained from the following places in Japan:—

Saghalien: Toyohara (H. ÔHASHI).

Hokkaidô: Prov. Ishikari: Sapporo, Kuriyama, Horomui, Jôzankei, Kotoni, Kiyomappu, Nopporo, Shimofurano. Prov. Shiribeshi: Kutchan. Prov. Teshio: Nayoro. Prov. Iburi: Abuta. Prov. Kitami: Nokkeushi.

The writer also had access to a large number of specimens which Dr. NAOHARU HIRATSUKA brought from Manchuria, Mongolia and China in 1914. The present fungus has been reported under one name or another, from North America (North Dakota, Iowa, Ontario, etc.), South America (Argentine), Europe (Great Britain, France, Germany, Russia, Italy, Bulgaria, Austria, Switzerland and Spain), Asia (India, Asia Minor, Siberia) and Australia. It is extremely probable that it occurs in all countries where flax is cultivated.

IV. Morphology of the Causal Fungus.

The causal fungus, *Melampsora liniperda* (KÖRN.) PALM is an autoecious Eumelampsora and has the following four spore-forms, *viz.* 1) Spermogonium (Pycnidium)—Spermatium (Pycnospore), 2) Aecidium (Aecium)—Aecidiospore (Aeciospore), Uredosorus (Uredinium)-Uredospore (Urediniospore) and 4) Teleutosorus (Telium)—Teleutospore (Teliospore).

A. Spermogonial stage.

1. *Spermogonium.* Spermogonia are produced generally on young seedlings when they are infected by the sporidia of the teleutospores of the fungus. But they never appear alone, being always followed by the formation of the aecidia apparently on the same mycelium. They occur on both sides of the foliage as well as cotyledonous leaves and occasionally on the stems. These spots are round and convex above, and when produced on the stems, cause hypertrophy of their host tissues, and sometimes a swelling at the point of production. The spermogonia are rather inconspicuous and pale-yellowish in colour. Several of them may occur in a close group in the discoloured spot. They are formed under the epidermal cells or somewhat sunk within the mesophyll of the host tissue. The spermogonium is a flattened flask-shaped body walled in by a large number of slender orange-coloured hyphae, and without ostiolar filaments at its opening or mouth. Its size is 97.2 to 162.0 μ in breadth and 63.0 to 93.6 μ in height. Sometimes the spermogonium is formed of merely a diffused layer of spermatiophores without a definite flask-shaped structure.

2. *Spermatiophore* and *spermatium.* The spermatiophores are formed from rectangular basal cells which are arranged in regular series at the base of the spermogonium. These are septate, branched, colourless and slightly swollen at the base. These spermatiophores differ from the unbranched non-septate ones of *Phragmidium violaceum* (SCHULTZ.) WINT. and *Gymnosporangium clavariaeforme* (JACQ.) DC. described by H. V. BLACKMAN[1] in that they are usually divided into two to four, each of which puts out a finger-like process from its upper end on whose tip a single spermatium is produced. According to FROMME[2],

1) Ann. Bot. XVIII, p. 323-373 (1904).
2) l. c.

the single nucleus in its spermatiophores divides successively to form the nuclei for a number of spermatia which are abstricted from the elongated finger-like tip of the spermatiophore. FROMME says that these characters of the spermatiophore may furnish a further basis for use in the classification of the *Uredinales*, and the writer agrees with this opinion.

The spermatia are much smaller than the other spore-forms, measuring 3.2 to 5.4 μ by 2.2 to 4.6 μ. They are oval or ellipsoid in shape and enclosed in a very thin wall. The cytoplasm is finely granular with apparently no reserve materials. The nucleus is relatively large in size.

B. Aecidial stage.

1. *Aecidium*. The aecidia are mostly on the under surface of the cotyledonous and foliage leaves, but rarely on the upper surface or on the stems, scattered, round or oblong, flatly pulvinate, 230 to 450 μ in diameter, and orange-yellow in colour. They develop under the epidermis and then rupture it at maturity, but without any peridium and paraphyses. It is of the *Caeoma*-type of aecidium, one of the characters of the genus *Melampsora*.

2. *Aecidiospore*. The aecidiospores are variable in shape, globose, ellipsoid or somewhat polygonal. They contain yellowish orange pigment and measure 17.6 to 27.2 μ by 16.2 to 24.0 μ in diameter. The epispore is colourless, thin and verrucose, without any distinct germ-pores.

C. Uredo stage.

1. *Uredosorus*. The uredosori arise from the mycelia resulting from the infection with the aecidiospores, and also later on from the infection by the first-formed uredospores. They occur on both sides of the foliage and cotyledonous leaves, and also on the stems, branches and inflorescences. They are produced under the epidermis, which is soon ruptured thus exposing the spores. The sori are round or oblong, scattered or clustered on the leaves, generally in circular groups up to about 4 mm. in diameter and elongated on the stem, up to about 2 mm. across, powdery, prominent, and bright orange-yellow in colour. The sori are indefinite in extent, having numerous paraphyses intermixed, and also a parenchymatous peridium in their younger stage.

2. *Uredospore*. The uredospore is singly borne upon a long stalk which

is made up of two or three elongated cells. The shape of the spore is globose, ovate or ellipsoid, measuring 12.6 to 23.4 μ in length and 12.6 to 21.6 μ in width. Its contents are granular and yellowish orange in colour. The walls are rather thin (1.6 to 2.0 μ thick), finely echinulate and colourless.

3. *Paraphyses*. The paraphyses are strongly capitate or clavate with long, slender stalk. The head is usually somewhat larger than the uredospore. The walls are thicker than those of the uredospores and mostly without echinulation. The stalks are undivided and contain but little cytoplasm. The size of the paraphyses is 40.0 to 66.5 μ long and 14.5 to 23.0 μ broad.

4. *Pseudoperidium*. At first, the uredosorus of this fungus is covered by a delicate parenchymatous peridium or pseudoperidium, but, later, it is absorbed or when present, it is found surrounding the uredosorus. Each cell of the parenchymatous peridium is globose or sometimes slightly polygonal in shape, and 6.8 to 9.2 μ in diameter. These facts were first reported by ED. FISCHER[1] in 1904. He stated that "anfänglich von polyedrisch-zelliger Peridie bedeckt". Several years later, J. I. LIRO[2] also described these facts in his "Uredineae Fennicae".

D. Teleuto stage.

1. *Teleutosorus*. The teleutosori generally appear around the uredosori and are formed on both sides of the leaves, bracts and seed capsules and more frequently on the stems. They are round (about 0.5 to 1.5 mm. in diameter) and isolated on the leaves, but on the stems are more often stretched and irregularly elongated in long streaks (up to 2.5 cm. in length). In colour they are reddish brown when young, becoming blackish-brown to brownish-black when the spores are in maturity. When the young host plants of 6 to 15 cm. in height are attacked by the fungus and when the teleutosori appear on the stems as the result, the mycelium develops rapidly in the soft host tissue and kills the plant upward, from the lesion. The teleutosori are formed uuder the epidermis and are long covered by it.

2. *Teleutospore* and *basidiospore*. The teleutospores are of the elongated,

1) Die Uredineen der Schweiz, p. 507 (1904).

2) Uredineae Fennicae, p. 556 (1908).

cylindrical or prismatical, one-celled type, closely compacted into a single layer. They are sessile on the short cubical cells at the base of the sorus, which lose their contents with the development of the teleutospores. The membrane is rather thin, but slightly thickened at the apex, yellowish-brown to brown colour and ordinary dark brownish colour at the upper part. The contents comprise many oil granules. The length is 46.8 to 81.0 μ and the breadth 8.0 to 19.2 μ. The basidiospore or sporidium is usually globose, 10.0 to 11.0 μ by 9.0 to 11.0 μ, smooth, with very thin epispore, containing many granules, pale yellow in colour.

3. *Abnormal teleutospore.* Peculiar shaped teleutospores are often observed in the old uredosori mixed among the paraphyses. These teleutospores are solitary (not compacted laterally), one-celled or rarely septated, sometimes pedicellate. This fact has been already observed in other species of *Melampsora* by NAOHARU HIRATSUKA[1] and P. DIETEL[2]. In 1896, NAOHARU HIRATSUKA described the peculiar shaped, one or two-celled, isolated teleutospores formed among the uredosori in *Melampsora Larici-epitea* KLEB. on the leaves of *Salix viminalis* L. var. *yezoensis* SCHNEID., but he did not discuss the fact in his graduation thesis. In 1901, DIETEL reported on the teleutospore forms of *Melampsora paradoxa* DIET. et HOLW. (=*Melampsora Bigelowi* THÜM.). He maintained that *Melampsora paradoxa* has different forms of teleutospores besides the typical one of the genus *Melampsora*. And he said that, "Wir sehen also an *Melampsora paradoxa* die Teleutosporen-charaktere zweier verschiedener Gattung *Melampsora* und *Uromyces* vereinigt, dieselbe könnte also als ein Bindglied zwischen diesen beiden Gattung betrachtet werde." in the conclusion of his paper. But, the writer does not agree, because those peculiar teleutospore-forms have no important meaning despite DIETEL's opinion, and it is only an abnormal form of the teleutospores. The writer believes that these abnormal teleutospores may be found in the species of *Melampsora* other than *Melampsora Larici-epitea*, *M. paradoxa* and *M. liniperda*.

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1) On the Melampsorae of Japan, 1896 (Graduation thesis).

2) Hedw. XL, p. (32)-(35) (1901).

V. Measurements of the Spores.

In the measurements of the aecidiospores and uredospores, the writer has used spores obtained from well matured pustules on the fresh leaves or stems. They were mounted 0.5 % KOH and measured with a Zeiss eyepiece micrometer.

A) *Aecidiospore.* ARTHUR who first described the life-history of the fungus, reported the size of the aecidiospores to be 21 to 28 μ by 19 to 27 μ in diameter. So far as can be ascertained by the writer, the description of this spore-form has been reported only by ARTHUR. Three hundred measurements were made for the aecidiospores from aecidia produced on the stems of the seedlings in the out of doors. The result of the measurements is as follows:—

Table I. *Measurements of the aecidiospores.*

a. *Length in Micron.*

Class	16.2	18.0	19.8	21.6	23.4	25.2	27.0	28.8	Mean
Frequency	8	15	37	61	70	60	36	13	23.153±2.365

Table II. *Measurements of the aecidiospores.*

b. *Width in Micron.*

Class	14.4	16.2	18.0	19.8	21.6	23.4	25.2	27.0	Mean
Frequency	10	17	62	75	58	40	27	11	20.622±2.515

The result shows that the majority of the aecidiospores are 18.0 to 28.8 μ in length and 16.2 to 27.0 μ in width, and quite agrees with those of ARTHUR.

B) *Uredospore.* The writer got the specimens of the fungus on the variety, "Saginaw" from his experimental plot; the measurements were made of five hundred spores each on leaves and stems. The following results were obtained.

Table III. *Measurements of the Uredospores.*

a. *Length in Micron.*

Class / On	12.6	14.4	16.2	18.0	19.8	21.6	23.4	Mean
leaves	22	46	88	154	121	50	19	
stems	13	52	79	142	131	53	30	
Total of frequency	35	98	167	296	252	103	49	18.247 ± 1.979

Table IV. *Measurements of the uredospores.*

b. *Width in Micron.*

Class / On	12.6	14.4	16.2	18.0	19.8	21.6	Mean
leaves	35	74	156	130	80	25	
stems	27	118	149	91	85	30	
Total of frequency	62	192	305	221	165	55	16.92 ± 1.943

The above tables show that the majority of the uredospores of *Melampsora liniperda* (KÖRN.) PALM measure 16.2 to 21.6 μ in length and 14.4 to 19.8 μ in width.

C) *Teleutospore.* The materials from different localities were examined and the measurements were made of two hundred teleutospores in each material which may be tabulated as follows:—

Table V. *Materials for measurements.*

No.	Locality	Formed on	Collector
I	Sapporo	leaves	the writer
II	Sapporo	stems	the writer
III	Mongolia	stems	NAOHARU HIRATSUKA
IV	Minnesota, U. S. A.	stems	A. W. HENRY
V	Russia	fibers*	——

*The fibers were imported from Russia in 1912 by the Teikoku Seima Kaisha.

Table VI. *Measurements of the teleutospores.*

a. *Length in Micron.*

Class / No.	46.8	48.6	50.4	52.2	54.0	55.8	57.6	59.4	61.2	63.0	64.8	66.6	68.4	70.2	72.0	73.8	75.6	77.4	79.2	81.0	Mean
I		1	2	2	3	5	6	9	10	12	9	18	29	25	26	13	11	8	7	3	
II				1	5	6	5	9	12	15	14	20	27	28	25	14	7	5	5	2	
III			2	0	3	7	9	7	10	12	13	24	31	25	21	13	8	6	4	5	
IV	1	0	1	3	3	2	8	11	13	14	16	21	27	30	19	15	8	5	3		
V				3	2	3	8	12	14	19	23	26	23	24	17	10	8	7	0	2	
Total of frequency	1	1	5	9	16	23	36	48	59	72	75	109	137	132	108	65	42	31	19	12	67.367±4.662

Table VII. *Measurements of the teleutospores.*

b. *Width in Micron.*

Class / No.	8.0	8.8	9.6	10.4	11.2	12.0	12.8	13.6	14.4	15.2	16.0	16.8	17.6	18.4	19.2	Mean
I	1	5	20	22	27	38	34	18	14	8	6	4	1	2		
II		6	14	18	27	35	32	31	20	7	4	4	2			
III	2	3	15	20	25	31	40	29	18	9	4	2	1	1		
IV	2	7	9	16	31	36	26	23	22	8	8	6	6			
V			6	12	14	26	38	30	28	18	14	6	4	3	1	
Total of frequeucy	5	21	64	88	124	166	170	131	102	50	36	22	14	6	1	12.643±1.647

From above tables we can find that the teleutospores of *Melampsora liniperda* (KÖRN.) PALM on *Linum usitatissimum* L. from different localities are quite similar, the majority being 61.2 to 73.8 μ in length and 9.6 to 15.2 μ in width.

VI. Nomenclature of the Flax Rust Fungus.

The discovery of *Melampsora* parasitic on the species of *Linum* dates back to the beginning of the 19th century, when PERSOON described it in 1801 as *Uredo miniata* PERS. var. *Lini* PERS. in his Synopsis methodica fungorum, p. 216. Since then many mycologists have found the fungus not only parasitic on *Linum catharticum* L. and *L. usitatissimum* L., but also on several other species of *Linum*, and have given it various different names as mentioned below:— *Uredo Lini* SCHUM., *U. polymorpha* STRAUSS var. *Lini* STRAUSS, *U. Lini* DC., *Caeoma Lini* LINK, *C. Lini* SCHLECHT., *Xyloma Lini* EHRENB., *Erysibe Lini* WALLR., *Lecythea Lini* BERK., *Podocystis Lini* FR., etc. In 1843, the genus *Melampsora* was established by LOUIS CASTAGNE[1] on *Melampsora Euphorbiae* CAST. as the type species, but, the binomial *Melampsora Lini* was first used by J. H. LÉVEILLÉ[2] in 1847. Prior to it, in 1818, C. G. EHRENBERG[3] described the teleuto-stage of the present fungus, under the name of *Xyloma Lini* EHRENB., and we must therefore regard *Melampsora* parasitic on *Linum* as *Melampsora Lini* (EHRENB.) LÉV.

In 1865, F. KÖRNICKE[4] found a clear distinction between *Melampsora* of the cultivated flax (*Linum usitatissimum* L.) and that of the wild species of *Linum*, and regarded it as a variety of *Melampsora Lini* TUL. naming it *Melampsora Lini* TUL. var. *liniperda* KÖRNICKE. According to his record, the seedlings of *Linum usitatissinum* var. *leucocarpum*, the seeds of which he obtained from the Botanic Garden of Copenhagen, were severely infected by *Melampsora Lini* TUL. var. *liniperda* KÖRNICKE, while none of the wild species of *Linum* in that neighborhood was attacked by it. Then, in 1869, L. FUCKEL[5]

1) Obserb. myc. II, p. 18 (1843).
2) Ann. Sci. nat. Sér. 3, VIII, p. 376 (1847).
3) Sylvae Myc. Berol. p. 27 (1818).
4) Land- u. Forstw. Zeit. Preussen (1865), p. 42 (1865).
5) Symb. Myc. p. 44 (1869).

distinguished two varieties in it, var. *major* and var. *minor*, the former variety parasitic on *Linum usitatissimum* L., the latter on *Linum catharticum* L. At last, in 1910, B. PALM[1] elevated *Melampsora Lini* var. *liniperda* to a specific rank and called it *Melampsora liniperda* (KÖRN.) PALM.

Melampsora liniperda (KÖRN.) PALM

in Svensk Bot. Tidskr. IV, p. (5), 1910; HIRATSUKA in Jour. Soc. Agric. & Forestr. Sapporo, XVIII, p. 106, 1926; Jap. Jour. Bot. III, p. 293, 1927; LIND, Danish Fungi, p. 292, 1913; SACC. Syll. Fung. XXIII, p. 833.

Synonyms.

Melampsora Lini TUL. var. *liniperda* KÖRNICKE in Land– u. Forstw. Zeit. Preussen (1865), p. 42, 1865; SACC. Syll. Fung. VII, p. 588; WINT. in Pilze Deutschl. I, p.242, 1881.

M. Lini TUL. var. *major* FUCKEL, Symb. Myc. p. 44, 1869.

Type host. *Linum usitatissimum* L.

Distribution. World-wide.

VII. The Life History of the Causal Fungus.

The life history of the causal fungus, *Melampsora liniperda* (KÖRN.) PALM is a complicated one consisting of four stages, all of which are passed on the flax as host. It was ARTHUR[2], who first in 1906 after many unsuccessful trials discovered the spermogonia and aecidia of *Melampsora* on the common flax. In 1906, he obtained a large collection of flax straw from Prof. H. L. BOLLEY of North Dakota, a most important state for flax culture in North America. Germination experiments with these materials had been all vain until one made in the last day of April on cultivated flax, dug from under a snow bank. This specimen showed strong germination of the teleutospores, and on May 4 the sporidia were sown on *Linum Lewissi* and *Larix laricina*, and on the following day on *Tsuga canadensis* and *Arisaema triphyllum*. Then, on May 16, spermogonia began to appear on *Linum Lewisii* and on May 21, aecidia.

1) Svensk Bot. Tidskr. IV, p. (5), (1910).

2) l. c.

The next sowing was made on May 18 on *Linum usitatissimum*, giving rise to spermogonia on May 26, and aecidia on May 30.

In Japan, for a number of years attempts have been made to study a full cycle of development of the fungus by NAOHARU HIRATSUKA, KENJI MIYABE and other phytopathologists, but they failed to secure the germination of its teleutospores. The writer also could not succeed in observing any germinating teleutospore in the spring of 1923 and 1924, but, in the spring of 1925, he at last obtained successful results. Several bundles of flax straw affected by the teleuto-stage of the rust fungus were obtained in the fall of 1924 and they were kept under the snow over winter in the field. On April 14 of the spring of 1925, the writer picked up several specimens of over-wintered teleutosori and kept them in Petri-dishes in a moist condition for a week at room temperature. On April 21, the writer made many longitudinal sections of the teleutosori samples. They were then floated on redistilled water. Twenty-four hours after, they showedstrong germination and many basidiospores were produced. Then, on April 22, these basidiospores were inoculated on *Larix Kaempferi* SARG., *Abies Mayriana* MIYABE et KUDÔ and *Linum usitatissimum* L. (Saginaw). These three host plants were tested in two series. The first series was kept in the green-house after the inoculation and the other series was tested out of doors. On May 4, spermogonia began to appear on the cotyledonous leaves and stems of the seedlings of *Linum usitatissimum* L. in the latter series. However, in the first series of *Abies*, *Larix* and *Linum*, no sign of spermogonia appeared. This failure is probably due to the higher temperature in the green-house. Further, on May 19, the writer also found numerous spermogonia on the cotyledonous and ordinary leaves and stems of the seedlings in the field plot. Then, after three or four days, aecidia appeared. Over the soil of this plot, the rusted flax straw had been spread and kept in place over winter. Six days after the appearance of the aecidia, a large number of uredosori were produced on every portion of the same host, and then, teleutosori appeared.

VIII. Comparative Inoculation Experiments with Varieties or Strains of Common Flax.

1) *Materials.* In these experiments, the uredospores on "Pernau", one of the varieties of flax commonly cultivated in Hokkaidô, were used only as inoculating materials. They were obtained from the Kitami Branch Station of the Hokkaidô Agricultural Experiment Station at Nokkeushi in Province Kitami, on August 24, 1924.

2) *Varieties or strains of flax which were used in inoculation experiments.* The varieties or strains of flax tested were obtained from the following sources:—

United States Department of Agriculture	24	varieties or strains.
Department of Agriculture for Ireland	8	"
Hokkaidô Agricultural Experiment Station	17	"
The Teikoku Seima Kaisha	36	"
College farm, Hokkaidô Imperial University	4	"

The list included duplicates of many of the varieties or strains. Plants bearing the same name from different sources were generally very similar in morphological characters, but there were some cases which differed somewhat from one another.

3) *Sign of susceptibility in the experiments.* The degree of the severity of the rust was measured on a scale of 0 to 4, in which 0 denotes immune, and 4 completely susceptible.

Experiment I.

The method used was to make a spore suspension of the uredospores and spray them on the host in the green-house by means of an atomizer. The pots were then covered with bell jars and placed where the temperature ranged between 14° and 25°C. The bell jars were removed after 48 hours. The results are shown in the following table:—

Table XV. *Results of Experiment I.*

Varieties	Date of inoculation	Appearance of uredo	Appearance of teleuto	Degree
Saginaw (T)	Aug. 24.	Sept. 1.	Sept. 12.	4
Washington No. 14 (T)	"	" 2.	" 14.	4
Pernau (T)	"	" 2.	" 12.	4
Blue Dutch (T)	"	" 2.	" 16.	4
Yorkshire (T)	"	" 3.	" 12.	4
Argentine (T)	"	" 2.	" 13.	4

(Inoculation with the uredospores from "Pernau")

Among six strains or varieties of cultivated flax used for the experiments, five strains are fiber-flax, only one variety namely "Argentine" (T) being seed-flax. These strains or varieties are obtained from the Teikoku Seima Kaisha and the sign (T) is put after each name for abbreviation.

Experiments II and *III.*

These inoculation experiments were made on 18 varieties and strains of cultivated flax in two series. The first series was tested out of doors, and the second series in the green-house. In the first series, the seeds were sown in the pots and brought out of doors. When they grew to the height of about six inches, the inoculation experiments were tried out of doors. The plants were sprayed on Sept. 10 with a suspension of the uredospores from "Pernau" (from Experiment I), and their control plants sprayed with sterilized water. The pots were covered with bell jars. After two days, the bell jars were removed and the plants kept well watered. After 8 days (Sept. 8), uredosori appeared on the leaves of "Yorkshire" and "White Blossom Dutch", the next day, they appeared on "Pernau" (T. & H.), "London" (seed), "Saginaw" (T.), "Prof. Minami, B" (F), "Russia" (H), "Tiensin" (H) and "Siberia, D" (H); after 10 days, on "Saginaw" (T), "Washington No. 14" (T) and "Prof. Minami" (H); and at last after 11 days, on "Belgium" (T), while none of the control plants showed any sign of the disease. In the second series, they were tested in the green-house using the same method as above (Experiment II). This time, they were inoculated on Oct. 14 and on Oct. 22 uredosori first appeared on the cotyledonous leaves of "Yorkshire" (T), "Saginaw" (H), etc. The results are tabulated as follows:—

Table XVI. *Results of Experiment II.*

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Pernau (T)	Sept. 10.	Sept. 19.	9 days	Oct. 5.	4
Pernau (H)	„	„ 19.	9 „	„ 11.	4
Yorkshire (T)	„	„ 18.	8 „	—	3
Saginaw (T)	„	„ 20.	10 „	Oct. 7.	4
Saginaw (H)	„	„ 19.	9 „	„ 8.	4
London (seed) (H)	„	„ 19.	9 „	„ 10.	3
Washington No. 7 (T)	„	„ 20.	10 „	„ 11.	3
Washington No. 14 (T)	„	„ 20.	10 „	„ 10.	4
Prof. Minami, A (F)	„	„ 20.	10 „	„ 5.	4
Prof. Minami, B (F)	„	„ 19.	9 „	„ 4.	4
Prof. Minami (H)	„	„ 20.	10 „	„ 3.	4
Holland No. 12 (H)	„	„ 21.	11 „	—	3
Russia (H)	„	„ 19.	9 „	Oct. 5.	3
White Blossom Dutch (H)	„	„ 18.	8 „	„ 8.	4
Tiensin (H)	„	„ 18.	8 „	„ 5.	3
Siberia-D (H)	„	„ 18.	8 „	„ 8.	3
Belgium (seed) (T)	„	„ 22.	12 „	„ 18.	2
Normandy (H)	„	„ 19.	9 „	„ 10.	4

(Inoculation experiments made out of doors in pots)

Remarks: The sign fixed to each variety or strain show its source as:

(T) .... The Teikoku Seima Kaisha.

(H) .... Hokkaidô Agricultural Experiment Station.

(F) .... College farm, Hokkaidô Imperial University.

Table XVII. *Results of Experiment III.*

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Pernau (T)	Oct. 14.	Oct. 23.	9 days	Nov. 2.	3
Pernau (H)	„	„ 23.	9 „	„ 3.	4

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Yorkshire (T)	Oct. 14.	Oct. 22.	8 days	Nov. 5.	4
Saginaw (T)	"	" 23.	9 "	" 4.	4
Saginaw (H)	"	" 22.	8 "	" 5.	4
London (seed) (H)	"	" 23.	9 "	" 4.	4
Washington No. 7 (T)	"	" 22.	8 "	" 7.	4
Washington No. 14 (T)	"	" 24.	10 "	" 10.	4
Prof. Minami-A (F)	"	" 22.	8 "	" 2.	3
Prof. Minami-B (F)	"	" 23.	9 "	" 1.	4
Prof. Minami (H)	"	" 23.	9 "	" 2.	4
Holland No. 12 (H)	"	" 24.	10 "	" 10.	2
Russia (H)	"	" 23.	9 "	" 4.	4
White Blossom Dutch (H)	"	" 22.	8 "	" 7.	4
Tiensin (H)	"	" 24.	10 "	" 5.	2
Siberia-D (H)	"	" 25.	11 "	" 6.	4
Belgium (seed) (T)	"	" 23.	9 "	—	2
Normandy (H)	"	" 22.	8 "	Nov. 9.	4

The temperature in the green-house { Maximum 34°C. / Minimum 8°C.

Experiment IV.

In this series, 17 varieties or strains were tested by the same method as Experiment III in the green-house. In this experiment, the following six new varieties or strains from new sources were added to eleven varieties or strains tested in Experiment III.

1. Canadian White Dutch (T).
2. Minnesota (seed-flax) (T).
3. White Blossom Dutch (T).
4. Blue Blossom Dutch (T).
5. Argentine (seed-flax) (T).
6. Russia (T).

The results show as the following table:—

Table XVIII. *Results of Experiment IV.*

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Pernau (T)	Oct. 19.	Oct. 28.	9 days	Nov. 9.	4
Yorkshire (T)	"	" 28.	9 "	" 10.	4

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Saginaw (T)	Oct. 19.	Oct. 27.	8 days	Nov. 8.	4
London (seed) (H)	„	„ 29.	10 „	„ 12.	4
Canadian White Dutch (T)	„	„ 28.	9 „	„ 8.	4
Minnesota (T)	„	„ 27.	8 „	„ 21.	4
Washington No. 7 (T)	„	„ 27.	8 „	„ 19.	4
Washington No. 14 (T)	„	„ 29.	10 „	„ 22.	3
Holland No. 12 (T)	„	„ 29.	10 „	„ 13.	4
White Blossom Dutch (T)	„	„ 28.	9 „	„ 8.	4
Blue Blossom Dutch (T)	„	„ 28.	9 „	„ 10.	4
Tiensin (H)	„	„ 28.	9 „	„ 11.	4
Siberia-D (H)	„	„ 27.	8 „	„ 17.	4
Normandy (H)	„	„ 28.	9 „	„ 16.	4
Argentine (T)	„	„ 27.	8 „	„ 19.	4
Russia (T)	„	„ 28.	9 „	„ 16.	4
Belgium (seed) (T)	„	„ 28.	9 „	„ 13.	3

(Inoculation experiments made in the green-house)

The temperature in the green-house $\begin{cases} \text{Maximum } 34°\text{C.} \\ \text{Minimum } 8°\text{C.} \end{cases}$

Experiment V.

The writer tried the culture of our fungus on "Pernau" in the pots in the green-house during the winter, beginning from Oct. 30, 1924 to April 12, 1925. As the epidemic was induced artificially on the older plants, an abundant production of the uredospores was secured. They were transferred by the same method as in Experiment III from the older to the younger plants.

Table XIX. *Results of the culture of the flax rust in the green-house during the winter, Oct. 30, 1924 to April 12, 1925.*

Cult. No.	Variety	Origin of inoculation	Date of inoculation	Appearance of uredosori
I.	Pernau (T)	Pernau from Exp. III.	Oct. 30.	Nov. 7.
II.	„	from Cult. I.	Nov. 14.	Nov. 24.
III.	„	„ „ II.	Dec. 2.	Dec. 12.
IV.	„	„ „ III.	„ 22.	Jan. 1.(1925)

Cult. No.	Variety	Origin of inoculation	Date of inoculation	Appearance of uredosori
V.	Pernau (T)	from Cult. IV.	Jan. 20.	Jan. 30.
VI.	„	„ „ V.	Feb. 18.	Feb. 29.
VII.	„	„ „ VI.	March 12.	March 22.
VIII.	„	„ „ VII.	March 29.	April 7.

The temperature in the green-house $\begin{cases} \text{Maximum } 43^{\circ}\text{C.} \\ \text{Minimum } 11^{\circ}\text{C.} \end{cases}$

Experiment VI and VII.

In the spring of 1925, 17 varieties and strains of flax were kindly sent by Mr. L. H. DEWEY, Bureau of Plant Industry, United States Department of Agriculture, at the author's request. These varieties and strains were obtained by Mr. DEWEY from two breeders, Mr. A. C. DILLMAN of Mandan, North Dakota and Mr. B. B ROBINSON, St. Paul, Minnesota.

These varieties or strains are enumerated as follows:—

from A. C. DILLMAN:

1. Flax C. I. No, 168. Grown at Mandan, N. D, in 1917. (A natural hybrid found in yellow seeded flax C. #25.)
2. Flax C. I. No. 169. Grown at Mandan, N. D. 1917. (Hybrid of C. #13 by #25. C. #13 is brown seeded short fiber type, and C. #25 yellow seeded dwarf much branched type.)
3. Flax C. I. No. 170. Grown at Mandan, N. D. 1917. (Hybrid between C. #19 and #25. C. #19 is of the European type.)
4. Flax C. I. No. 301. St. I. 58763. Abyssinia.
5. Flax C. I. No. 280. Sel. N. D. R. Long 79. (Argentine Sel.)
6. Flax C. I. No. 116. Cayagneo. (Type of flax grown in Argentina.)
7. Flax C. I. No. 25. Williston Golden. (Moccasin, Mont. 1924.)

from B. B. ROBINSON:

8. Blue Blossom Dutch.
9. White Blossom Dutch.
10. Ottawa 770 B.
11. Ottawa 829 C.

12. Ottawa Long Stem.
13. Saginaw.
14. Burbank.
15. Ireland Pure Line # 3.
16. Ireland Pure Line # 5.
17. Ireland Pure Line # 6.

The writer made the inoculation experiments using the uredospores secured in Experiment V with the above mentioned varieties and strains from North America together with Pernau (T) and Saginaw (T) for control.

It was done in two series, the first series in the green-house and the second out of doors. The method of experiments was just the same as Experiments II and III. The results are shown in the following tables.

Table XX. *Results of Experiment VI.*

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Abyssinia	April 23.	May 4.	11 days	May 20.	4
Argentine Sel.	„	—	—	—	0
Williston Golden	„	—	—	—	0
Pure Line 3	„	May 3.	10 days	May 18.	4
Pure Line 5	„	„ 2.	9 „	„ 19.	4
Pure Line 6	„	„ 3.	10 „	„ 17.	4
Blue Blossom Dutch	„	„ 2.	9 „	„ 19.	3
White Blossom Dutch	„	„ 3.	10 „	„ 17.	4
Saginaw	„	„ 1.	8 „	„ 17.	4
Cayagneo	„	„ 4.	11 „	—	1
Ottawa 829 C	„	„ 3.	10 „	May 20.	3
Ottawa Long Stem	„	—	—	—	0
Ottawa 770 B	„	May 3.	10 days	May 18.	4
Burbank	„	„ 1.	8 „	„ 17.	4
Mandan No. 168	„	„ 2.	9 „	„ 16.	4
Mandan No. 169	„	„ 1.	8 „	„ 13.	4
Mandan No. 170	„	April 30.	7 „	„ 18.	4
Pernau (T) (*Control*)	„	May 2.	9 „	„ 18.	4
Saginaw (T) („)	„	„ 2.	9 „	„ 16.	4

(Inoculation experiments made in the green-house)

The temperature in the green-house { Maximum 37°C. / Minimum 6°C.

Table XXI. *Results of Experiment VII.*

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Abyssinia	April 25.	May 4.	9 days	May 21.	4
Argentine Sel.	,,	—	—	—	o
Williston Golden	,,	—	—	—	o
Pure Line 3	,,	May 4.	9 days	May 17.	4
Pure Line 5	,,	,, 1.	6 ,,	,, 15.	4
Pure Line 6	,,	,, 4.	9 ,,	,, 12.	4
Blue Blossom Dutch	,,	,, 4.	9 ,,	,, 19.	3
White Blossom Dutch	,,	,, 3.	8 ,,	,, 17.	4
Saginaw	,,	,, 5.	10 ,,	,, 17.	4
Cayagneo	,,	—	—	—	o
Ottawa 829 C	,,	May 3.	8 days	May 14.	4
Ottawa 770 B	,,	—	—	—	o
Ottawa Long Stem	,,	May 5.	10 days	May 14.	4
Burbank	,,	,, 2.	7 ,,	,, 16.	4
Mandan No. 168	,,	,, 3.	8 ,,	,, 15.	4
Mandan No. 169	,,	,, 2.	7 ,,	,, 17.	4
Mandan No. 170	,,	,, 3.	8 ,,	,, 16.	4
Pernau (T) (*Control*)	,,	,, 4.	9 ,,	,, 14.	4
Saginaw (T) (,,)	,,	,, 6.	11 ,,	,, 13.	4

(Inoculation experiments made out of doors in pots)

Experiment VIII.

While the writer was conducting Experiment VII, he was sent the following four varieties and strains of cultivated seed-flax to be tested by Dr. A. W. HENRY of University Farm at St. Paul, Minn.

1. Argentine (seed-flax).
2. Winona (,, ,,).
3. Chippewa (,, ,,).
4. Red Wing (,, ,,).

According to HENRY, these varieties and strains are highly wilt-resistant, among which "Argentine" is rust- and wilt-resistant. The inoculation experiments were carried in the green-house using the uredospores from Experiment V. In this case, "Pernau" (T) was used for control. The results are shown in the following table.

Table XXII. *Results of Experiment VIII.*

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Argentine	May 4.	—	—	—	0
Winona	„	May 12.	8 days	May 21.	4
Chippewa	„	„ 13.	9 „	„ 24.	4
Red Wing	„	„ 13.	9 „	„ 28.	4
Pernau (*Control*)	„	„ 13.	9 „	„ 27.	4

(Inoculation experiments made in the green-house)

The temperature in the green-house { Maximum 34°C. / Minimum 6°C.

Experiment IX.

The several varieties and strains of flax were procured by Mr. Y. SANTÔ during his stay in Europe for the study of flax culture. They were placed in the writer's hand for the inoculation experiments. Among them, 8 varieties and strains of fiber-flax from Ireland are most important, so the writer has tested these 8 varieties and strains together with "Pernau" (T) and "Saginaw" (T) for control. The results are shown in Table XXIII.

Table XXIII. *Results of Experiment IX.*

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Danish P. L. 21	May 10.	May 19.	9 days	June 7.	4
Danish P. L. 40	„	„ 19.	9 „	„ 8.	4
Ireland P. L. 3	„	„ 20.	10 „	„ 4.	4
Ireland P. L. 5	„	„ 19.	9 „	„ 3.	4
Ireland P. L. 6	„	„ 18.	8 „	„ 3.	4
Ireland P. L. 25	„	„ 19.	9 „	„ 5.	4
Ireland P. L. 27	„	„ 19.	9 „	„ 4.	4
M. D. Selection	„	„ 19.	9 „	„ 7.	4
Saginaw (T) (*Control*)	„	„ 18.	8 „	„ 5.	4
Pernau (T) („)	„	„ 19.	9 „	„ 3.	4

(Inoculation experiments made in the green-house)

The temperature in the green-house { Maximum 38°C. Minimum 6°C.

Experiment X.

In this experiment, five strains of seed-flax of Argentine origin were tested for comparison. They are:

1. Argentine (H) from the Hokkaidô Agricultural Experiment Station.
2. Argentine (T) from the Teikoku Seima Kaisha.
3. Argentine (HENRY) from A. W. HENRY.
4. Argentine Sel. from A. C. DILLMAN.
5. Cayagneo from A. C. DILLMAN.

The inoculating materials were obtained from those on "Pernau" (T) in Experiment VI. The results are shown in the following table.

Table XXIV. *Results of Experiment X.*

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Argentine (H)	May 11.	May 20.	9 days	June 1.	4
Argentine (T)	"	" 19.	8 "	May 30.	4
Argentine (HENRY)	"	—	—	—	0
Argentine Sel.	"	—	—	—	0
Cayagneo	"	—	—	—	0
Pernau (T) (*Control*)	"	May 20.	9 days	June 1.	4

(Inoculation experiments made in the green-house)

The temperature in the green-house { Maximum 34°C. Minimum 6°C.

As we find in the above table, the so-called "Argentine" from the Hokkaidô Agricultural Experiment Station and the Teikoku Seima Kaisha, did not show any sign of rust-resistance, being very susceptible to it, while the other strains are immune.

Experiment XI.

Five varieties or strains of seed-flax seeming to be immune or highly resistant to our disease, were tested in this experiment. Four varieties or strains, Argentine (HENRY), Cayagneo, Ottawa 770 B and Argentine Sel. proved to be perfectly immune. On several cotyledonous leaves of "Williston Golden", however, minute uredosori appeared, but they did not develop to any extent. The leaves thus affected by the fungus soon fell off. "Pernau" (T) used for control was severely affected. The results are shown in the following table.

Table XXV. *Results of Experiment XI.*

Varieties	Date of inoculation	Appearance of uredo	Period of incubation	Appearance of teleuto	Degree
Argentine (HENRY)	June 20.	—	—	—	0
Cayagneo	"	—	—	—	0
Ottawa 770 B	"	—	—	—	0
Williston Golden	"	June 29.	9 days	—	1
Argentine Sel.	"	—	—	—	0
Pernau (T) *(Control)*	"	June 28.	8 days	July 14.	4

(Inoculation experiments made in the green-house)

The temperature in the green-house $\begin{cases} \text{Maximum } 34°\text{C.} \\ \text{Minimum } 12°\text{C.} \end{cases}$

IX. Varieties and Strains Resistant or Immune to the Flax Rust.

In 1923, J. C. DORST[1] reported on the resistance to the flax rust of several strains of white flowering flax, free from rust in a field severely attacked by the rust.

In the next year, A. W. HENRY[2] reported that several immune or highly resistant seed-flax varieties had been found at St. Paul, Minnesota, U. S. A., and he added that numerous strains of large-seeded, blue-flowered Argentine race are immune and some also are wilt-resistant.

H. D. BARKER[3] also reported that "Chippewa" is not only resistant to wilt,

1) l. c.

2) l. c.

3) Minn. Agric. Exper. Stat. Tech. Bull. XX (1923).

caused by *Fusarium Lini*, but also is moderately resistant to the flax rust in his "A study of wilt resistance in flax".

The writer fortunately obtained in the spring of 1925, the seed of various valuable varieties and strains which were tested by HENRY and BARKER, from the Bureau of Plant Industry, U. S. Department of Agriculture. Those varieties and strains were used in inoculation experiments as shown in Chapter VIII. The following varieties and strains were found by the writer's experiments to be highly resistant or immune to the rust. They are:

1. Argentine (HENRY).
2. Argentine selection (DILLMAN).
3. Belgium (seed) (T).
4. Cayagneo (DILLMAN).
5. Ottawa 770 B (ROBINSON).
6. Williston Golden (DILLMAN).

The results obtained by the inoculation experiments with the rust-resistant or immune varieties and strains already described, may be summarised in the following table.

Table XXVI. *Results of inoculation experiments with the rust-resistant or immune varieties or strains.*

Varieties	I.	II.	III.	IV.	V.	VI.	VII.
	Exp. II.	Exp. III.	Exp. VI.	Exp. VII.	Exp. VIII.	Exp. X.	Exp. XI.
Argentine (HENRY)	–	–	–	–	0	0	0
Argentine Sel.	–	–	0	0	–	0	0
Belgium (seed)	2	2	–	–	–	–	–
Cayagneo	–	–	1	0	–	0	0
Ottawa 770 B	–	–	0	0	–	–	0
Williston Golden	–	–	0	0	–	–	1
Pernau (T) *(Control)*	4	4	4	4	4	4	4

The results of the writer's experiments shown in the above table indicate that they are entirely in accord with HENRY's suggestions.

X. Summary.

1. The flax rust is now widely distributed throughout the flax regions of our country.

2. The causal fungus, *Melampsora liniperda* (KÖRN.) PALM belongs to an autoecious *Eu-melampsora* as well demonstrated by J. C. ARTHUR.

3. This fungus affects not only the stems and leaves of the host plant, but also the pods and bracts.

4. Its spermatia are produced on septate branching spermatiophores as well described by F. D. FROMME.

5. Its aecidium is a typical *Caeoma*-type.

6. The parenchymatous peridium covering its uredosorus was observed as first demonstrated by ED. FISCHER.

7. Teleutospores require a rest period and germinate at early spring.

8. Six to ten days are required for the formation of the spermogonia and 10 to 17 days for that of the aecidia.

9. The incubation period of the uredospores from the time of inoculation of either aecidiospores or uredospores to the appearance of new uredosori, varied within a limit of 7 to 12 days, the average period being 9 days.

10. Ottawa 770 B and Williston Golden and three strains of Argentine race [Argentine (HENRY), Argentine Sel. and Cayagneo] are immune or very resistant to the rust.

11. The so called "Argentine" from the Hokkaidô Agricultural Experiment Station and the Teikoku Seima Kaisha is susceptible to the disease.

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摘　　要

亞麻銹病は栽培亞麻の一大病害にして、立枯病及び炭疽病の二者と共に亞麻栽培者にとりて最も恐れられつゝあるものなり。本病害は世界各地の亞麻栽培地方に廣く分布し、本邦に於ては其の主要產地たる北海道に於て此れに基く被害頗る甚大なり。

予は數年來、本病害の研究に從事しつつあり。本報文に於ては其の研究の一端として本病病原菌の形態及び生活史を明かにし、又多數の亞麻品種に就きて本病に對する抵抗性並びに感受性の實驗結果を公けにせり。

本病病原菌は古くより一般病理學者及び菌學者間に *Melampsora Lini* として知られつつあるも、予は本種名を歐洲產野生種 (*Linum catharticum*) に寄生するものに附し、栽培亞麻の銹病菌は此れを *Melampsora liniperda* (KÖRN.) PALM となすを以て適當なるものと信ず。本菌は同種寄生性を有し、精子器、銹子腔、夏胞子及び冬胞子の四時代を完全に有す。即ち "Autoecious Eumelampsora" なり。

更に予の實驗結果に據れば、亞麻銹病に對する抵抗性若くは免疫性品種は現に本邦に於て栽培せられつつあるものの中に認むる能はず。僅かに北米合衆國農務局より得たる品種中、種子用の Argentine (HENRY), Argentine Sel., Cayagneo., Ottawa 770 B 及び Williston Golden の五品種は本病に對して免疫性或は著しき抵抗性を有する事を知れり。前記五品種中、Argentine (HENRY), Argentine Sel. 及び Cayagneo は「アルゼンチン」系統なり。更に、銹病抵抗性と他の亞麻病害の抵抗性とは何等其間に關係を認め得ず。特に前記の銹病抵抗性品種中 Argentine (HENRY) を除く四品種は立枯病並びに炭疽病に頗る弱し。立枯病抵抗性品種も亦特に銹病に抵抗性を有せざるが如し。

要するに、現今纖維用亞麻品種中一として銹病に抵抗性を有するものなく、從て抵抗性若くは免疫性品種育成の極めて必要なるを認めらるると雖、本邦に於ける焦眉の實際問題としては須く先づ耐寒性の優良品種を撰定し出來得る限り早播を行ひ以て銹病の被害を輕減せしめ、而して後除ろに抵抗性品種育成に努めざるべからざるものと考へらる。