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ERYSIPHACEAE OF JAPAN

By

Yasu HOMMA

Contents

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Introduction

The first record of Erysiphaceae from Japan was that by M. J. BERKELEY and M. A. CURTIS, in a paper reporting new Fungi collected in the North Pacific Exploring Expedition by CHARLES WRIGHT. In that paper, *Cystotheca Wrightii* on *Quercus stenophylla* collected in Loo-choo in April 1855 was first described as a new genus, which was considered to belong to Perisporiaceae. Since the publication of "The Monograph of Erysiphaceae" in 1900 by E. S. SALMON, a large number of our powdery mildews have been collected by Japanese mycologists, and those specimens were identified by E. S. SALMON, P. HENNINGS and P. & H. SYDOW. The reports were published in the Bulletin of the Torrey Botanical Club, Engler's Botanische Jahrbücher, Mémoires de l'Herbier Boissier, and Annales Mycologici by these authors. As these reports were published at about the same time, different names have been given to the same fungus by the different authors. From about this period, monographic treatments of Erysiphaceae have begun to appear in different countries in Europe, as for example in Italy by G. POLLACCI (1905), in Czechoslovakia by J. KLIKA (1924), in Norway by I. JØRSTAD (1925), in Croatia by V. ŠKORIĆ (1926), and in Rumania by TR. SĂVULESCU and C. SANDU-VILLE (1929). Also in this country, the new genera Sawadaea MIYABE (1914), Typhulochaeta S. ITO and HARA (1915), and Uncinulopsis SAWADA (1916) were described. The writer began studies on the Japanese species of Erysiphaceae in the year 1922, and has continued her researches up to the present time. The rich collection of specimens deposited in the Herbarium of the Faculty of Agriculture, Hokkaido Imperial University has been freely used in her studies. For the collection of the complete specimens of the conidial and perithecial stages, a long time has been spent. For each species, the writer has endeavored to give full descriptions of both stages.

Besides, the comparative studies of all genera have been made on the form and formation of conidia as well as on the structure and formation of peritheria, because such investigations have not been carried out for all genera. The writer also studied with interest the relation between the powdery mildews and their host plants. Also, on *Erysiphe graminis* f. sp. *Tritici* parasitic on wheat, a special study on the question of specialization has been made.

In this paper, the writer endeavors to present not only a monographic study on all the Japanese species but also a consideration of many biological and morphological problems in Erysiphaceae. The paper is divided into two parts, the general and the systematic. In the former part, (1) the morphology and physiology, (2) the host and parasitism, (3) specialization and resistance are treated. In the latter part, all specimens which have been collected in every part of this country were carefully identified and classified. They are included in eleven genera, viz. Cystotheca, Sphaerotheca, Podosphaera, Erysiphe, Uncinula, Sawadaea, Typhulochaeta, Microsphaera, Phyllactinia, Uncinulopsis and Leveillula.

The writer wishes to express here her hearty thanks to Prof. Emer. K. MIYABE for his valuable suggestions and constant guidance, and moreover for his kindness in granting leave to study the numerous specimens deposited in the Herbarium of the Hokkaido Imperial University. This collection includes the many interesting specimens which were collected by himself and his assistants and pupils, accompanied sometimes with his valuable notes. The writer wishes also to acknowledge her indebtedness for the free use of his library rich in the literature relating to Erysiphaceae.

To Prof. S. ITO, the writer desires to express here her greatest gratitute for his valuable suggestions and kind guidance.

The writer has to thank Prof. Y. TOCHINAI for his kind advice; and her indebtedness is also acknowledged to the laboratory colleagues who helped her with many valuable specimens.

The writer has to thank Sir ARTHUR HILL, the Director of the Royal Botanic Gardens, Kew, for a part of the type specimen of *Phyllactinia suffulta* (REBENT.) SACC. f. *Pyri* preserved in the Herbarium of the Gardens, which he most kindly sent at her request. To Dr. C. L. SHEAR, she desires to express her thanks for the specimens of *Uncinula polychaeta* and *Microsphaera Alni* on Quercus.

The writer wishes also to express thanks to many Japanese mycologists for their kind help; to Dr. S. HORI who most kindly lent to our Institution numerous specimens from the Herbarium of the Agricultural Experiment Station, Nishigahara, Tokyo; to Prof. S. KUSANO who most kindly gave her about six hundred specimens from his private collection; to Prof. T. MATSUMOTO who very kindly sent to our Herbarium the numerous specimens from the Herbarium of the Imperial College of Agriculture and Forestry, Morioka; to the Late Dr. T. NISHIDA who contributed to our Institution many specimens from the Herbarium of the Agricultural Experiment Station, Kyushu; to Dr. KITAJIMA who very kindly sent to our Herbarium many specimens of the powdery mildews on trees and shrubs from the Herbarium of the Imperial Forestry Experiment Station, Meguro, Tokyo; to Prof. K. TOGASHI who most kindly sent the specimens collected by himself in Hokkaido and on Mt. Hayachine; to Mr. K. SAWADA who very kindly sent many interesting specimens from Formosa; to Messrs. T. YOSHINAGA, K. YOSHINO, K. HARA, S. IGATA, E. KUROSAWA, S. TANAKA and S. IWAYAMA who most kindly sent many important specimens at the writer's request.

The writer wishes to acknowledge her indebtedness for the grant by the Imperial Academy for carrying out the present research.

The specimens studied are all kept in the Herbarium of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan.

General Part

I. Morphology and Physiology

Mycelia

Erysiphaceae have been classified in three subfamilies, Erysipheae, Phyllactinieae and Leveilluleae, by the character of parasitism.

In Erysipheae, the mycelial hyphae are external creeping on the surface of the host plants and sending haustoria into epidermal cells. The hyphae are abundantly produced in Cystotheca, Sphaerotheca, Microsphaera and Erysiphe; in Uncinula and Typhulochaeta, they are thinly effused; and in Podosphaera (except on the shoots) and Sawadaea, they are produced in intermediate quantity of the above two groups.

In the conidial stage, the hyphae are hyaline in all genera. In the perithecial stage, although they are generally hyaline, in not a few cases they turn gray, light brown, brown or blackish-brown in color. *Erysiphe Pisi, Typhulochaeta japonica* and almost all the species of Uncinula are examples belonging to the former, while *Cystotheca Wrightii, Cystotheca lanestris, Sphaerotheca Mors-Uvae, Sph. Humuli* and *Sph. japonica* belong to the latter.

For the examination of the mycelium, the following method was used.

The mycelial hyphae were stripped off from the surface of the affected leaf with needles under a magnifier, and placed on a slide-glass which had been moistened to a suitable degree. They were left exposed in the air for several minutes in order to make them stick to the surface of the slide. Iron-acetocarmine was poured on them and the slide was warmed over a gas flame for a short time.

Small pieces of the affected leaf were fixed with Flemming's weak solution which had been diluted with three times its amount of water. After 12 hours, the pieces were slightly washed in water and stained with alcoholic solution of safranin. After 24 hours, they were washed again, and the mycelial hyphae were stripped off with needles from the surface of the leaf and were examined under the microscope. The nucleus in each cell was stained dark red in color. By this method, the nuclei in the mycelial cells could be exactly counted. Also, this method was used to determine the mother cell of the conidia.

The nuclei in the vegetative mycelial cells have already been reported by R. A. HARPER in 1896 (13). Each cell includes one or many nuclei, but generally one.

The vegetative mycelium is composed of long cells, especially so in the case of *Erysiphe graminis* and *Sphaerotheca pannosa* which are produced in the late autumn. The hyphae send out branches of a similar width or somewhat slender in diameter, and each branch is delimited from the creeping hypha by a septum. It seems that the hyphae have a tendency to branch especially at the margin of the mycelial patch. The mycelial hyphae of Uncinula, Microsphaera, Sawadaea, and Typhulochaeta are flexuous, delicate and easily broken, while those of Sphaerotheca, Cystotheca, Podosphaera, and Erysiphe are slightly flexuous and strong. The mycelium produced in the late autumn is more strong, smooth and thick-walled, and sometimes shining, especially so in *Erysiphe graminis* and *Sphaerotheca pannosa*, in which cases the mycelial branches are rarely produced. In Cystotheca, special hairy branches are produced from the vegetative hyphae.

From the mycelial hyphae, appressoria of an irregularly lobed shape are produced. They are firmly fastened on the epidermal surface of the host plant.

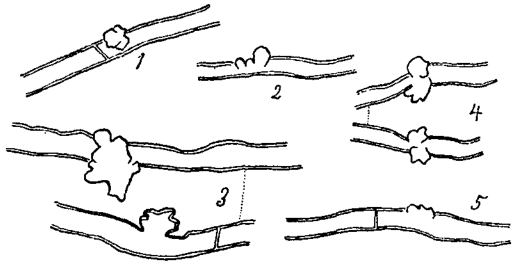


Fig. 1. Appressoria. (×550)

1. *Sphaerotheca fuliginea* (Schlecht.) Pollacci on *Taraxacum ceratophorum* DC.
2. *Podosphaera tridactyla* (Wallr.) de Bary on *Prunus triflora* Roxb.
3. *Erysiphe Polygoni* DC. on *Polygonum aviculare* L.
4. *Microsphaera Alni* (Wallr.) Salm. on *Castanea crenata* Sieb. & Zucc.
5. *Phyllactinia imperialis* Miyabe on *Paulownia tomentosa* Steud.

The hyphae send haustoria into the epidermal cells of the host plant, and rarely, into the underlying mesophyll cells in the case of Uncinula. The haustoria are globose, subglobose or ellipsoidal in shape, sometimes in irregular forms, and about 14.4–16.8 × 7.2–14.4 μ in size (Pl. VI, D, figs. 1–8). In *Erysiphe graminis*, the haustoria produce finger-like branches on one or both sides which are larger than those of other species, about 57.6–70.8 × 4.8–10.8 μ in size. The haustoria at first appear as small globular bodies at the apex of the penetration tube, and they gradually grow, assuming special forms peculiar to each species.

In Phyllactinieae, the mycelial hyphae are of two forms, external and internal. From the external mycelial hyphae, special branches are sent through the stomata into the intercellular spaces of the mesophyll. In Phyllactinia, the external hyphae are more numerous than the internal, and on them we can notice here and there poorly developed appressoria with which they fasten to the surface of the leaf, but from which haustoria have never been found penetrating into the epidermal cells. The internal mycelium is simple or branched, and it sends haustoria, 1 or 2 in number (usually 1) into the parenchyma or palisade cells, with which it comes in contact. When the internal mycelium reaches a certain length, it is checked in growth. The internal mycelium is composed of 1–3 cells (Pl. VI, D, fig. 10).

In 1899, the presence of the internal mycelium was first recognized in the intercellular spaces of the mesophyll of the leaves of Berberis and Corylus by E. PALLA (26). In 1900, E. S. SALMON (32) and G. SMITH (41) reported on the internal mycelia and haustoria. In 1903, G. DELACROIX (7) reported on those of *Ovulariopsis moricola.* In 1930, K. SAWADA (38) published a paper under the title "On the systematic investigation of Phyllactinia in Formosa" (in Japanese), in which he used for the criteria of classification the characters of the internal mycelia and haustoria.

In Uncinulopsis, the internal mycelium is more developed than that of Phyllactinia, while the characters of the external mycelia are similar to those of Uncinula and Sawadaea (Pl. VI, D, fig. 9).

In *Leveilluleae,* the external mycelia are very scanty, and the internal mycelia spread widely in the intercellular spaces of the mesophyll of the leaves and send the haustoria into the surrounding parenchyma cells. The conidiophores are branched from the internal mycelia and are sent out through the stomata (Pl. VI, D, fig. 11).

Conidia

The conidia of Erysiphaceae are produced in a chain on the conidiophore. There are two types in the formation. In one of them, the matured spore is solitary remaining at the apical end of the conidiophore and the second spore grows after the first matured spore has fallen down. In another type, the spores in a chain mature gradually downward from the apical one. Microsphaera, Uncinula, Uncinulopsis, Leveillula and Erysiphe Polygoni-section belong to the former type, while the others are of the latter type. In the former type, the spores rarely form a chain under certain conditions of the environment. In *Uncinula Sengokui* and *U. Actinidiae,* the conidia are sometimes, but not often, catenated in a chain with two or three matured spores when they are luxuriantly formed in nature.

1. Form

Cystotheca. The matured conidia are borne in a chain, the free end of the terminal spore is obtusely pointed, and the other spores are barrel-shaped, including vacuoles, granules and well-developed fibrosin bodies. The septum of the conidiophore is about 17 μ above the branching point of the mycelium.

Sphaerotheca. The matured conidia are produced in a chain 4–9 in number; they are subglobose or ellipsoidal in shape, including well-developed fibrosin bodies.

Podosphaera. The matured conidia are produced in a chain 4–5 in number; they are subglobose or ellipsoidal in shape, including well-developed fibrosin bodies. They are more or less smaller than those of Sphaerotheca.

Erysiphe. There are three types of conidia in this genus. The first type belongs to the Polygoni-section in which the matured spore is produced singly at the apex. It is elongate-ellipsoidal or cylindrical in shape, including vacuoles and granules, but lacking well-developed fibrosin bodies. The conidiophore is separated directly from the mycelium by a septum. The second type is represented by the species belonging to the Cichoracearum-section, in which the matured spores are produced in a chain, and they are ellipsoidal or oblong in shape, including the vacuoles and granules, but lacking well-developed fibrosin bodies. The conidiophore is sometimes branched laterally from the mycelium. To the third type belongs the Graminis-section, in which the matured spores are produced in a chain; they are elongate-ellipsoidal in shape. The conidiophore has a bulbous swelling at the base, and the septum lies close to the creeping mycelium or slightly above. The contents of the conidia are similar to those of the first and second types.

Uncinula. The conidia are found always scantily. They are ellipsoidal or elongate-ellipsoidal in shape. The conidiophore branches from the creeping mycelium. The conidia contain vacuoles and granules, lacking well-developed fibrosin bodies.

Typhulochaeta. The conidia have not yet been found.

Sawadaea. This genus has conidia of micro- and macro-forms. The matured conidia of both types are produced in a chain. The micro-conidia are globose or subglobose in shape, and they are very small, including well-developed fibrosin bodies. The macro-conidia are ellipsoidal in shape, including well-developed fibrosin bodies.

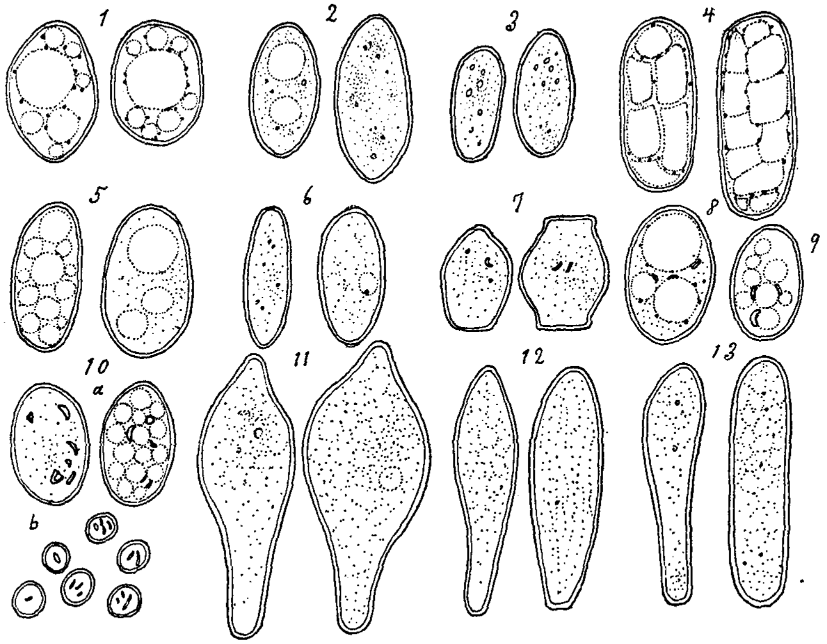


Fig. 2. Conidia. (×550)

1. *Microsphaera alphitoides* GRIFF. & MAUBL. on *Quercus dentata* THUNB.
2. *Microsphaera Grossulariae* (WALLR.) LÉV. on *Sambucus Buergeriana* BLUME var. *Miquelii* NAKAI
3. *Uncinula Salicis* (DC.) WINT. on *Salix Hultenii* FLOD. var. *angustifolia* KIMURA
4. *Erysiphe Polygoni* DC. on *Polygonum aviculare* L.
5. *Erysiphe Cichoracearum* DC. on *Artemisia vulgaris* L. var. *kamtschatica* BESS.
6. *Erysiphe graminis* DC. on *Triticum sativum* LAM. var. *vulgare* HACK.
7. *Cystotheca lanestris* (HARKN.) MIYABE on *Quercus major* NAKAI
8. *Sphaerotheca fuliginea* (SCHLECHT.) POLLACCI on *Lactuca Raddeana* MAXIM.
9. *Podosphaera tridactyla* (WALLR.) DE BARY on *Prunus triflora* ROXB.
10. *Sawadaea Tulasnei* (FUCK.) HOMMA on *Acer pictum* THUNB. var. *eupictum* PAX. a. Macro-conidia. b. Micro-conidia.
11. *Phyllactinia Fraxini* (DC.) HOMMA on *Alnus japonica* SIEB. & ZUCC. var. *arguta* CALL.
12. *Uncinulopsis Shiraiana* (P. HENN.) HARA on *Celtis sinensis* PERS.
13. *Leveillula taurica* (LÉV.) ARNAUD on *Capsicum annuum* L.

Microsphaera. The conidia belonging to the Alni-section are subglobose or ellipsoidal in shape. In the Diffusa-section, the conidia are elongate-ellipsoidal, oblong or cylindrical, including vacuoles and granules, but lacking well-developed fibrosin bodies. The conidiophore has the septum at the point of branching from the creeping mycelium or sometimes slightly upward.

Phyllactinia. The matured conidia are produced singly at the apex and they are the largest among the conidia in Erysiphaceae. Also, their form differs entirely from that of the other genera. They are clavate or broad-clavate in shape and those in some species have a papillate apex, including granules, vacuoles and rarely well-developed fibrosin bodies.

Uncinulopsis. The matured conidia are produced singly at the apical end. They are elongate-ellipsoidal or clavate in shape, and smaller in size than those in Phyllactinia. The conidiophore presents a true spiral at the base.

Leveillula. The matured conidia are produced singly at the apex, and they are clavate or cylindrical in shape. The conidiophore branches from the internal mycelium at the opening of a stoma.

Although the genera in Erysiphaceae could be distinguished from one another by the conidial forms, the species belonging to the Polygoni-section of Erysiphe, the Diffusa-section of Microsphaera and one part of Uncinula have conidia similar to one another, and their classification is very difficult.

2. Formation of conidia

Erysipheae. In 1912, E. FOËX (8) reported the following four types in the formation of conidia.

1st. type—*Erysiphe graminis.* The basal cell is the conidiophore, which produces at its apex a spore-mother cell which divides into two conidia, and another new spore-mother cell is again formed on the apex of each conidiophore, repeating the process.

2nd. type—*Erysiphe Polygoni, Uncinula Salicis, Microsphaera Mougeotii, Oidium Evonymi-japonici,* and *Oidium alphitoides.* The spore-mother cell divides into a conidium and a new spore-mother cell, repeating the process. A fully matured conidium is formed at the end of the chain, followed by several elongated immatured spores, called pedicellate cells by Foëx.

3rd. type—*Phyllactinia corylea.* This type is of the same form as the 2nd. type, but the pedicellate cells are composed of slender cells and frequently of many cells.

4th. type—*Oidiopsis taurica.* The conidiophores arising from the internal mycelium produce pedicellate cells composed of many cells. A single conidium is formed on each conidiophore.

In 1913, the same author (10) described the development of the conidia of *Sphaerotheca Humuli* var. *Humuli* parasitic on *Erodium malacoides* and also of *Sphaerotheca Humuli* var. *fuliginea* on *Calendula arvensis.* The basal cell (conidiophore) is unceasingly divided, forming spore-mother cells. A spore-mother cell divides into two cells, each cell developing into a normal conidium. In *Sphaerotheca pannosa* on *Rosa, Erysiphe Cichoracearum* on *Senecio vulgaris,* and *Podosphaera Oxyacanthae* on apricot, the formation of the conidia belongs to the first type. In 1925, the same author (11) (p. 418) reported again on the formation of the conidia of *Sphaerotheca pannosa* parasitic on *Rosa, Podosphaera Oxyacanthae* var. *tridactyla* on *Armeniaca vulgaris, P. leucotricha* on *Malus pumila* var. *domestica,* and *Microsphaera Mougeotii* on *Lycium barbarum.* In *Sphaerotheca pannosa, Podosphaera Oxyacanthae* var. *tridactyla,* and *P. leucotricha,* the conidiophore divides at its apex into two cells, the short upper cell dividing again into two cells. The upper one enlarges, becoming a conidium. The under one is divided continually and the conidia are thus formed in a chain. In Podosphaera, eight cells are formed in a chain on the conidiophore, and the uppermost four cells become the matured conidia. In Microsphaera, the conidiophores and conidia are produced in the same manner as those in Sphaerotheca. In this case, only the terminal cell becomes a matured conidium.

In 1905, E. S. SALMON (36) reported that when *Erysiphe Polygoni* and *Oidium Euonymi-japonici* forming abundant tufts of conidiophores are placed in a damp and still atmosphere, the conidia are produced in a chain, although normally only a single matured conidium is produced on a conidiophore.

For the study of the formation of conidia the following species were used.

Sphaerotheca fuliginea on *Taraxacum ceratophorum* (Pl. IV, A, fig. 1), *Podosphaera tridactyla* on *Prunus triflora* (Pl. IV, A, fig. 2), *Erysiphe Cichoracearum* on *Plantago major* var. *asiatica* (Pl. IV, A, fig. 3), *E. graminis* on *Triticum vulgare,* (Pl. IV, A, fig. 4), *Sawadaea Tulasnei* on *Acer pictum, Erysiphe Polygoni* on *Polygonum aviculare* (Pl. IV, A, fig. 5), *Microsphaera Picrasmae* on *Picrasma quassioides,* *M. alphitoides* on *Quercus crispula* (Pl. IV, A, fig. 7), and *Uncinula Actinidiae* on *Actinidia arguta* (Pl. IV, A, fig. 6). The experiments were made using the same method as that employed in the case of the mycelial staining. Nuclear staining is found necessary to discriminate the spore-mother cells from the conidial cells. In all samples, at first, the incipient conidiophore is formed as a branch from the creeping mycelium on the surface of the host plant, and it is easily distinguished from the ordinary mycelial branches by its larger size and position. The young conidiophore assumes a cylindrical form, and when it reaches about 50 μ in length, it is delimited from the mycelium by a septum. The young conidiophore is divided by a septum at its upper portion, forming a new spore-mother cell. The nucleus of the young conidiophore divides into two, one of which is included in the new spore-mother cell, and the other remains in the conidiophore. The spore-mother cell divides again into two cells, the apical one becoming a normal conidium when matured, and the lower spore-mother cell dividing again into two cells. Similar divisions are repeated forming a chain of conidiospores. The spore-mother cell is always left remaining between the immatured conidium and conidiophore. In *Sphaerotheca fuliginea, Erysiphe Cichoracearum, Podosphaera tridactyla, Erysiphe graminis,* and *Uncinula Actinidiae* (when the conidia were produced most abundantly), 5 to 12 cells are formed in a chain on the conidiophore, and the uppermost 2 to 5 cells become matured conidia. In *Erysiphe graminis* and *Podosphaera tridactyla,* when the conidia are luxuriantly produced under favorable conditions, the conidiophore sometimes divides again into two cells, the upper one of them forming a new spore-mother cell. In *Microsphaera alphitoides, Sawadaea Tulasnei, Erysiphe Polygoni,* and *Uncinula Actinidiae* (when the conidia are produced in a normal condition), 4 cells are formed in a chain on the conidiophore, and only the terminal cell becomes a matured conidium while the second cell develops into a matured conidium after the first matured spore has fallen down.

Phyllactinieae. In 1902, F. W. NEGER (24) reported that if a leaf of Corylus producing vigorous tufts of conidiophores be placed in a damp and still atmosphere, the conidia formed remain connected, making ultimately a chain of 2–4 conidia. In 1925, E. FOËX (11) noted the conidia formation of *Phyllactinia corylea* on *Paliurus australis.* According to him, the young conidiophore develops as a long cylindrical cell, branching erect from the mycelium. The conidia are produced in the same manner as those in Microsphaera, 2–4 cells being formed in a chain. The terminal one only becomes a matured conidium of ovoid-conical shape.

The conidia on *Paulownia tomentosa* (Pl. IV, A, fig. 8) were used for the study of the conidia formation in Phyllactinia. The mode of conidia formation resembles that in Uncinula and Microsphaera. But, the young conidiophore is not for a long time separated from the creeping mycelium by a septum. The septum is produced at about 70–100 μ above the branching point. The conidiophores are very long and slender. The conidia are produced in a chain of always 3 in number. Only the terminal conidium becomes matured. In Uncinulopsis, no living samples were available for examination. But, judging from the dry materials, the conidia formation may be similar to that in Phyllactinia.

3. **Fibrosin bodies**

In 1887, the fibrosin bodies contained in conidia and conidiophores of *Podosphaera Oxyacanthae* on *Crataegus Oxyacantha* were first reported by W. ZOPF (48). They were called "Fibrosinkörper". In 1912 and 1925, FOËX (9, 11) noted their chemical natures and formation. The writer (16) also reported on them in a paper entitled "On the fibrosin body of Erysiphaceae" (in Japanese) in 1928.

The fibrosin bodies are the small shining bodies contained in the cells of every organ of all species belonging to the family Erysiphaceae. There are two types, one of which assumes the special forms of a disk, cylinder, cone, or truncated cone which are hollow inside except the disk-shaped one. The other type is of a granular form. The former is called the well-developed fibrosin bodies, while the latter the granular fibrosin bodies.

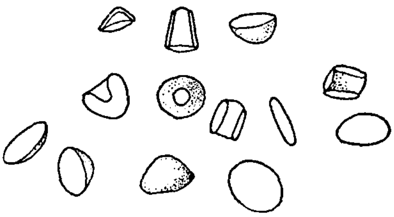


Fig. 3. Well-developed fibrosin bodies which are included in the conidia and conidiophores of *Podosphaera leucotricha* (ELL. & EVERH.) SALM. on *Malus baccata* BORCKN. var. *mandschurica* SCHNEID. (×1350)

The well-developed fibrosin bodies develop prominently in the conidia and conidiophores of Cystotheca, Podosphaera, Sphaerotheca, Sawadaea, and some species of Uncinula. These bodies are consumed when the conidia have germinated. They are considered to be a reserve material.

As the results of tests by staining, and by enzymic and chemical reactions, the fibrosin bodies seem to be a β-VI-carbohydrate containing N (16).

4. Germination of conidia

When the conidia are placed under a favorable condition, they produce germ-tubes after 17 hours to 4 days. The germ-tube is mostly single to a conidium, but frequently 2 or 3 tubes are formed. After 3 days from the germination, the appressoria appear at the apices of the germ-tubes. The incubation period for the germination differs with the degree of the ripening of the conidia, and with the environmental factors.

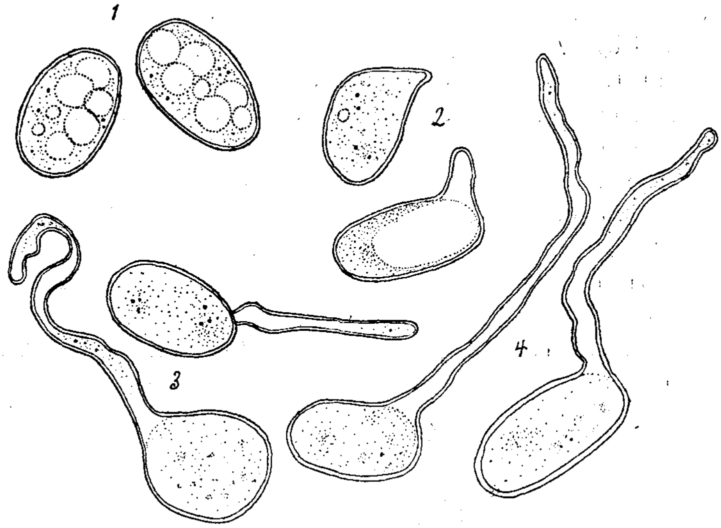


Fig. 4. Germination of conidia of *Erysiphe Cichoracearum* DC. on *Plantago major* L. var. *asiatica* DECNE. (×550)

1. Conidia when germination experiment started.
2. Conidia after 17 hours from the start of germination experiment.
3. Conidia after 41 hours from the start of germination experiment.
4. Conidia after 65 hours from the start of germination experiment.

After 6 hours from the beginning of the germination experiment, the vacuoles begin to disappear and the fibrosin bodies become gradually smaller in size and indistinct. At the time when the germ-tubes are pushed out, the fibrosin bodies generally disappear.

TABLE 1.

Changes observed in the cell contents of the conidia of *Podosphaera tridactyla*, *Erysiphe Polygoni* and *Sphaerotheca Humuli* during their germination.

Aug. 27	a.m. 5	9	11	p.m. 1	3	5	7	9
Podosphaera tridactyla on *Prunus triflora*	Germination experiment was started	No change	—	Fibrosin bodies became indistinct	—	—	Fibrosin bodies entirely disappeared	—
Erysiphe Polygoni on *Polygonum aviculare*	,,	,,	—	Vacuoles became indistinct	—	Granules decreased in number	—	Germ-tube was produced
Sphaerotheca Humuli on *Agrimonia pilosa*	,,	,,	—	Fibrosin bodies became smaller in size	—	Vacuoles became indistinct	Fibrosin bodies disappeared	Small granules only remained

In the above experiments, the conidia of Sphaerotheca and Podosphaera did not germinate within 16 hours.

In the conidia of Phyllactinia, one to three germ-tubes are produced at their upper shoulders generally after about 24 hours from the time of sowing.

Perithecia

1. Forms and Appendages

Erysipheae. Perithecia in their earliest stage appear as exceedingly small hyaline shining bodies under a magnifier. As they develop gradually, they begin to turn yellow. In this stage, the perithecia are always spherical in form in all species. When the perithecia become matured, they turn brown, deep brown and brownish black in color. In Cystotheca, Sphaerotheca, and some species of Erysiphe, Microsphaera, and Uncinula, the matured perithecia are spherical. In Sawadaea, Typhulochaeta, and a majority of the species belonging to Erysiphe, Microsphaera, and Uncinula, they are depressed-globose or lenticular in shape.

In Cystotheca, the appendages are very scanty or generally wanting; in Podosphaera, those of the Tridactyla section arise erect at the upper part of the perithecium, while in the Oxyacanthae section, they are produced from about the equatorial region; in Sphaerotheca, Uncinula, Microsphaera, and Erysiphe, the appendages are generally produced from the equatorial portion or from the part nearer to the base; and in Sawadaea and Typhulochaeta, they spring from the upper part of the perithecium forming broad coronate rings of about 3 rows and also those perithecia turn over upside down when matured.

The appendages of the perithecia of Sphaerotheca and Erysiphe are hyaline, pale brown or deep brown in color, aseptate or septate, simple or irregularly branched and sometimes interwoven in the mycelial hyphae. Those of Uncinula and Sawadaea are hyaline, or brown in some species of Uncinula, simple, dichotomously or trichotomously branched, aseptate or septate, and uncinate or circinate at their apices. Those of Microsphaera and Podosphaera are hyaline or brown in color, 2–6 times dichotomously branched at the apical portion, aseptate or 1–3 septate. Those of Typhulochaeta are clavate in shape, hyaline and aseptate.

Phyllactinieae. The young perithecia coincide in shape with those in Erysipheae. The matured perithecia are, however, lenticular or concave in shape, and their diameter is always larger than that in Erysipheae. The perithecia of Uncinulopsis can be distinguished from those of Uncinula only by their larger size and the appendages are the same in character.

The appendages of Phyllactinia are always simple, excepting a case in which abnormal branches are produced. They are needle shaped, having a bulbous base. They are produced from the special large cells of the outer perithecial wall, and these cells are arranged in the equatorial zone of the perithecium. The bulbous part of the appendage is first produced and then the needle part grows straight out. When the perithecia are matured, they are lifted up on the surface of the leaves by the reflexed appendages, and then they turn over upside down. The penicillate cells are produced at the apical part of the perithecium at the same time with the formation of the appendages. In the formation of the penicillate cells, some of the outer wall cells at the apical part of the perithecium enlarge into oblong-shaped cells, from the apical ends of which numerous branches are produced in a rosette form. When the perithecia are turned over, by the branches of the penicillate cells which have made a gelatinous modification, they adhere to the surface of the leaves.

2. Structure

The wall of the matured perithecium is divided into two layers, the inner and the outer. For the study of the perithecial structure, the usual paraffin method was used. The sections were stained with safranin and gentian-violet. The outer wall was stained reddish-brown in color and the inner wall a violet color. The outer wall is composed of large cells whose wall is thickened and lignified. The nucleus and cytoplasm could not be found in them. The inner wall is composed of small hyaline pseudo-parenchymatous cells including 1 or 2 nuclei.

Erysipheae. The perithecia of *Cystotheca lanestris* on *Quercus serrata* (Pl. IV, B, fig. 2), *Cyst. Wrightii* on *Quercus glauca* (Pl. IV, B, fig. 1), *Podosphaera tridactyla* on *Prunus triflora* (Pl. IV, B, fig. 4), and *Sphaerotheca fuliginea* on *Taraxacum ceratophorum* (Pl. IV, B, fig. 3) were used for the study of the perithecial structure of the single-ascus group. In Cystotheca, the outer perithecial wall is composed of the collapsed cells of 4–5 layers, while the inner wall is always of 2 layers. The innermost layer of the inner wall is composed of cells of larger size surrounding an ascus, while the outer layer becomes degenerate, when the perithecia are matured. When pressure is applied to the perithecium, the innermost layer enclosing an ascus easily separates from the ruptured outer wall. Cystotheca is distinguished from Sphaerotheca by the difference in this structure of the perithecial wall. Judging from the perithecial structure, Cystotheca belongs evidently to Erysiphaceae, having a close affinity to Sphaerotheca. In *Podosphaera tridactyla* and

Sphaerotheca fuliginea, the outer wall is composed of 2 or 3 layers of thick-walled cells while the inner wall is of about 2 layers of ordinary structure.

The perithecia of *Erysiphe Cichoracearum* on *Plantago major* var. *asiatica* (Pl. IV, B, fig. 7), *Uncinula Actinidiae* on *Actinidia arguta* (Pl. IV, B, fig. 8), *Sawadaea Tulasnei* on *Acer pictum* (Pl. IV, B, fig. 10), *Typhulochaeta japonica* on *Quercus serrata* (Pl. IV, B, fig. 5) and *Microsphaera Alni* on *Picrasma quassioides* (Pl. IV, B, fig. 9) were used for the study of the perithecial structure of the many-asci group. In this group, the boundary line of the inner and outer walls is indistinct, and the inner-wall cells are gradually continuous to the pseudo-parenchyma cells surrounding the asci. In Erysiphe, the outer and inner walls are both composed of 2 or 3 layers. In Uncinula, the outer wall is composed of 3 layers of large cells, and the inner wall is of 2–3 layers. In Sawadaea, the outer wall is composed of 3–5 layers, while the inner wall is of 2 or 3 layers. On the outer surface of the outer wall, the hyaline cells are arranged in a disconnected layer, and the appendages are grown from some of these cells. In Typhulochaeta, the outer wall is composed of more or less depressed cells. The inner wall is of 2–3 layers. In Microsphaera, the outer wall is composed of 3–4 layers, while the inner wall is of 2–3 layers.

Phyllactinieae. The outer wall is composed of 3–6 layers made up of thick-walled cells. The inner wall is of 3–7 layers of pseudoparenchymatous cells, which are gradually continuous to the pseudoparenchyma cells surrounding the asci. These cells are almost always binucleate. In the under half of the outer perithecial wall in Phyllactinia, 2–3 layers on the outside are composed of especially large cells of irregular forms and arrangement (Pl. IV, B, figs. 6, 11).

3. Formation of perithecia

The perithecia formation of Erysiphaceae has been studied by many authors. In 1863, the fundamental work on the development and structure of the ascocarp of *Sphaerotheca Castagnei* (*Sph. Humuli*) was done by A. DE BARY (4). The oogonium and antheridium were found to be formed at the crossing or touching point of two special hyphae. In 1870, the same author (5) reported on the perithecia formation of *Erysiphe communis* on *Trifolium medium*, *Podosphaera Castagnei* on *Melampyrum silvaticum*, *Impatiens Noli-tangere* and *Taraxacum*, and *Erysiphe Umbelliferarum* on *Angelica silvestris*. R. A. HARPER (12, 14) published very important papers as the results of his extensive studies on the perithecia formation of *Sphaerotheca Castagnei*, *Phyllactinia corylea*, *Erysiphe communis*, and *E. Cichoracearum* from 1895 to 1905. Especially, the investigation of *Phyllactinia corylea* is the most valuable cytological contribution. In 1906, V. H. BLACKMAN and H. C. L. FRASER (2) reported on the ascocarp formation of *Sphaerotheca Humuli* parasitic on *Humulus*. In 1906, P. CLAUSSEN (3) published a summary report on the development history of Ascomycetes. In 1907, cytological studies of the perithecia formation were made in *Microsphaera Alni* by M. C. SAND (37), especially the nuclear divisions in the ascus were observed. In 1907, P. A. DANGEARD (6) noted on the perithecia formation of *Erysiphe Polygoni* parasitic on *Pisum sativum* and *Ranunculus acris*, *E. Cichoracearum* on *Sonchus oleraceus*, *Phyllactinia corylea* on *Corylus Avellana*, *Uncinula Salicis* on *Populus*, and *Sphaerotheca Humuli* on *Humulus*. In 1911, Ö. WINGE (47) reported on that of *Sphaerotheca Castagnei* parasitic on *Melampyrum*. In 1914, N. BEZSSONOFF (1) reported on the perithecia formation of *Sphaerotheca Mors-Uvae*, *Sph. Humuli*, *Microsphaera Astragali*, *Podosphaera leucotricha*, *Erysiphe Polygoni*, and *Uncinula Salicis*. In 1931, observations were made on the process of the perithecia formation in *Erysiphe aggregata* parasitic on *Alnus incana* by E. A. WENTZEL (46). In 1933, the writer (18) reported that the ascogonial and antheridial hyphae of *Sphaerotheca fuliginea* parasitic on *Taraxacum ceratophorum* are formed on a single mycelium derived from the monosporic infection.

Method. (1). The experiments were made using the same method as that employed in the case of mycelia staining with iron aceto-carmine. By this method, the relation between the antheridial and ascogonial hyphae and between the young antheridium and ascogonium became clearly differentiated.

(2). Small pieces of the affected leaf on which perithecia of different stages had been produced were put in water, the air was removed from the materials by means of a hydraulic suction pump and they were transferred to the fixing fluid. For the fixing fluid, FLEMMING's weak solution or the same diluted with three times its amount of water, CARNOY's solution, BOUIN's solution or ALLEN's modification of BOUIN's solution, and formalin alcohol were used. In the case of young stage, the use of dilute FLEMMING's weak solution has obtained a good result. The sections were cut 5–7 μ in thickness, and Heidenhain's iron-alum haematoxylin, safranin and gentian-violet, or crystal-violet were used for staining.

Erysipheae. *Cystotheca lanestris* on *Quercus serrata, Sphaerotheca fuliginea* on *Taraxacum ceratophorum,* and *Podosphaera tridactyla* on *Prunus triflora* were used for the study of the perithecia formation of the single-ascus group. In *Sphaerotheca fuliginea,* for the investigation on the origin of the ascogonial and antheridial hyphae, a single spore inoculation was made with the method and arrangement as already reported in the papers, "Homothallism in *Sphaerotheca fuliginea* (SCHLECHT.) POLLACCI" and "A life-cycle of *Sphaerotheca fuliginea* (SCHLECHT.) POLLAC. parasitic on *Taraxacum ceratophorum* DC." by the writer in 1933 and 1934 (17, 18).

The antheridium and ascogonium on the mycelial hyphae which were produced by the single spore inoculation entirely coincided with those of the natural formation. The perithecia are formed from the center of the mycelial patch. The ascogonium and antheridium are formed at the place where the ascogonial and antheridial hyphae cross each other and touch (Pl. V, figs. 1, 2, 4 and Pl. VI, A, figs. 3, 8). The antheridial hypha is more slender than the ascogonial (Pl. V, fig. 5). Both hyphae always run side by side or coil about each other or cross each other. The ascogonium and antheridium seem to arise simultaneously, and the former is larger than the latter from the start, also the ascogonium grows more rapidly (Pl. V, figs. 1, 3 and Pl. VI, A, fig. 1). Sometimes both organs swell up at the base, adhere closely to each other and become more or less spirally twisted (Pl. V, fig. 4). At first, they are single cell and delimited from the sexual hyphae by a septum (Pl. VI, A, fig. 1). Later, they divide into two cells (Pl. VI, A, fig. 2). The apical cell is the ascogonium or antheridium, and the under one is the stalk cell. The ascogonium soon becomes larger than its stalk cell, while the antheridium remains smaller. The ascogonium grows straight up forming a subglobose body, while the antheridium clinging to the side of the ascogonium adheres at its upper part (Pl. VI, A, fig. 5). The antheridial nucleus divides into two nuclei, one of which goes into the ascogonium. Two, or rarely three, nuclei are found enclosed in the ascogonium, and one of them, which is apparently the male nucleus, is always more or less smaller than the other (Pl. VI, A, figs. 6, 7).

The primary perithecial wall cells are formed from the twisting hyphal cells springing upward from the stalk cell of the ascogonium (Pl. VI, A, figs. 4, 5). The enclosing wall thus formed is closed at the upper part of the ascogonium. At this time, the antheridium is seen adhering at the outer side of the primary perithecial wall. The secondary perithecial wall cells develop between the ascogonium and the first wall (Pl. VI, A, figs. 7, 9). In this stage, the antheridium withers and gradually disappears. Thus, when about 4 to 5 layers of the wall are developed, the appendages begin to arise from the region nearer to the base of the perithecium, and the perithecial hyphae are sent out from its basal portion (Pl. VI, A, fig. 17). The outer two layers are composed of larger cells, whose walls gradually turn brown in color (Pl. VI, A, figs. 14, 16). These layers constitute the so-called outer wall. The inner 2 or 3 layers make up the inner wall, whose cells are always hyaline and binucleate (Pl. VI, A, fig. 14).

At the time when two layers of the outer perithecial wall are developed, the male and female nuclei in the ascogonium conjugate to form a more or less large nucleus (Pl. VI, A, fig. 10). Then, the ascogonium divides into two cells (Pl. VI, A, fig. 11). The upper cell divides again into two cells (Pl. VI, A, fig. 12). The same process is repeated, thus forming 4 to 5 cells (Pl. VI, A, fig. 13). The penultimate cell is always more or less larger than the rest, and its reaction to the staining solution differs from the others. The second cell only is clearly stained a red color by safranin, while the rest of the cells take violet color from gentian-violet. This penultimate cell develops into an ascus. In the young ascus, a single large nucleus is found (Pl. VI, A, fig. 14). This nucleus divides three times, and eight free ascospores are formed. Eight chromosomes could be counted in the first nuclear division, but it was difficult to detect them in the second and third divisions, as these divisions generally take place enclosed in the intact nuclear wall.

In *Podosphaera tridactyla* (Pl. VI, B, fig. 2) and *Cystotheca lanestris* (Pl. VI, B, fig. 1), single spore inoculations were always unsuccessful. The perithecia formation was similar to that of Sphaerotheca.

Erysiphe Cichoracearum on *Plantago major.* var. *asiatica* (Pl. VI, B, fig. 3), *Uncinula Actinidiae* on *Actinidia arguta* (Pl. VI, B, fig. 4), *Sawadaea Tulasnei* on *Acer pictum* (Pl. VI, B, fig. 5), *Typhulochaeta japonica* on *Quercus serrata* (Pl. VI, B, fig. 6), and *Microsphaera Alni* on *Picrasma quassioides* (Pl. VI, B, fig. 7) were used for the study of the perithecia formation of the many-asci group. In *Erysiphe Cichoracearum,* single spore inoculation was made with a conidium using the same method as that employed in the case of Sphaerotheca. Between July 14, 1931 and Nov. 8, 1932, 62 pots of *Plantago major* were inoculated each with a single spore. Nine pots out of them were found infected after 7 to 19 days. But the perithecia did not appear in every case. Abundant perithecia were produced on the stock plant which had been left to natural infection. In Sept. and Nov. 1933, 8 pots which were covered with large glass tubes were inoculated with numerous conidia. The perithecia did not appear on the mycelial patches even after 3 months. The young perithecia were produced on the leaves of the stock plant on Oct. 25, 1933. The species may be heterothallic in nature. This point will be discussed in Chapter II.

The perithecia formation in *Erysiphe Cichoracearum* (Pl VI, B, fig. 3, a–h) is similar to that of Sphaerotheca. The ascogonium divides into 4 or 5 cells. The ascogenous hyphae may be branched from the second cell, which is found including two nuclei. As shown in Plate VI, B, Fig. 3, h, the young ascus is formed from the ascogenous hyphae. In this way many asci are produced. The nuclear division in each ascus is similar to that in the case of Sphaerotheca. Eight free ascospores are formed. In other species, the perithecia formation was similar to that of Erysiphe, as shown in Plate VI, B.

Phyllactinieae. *Phyllactinia imperialis* on *Paulownia tomentosa,* and *Uncinulopsis Shiraiana* on *Celtis sinensis* were used for the study of the perithecial formation. In Phyllactinia, the ascogonium and antheridium are formed on the ascogonial and antheridial hyphae and they adhere to each other as in the case of Erysiphe. The primary perithecial wall cells also arise from the stalk cell of the ascogonium by the same process as those in the case of Erysiphe. These cells grow up somewhat in a spiral manner enclosing the ascogonium. The formation of perithecial wall and asci coincides with that of Erysiphe. The nucleus in the young ascus divides three times and eight free nuclei are formed. Generally 2 or 3 matured ascospores are developed, the rest being degenerated. In Uncinulopsis, the perithecial formation was similar to that of Phyllactinia.

HARPER (14) reported that the oogonia and antheridia arise as lateral branches from separate hyphae, though it seems fairly clear, from the circular shape of the infected spots in most cases in Phyllactinia, that both these hyphae belong to a single mycelium, which in all probability is the product of the growth of a single spore. BLACKMAN and FRASER (2) noted that the oogonium and antheridium are borne on the hyphae of separate origin in *Sphaerotheca Humuli* on Humulus. DANGEARD (6) noted that the male and female cells of Erysiphe arise from the separate hyphae and these hyphae may come from separate mycelia. As the result of experiments, in *Sphaerotheca fuliginea* on *Taraxacum ceratophorum,* it is seen that the ascogonium and antheridium are formed evidently on the ascogonial and antheridial hyphae originating from a single spore. In *Erysiphe Cichoracearum* on *Plantago major* var. *asiatica,* both sexual organs seem to be produced on the hyphae originating from the infection of the spores of two different strains.

In Erysiphaceae, there are two types of sexual process, the heterothallic and homothallic. The heterothallic species seem to be more common. The homothallic case is proved by the experiments to occur only in *Sphaerotheca fuliginea* on *Taraxacum ceratophorum.*

On the conjugation of the nuclei of the male and female organs, HARPER (14) recognized that fertilization occurs in Phyllactinia, Sphaerotheca and Erysiphe. A portion of the walls between the antheridium and oogonium is dissolved in such a fashion as to form a circular conjugation-pore leading from the antheridium to the oogonium. The protoplasm of the antheridial and oogonial cells is thus brought into direct contact and combines to form a continuous protoplasmic mass. The nucleus of the antheridium migrates through the conjugation-pore into the oogonium and approaches the egg nucleus. BLACKMAN and FRASER (2), and also BEZSSONOFF (1) have the same opinion as that of HARPER. According to DANGEARD (6), fertilization does not take place, the male nucleus degenerating in the antheridium. WINGE (47) supports this opinion. In 1931, WENTZEL (46) reported that no actual fertilization was observed. The writer recognized that the nucleus in the antheridium seems to have migrated into the ascogonium, as two, or rarely three, nuclei were found in the latter.

Asci and Ascospores

In the single-ascus group of Erysipheae, the ascus is subglobose in shape, and is generally larger than that of the many-asci group. The asci of the many-asci group are elongate-ellipsoidal or elongate-ovate in shape, and with or without a stalk. The ascus of Cystotheca is largest, and that of Erysiphe is smallest. The wall of an ascus generally becomes thin at the apex. The spores are ejected from this portion. The ascospores in an ascus are 2–8 in number.

Infection experiment. The perithecia on the affected leaves of *Taraxacum ceratophorum* which had been kept in the green house were collected in early March. Experiments on the germination of the ascospores were made in the laboratory every ten days. On July 5, the ascospores germinated. These ascospores were inoculated on the leaves of *Taraxacum ceratophorum* planted in pots, which had been covered with large glass tubes. On July 16, small white mycelial patches were observed on the inoculated portions. On the check plant, the mycelial hypae did not appear on the leaves. The mycelial patches increased in number by the secondary infection, and numerous conidia were produced. On July 22, young perithecia were produced on the first mycelial patch.

Hibernation

For the study on the hibernation of the perithecia, *Microsphaera alphitoides* on *Quercus crispula, Sawadaea Tulasnei* on *Acer pictum,* and *Sphaerotheca Humuli* on *Agrimonia pilosa* were kept in linen bags which were put in an open box planted in the ground in late autumn. The box was kept out of doors over winter. In early spring, when the materials were examined, numerous perithecia were found remaining on the host leaves, but matured asci could not be seen in any of them. The perithecia in a natural condition may lose their ascospores during winter when the affected leaves fall down on a moist soil.

In 1931, the pots of *Taraxacum ceratophorum* affected by *Sphaerotheca fuliginea* were carried into the green house in late autumn. Perithecia were abundantly produced on the leaves. In early March of the next year, several leaves were collected; one part was carried into the laboratory and the other part was put on the soil in the green house. The ascospores in the former case germinated in the early summer, while in the latter, on which water had been poured every day, the ascospores seem to have been liberated earlier in the season.

The hibernation of *Sphaerotheca Mors-Uvae* parasitic on *Ribes grossularia* has been observed for several years. The perithecia on the leaves fall down with the leaves in winter, but those on the upper part of the shoots remain firmly attached till the next spring. Besides, a certain portion of the mycelia seems to hibernate between the scales of the buds.

The perithecial stage of *Sphaerotheca pannosa* on Rosa has not yet been collected in this country. Observations on its hibernation have been continued with interest for several years. In late autumn, the writer found the special mycelial masses on the shoots. A mycelium from such a mass was smooth, thick-walled and grayish in color, also it was composed of very long cells. In the next spring, although a careful observation was made on the changes of these masses, no new mycelial growth took place from them. New white mycelial patches appeared on the young leaves at the end of the shoot. The mycelial hyphae may probably have hibernated among the scales of the buds.

II. Host and Parasitism

A. Infection

For the studies of the infection process, wheat was generally used for the host and *Erysiphe graminis* f. sp. *Tritici* for its parasite. The following experiments were made in the green house of our University.

Experiment I

On the susceptible varieties of wheat

The seeds of *Triticum vulgare* (Sapporo Spring Wheat No. 9) were sown on moistened cotton in a large Petri-dish (diam. 15 cm.) on Feb. 8, 1927. On Feb. 15, the seedlings were inoculated on their coleoptiles with the conidia of *Erysiphe graminis* f. sp. *Tritici*. The next day, the inoculated portions were stripped off with a razor. The spore was found to have produced short germ-tubes 1–3 in number, and some of the tubes produced a septum at their apical portion (Pl. VI, C, figs. 1, 2). After 3 days, the terminal portion of the germ-tube became enlarged and adhered to the surface of the leaf functioning as an appressorium (Pl. VI, C, fig. 3). On the 4th day, a roundish refractive body had been formed under the appressorium in the epidermal cell of the host plant (Pl. VI, C, fig. 4). This body is the primary stage of the haustorium. A minute hole was seen in the epidermal wall at the under-side of the appressorium. This hole shows the penetrated portion (Pl. VI, C, fig. 5). In a longitudinal hand section, one could see a protuberance inside of the epidermal wall at the place where the appressorium had been formed, and a very slender infection tube passing through its middle portion (Pl. VI, C, fig. 6). A globular body was formed at the terminal end of this tube. This is the primary haustorium. On Feb. 20, the globular incipient haustorium gradually became elongated (Pl. VI, C, fig. 7). On Feb. 23, the haustorium which has 3–5 finger-like branches on one or both sides was produced (Pl. VI, C, figs. 8, 9). The mycelial branches then began to grow from the appressoria and they formed mycelial hyphae creeping on the epidermis of the host plant.

The same experiments were repeated again on Feb. 23, 1932. They came to similar results, although the time of the formation of every part more or less differed.

The rest of the experiments were performed on wheat seedlings in which the inoculation was made on the green leaves. The materials 72 hours after inoculation were imbedded in paraffin by the usual method. The blocks were sectioned longitudinally at a thickness of 7μ. They were stained with the double staining of safranin and gentian-violet. The swollen portion of the epidermal wall was stained red in color, therefore, it could be easily distinguished from the other parts. The infection tube was readily found to be penetrating through its center. Numerous haustoria were often produced in an epidermal cell.

The epidermis of the same material was stripped off with a razor and stained with the same solution. The infected point of the epidermis stained light red in color in a circle of about $14.6\,\mu$ in diameter, and the other parts were violet in color (Pl. VI, C, fig. 10). The center of the circular patch was especially stained in deep red color, and a minute hole was seen at its middle portion.

The part of the epidermis which was in contact with the appressorium was at first stained in a light red color. In this stage, the penetration of the infection tube was not yet seen. The reddish patch then gradually spread out and a deep red portion appeared in its center. This center is the swollen part of the epidermal wall. In this stage, it was found that the penetration of the infection tube began to take place in the epidermal wall. When a haustorium had reached its perfect development, the epidermis of the infected portion was stained violet in color.

The tips of the germ-tubes of the conidia were stained light red, and the red granules were found gathered in those parts.

FEHLING'S solution was poured on the stripped epidermis of the affected leaf, and it was warmed with a gas flame for some minutes. The infection tube was found surrounded with a dense circular mass of small brown granules. Similar granules though few in number were found scattered in other parts. The same experiments were tried on the epidermis of a healthy leaf. The small brown granules were also found scattered in small numbers in the epidermal cells.

One and one-fourth percent HCl or Na (OH) was poured on the stripped epidermis of the diseased leaf and it was warmed as above described. The infection hole became enlarged to twice its diameter, showing that the cellulose portion of the epidermis was changed to soluble substances by enzymic action.

As the results of the above experiments, the mode of penetration of *Erysiphe graminis* f. sp. *Tritici* is considered as follows. The reserve materials in the matured conidia change to soluble substances and they are carried toward the apical portion of the germ-tube. These soluble substances may most likely be of the nature of soluble sugars, as in the case of the germination of seeds, in which the apex of the roots is always rich in soluble sugar and has an acid reaction. From the results of the reaction to FEHLING'S solution, the presence of the reducing sugar is proved in the center of the infected spot of the epidermis, and that the infected patches are always acidic is proved by the staining reaction. From these facts, it is most likely that an enzyme is secreted from the under surface of the appressorium and from the infection tube, acting slowly on the cell wall of the epidermis. At first, the cell wall is changed to reducing sugar by the action of the cytase, and the reducing sugar thus produced immediately becomes changed to soluble sugar which permeates slowly to the substance of the cell wall in immediate contact with the infection tube. In this stage, the reducing sugar reaction is not recognized and the presence of the soluble sugar is shown by the acid reaction. The infection tube penetrates through the center of the cellulose sheath. When the penetrating action attains a certain point, a part of the soluble sugar becomes reversed again to reducing sugar, when the sugar reaction can be recognized. After the haustorium is perfectly formed, the red patch in the cellulose sheath becomes gradually light in color and finally changes to a violet color similar to the rest of the cell wall.

Experiment II

On the immune varieties of wheat

Conidia from the affected leaves of *Triticum vulgare* were inoculated on the leaves of *T. dicoccum* var. *Khapli* on Feb. 12, 1932. After

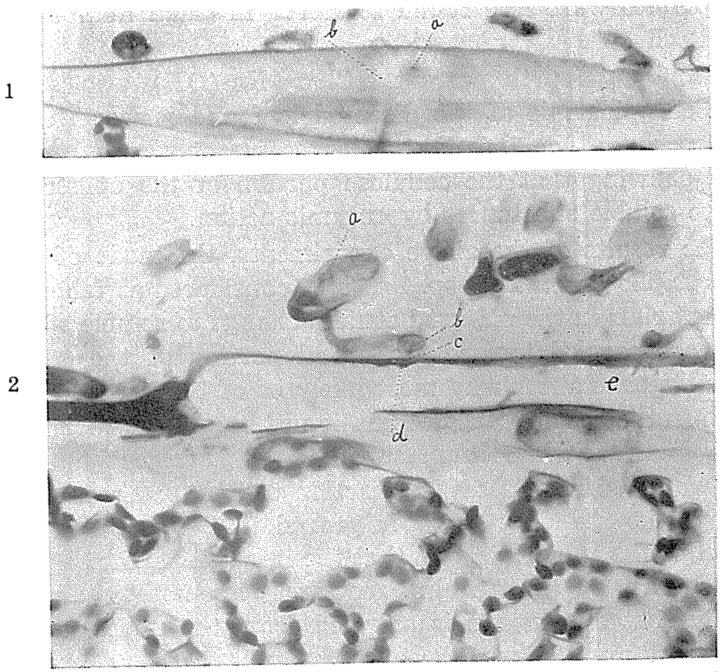


Fig. 5. Showing the changes of epidermis of *Triticum dicoccum, Khapli,* after 48 hours from inoculation. (×550)

1. Stripped epidermis seen from above.
   a. Infection spot colored deep red.
   b. Roundish halo stained light red.

2. Longitudinal section.
   a. Conidium.
   b. Appressorium.
   c. Point of infection.
   d. A portion of epidermis stained deep red.
   e. Epidermal cell.

3 days, several of the germ-tubes had already formed the appressoria and several others produced a septum at the apical portion of the tube. After 5 days, the mycelial branch began to be produced from the appressorium. At this time, a minute hole was seen on the epidermal wall under the appressorium. The pieces of the stripped epidermis were stained with safranin and gentian-violet. The epidermis was colored violet, but the infected portion was stained light red in a circular shape of about 22 μ in diameter, and at its center a space of about 6 μ in diameter was especially stained deep red. These changes in the epidermis are similar to those of the susceptible varieties.

After 48 and 72 hours from the inoculation, the pieces of the inoculated leaves were fixed and imbedded in paraffin. The blocks were sectioned longitudinally at a thickness of 8 μ, and were stained by the same method. In the present case, the infection tube was found penetrating part way into the center of the cellulose sheath, but it could not be seen that any had succeeded in passing through the sheath, nor was there even any formation of an incipient haustorium.

Experiment III

On several other plants

On Feb. 12, 1932, the conidia of *Erysiphe graminis* f. sp. *Tritici* were inoculated on the leaves of barley (Chevalier). After 48 hours, small pieces of the inoculated leaves were treated as in the previous cases. The mode of infection was found to be similar to the case of the immune varieties of wheat.

On Feb. 15, 1932, similar conidia were inoculated on the leaves of *Prunus communis* and *Plantago major* var. *asiatica*. After 48 hours, the epidermis of the inoculated parts was stripped off with a razor. The spores had produced one or two germ-tubes which had frequently formed a septum. The appressorium was found at the tip of the germ-tube. No further development took place.

On March 5, 1932, the inoculation experiments were made on *Plantago major* var. *asiatica* and *Acer pictum* with similar conidia. After 72 hours, small pieces of the inoculated leaves were imbedded in paraffin, after carrying though the ordinary process. The wall of the epidermis was stained violet and the reddish patches at the inoculated places could not be seen, moreover there was no observation of the cellulose sheaths in the epidermal cells just under the appressoria in both materials.

Summary as to the infection process

When the conidia of *Erysiphe graminis* f. sp. *Tritici* were inoculated on the immune and susceptible varieties of wheat, the infection tube produced from the appressorium of the germ-tube penetrated the cell wall of the epidermis in both varieties. In the susceptible varieties, the haustoria were quickly formed in the epidermal cells, while in the immune varieties, they were never produced. Also in barley, a process similar to that in the immune varieties of wheat was observed. According to SALMON (35), when the conidia formed on wheat were sown on barley, after 24 hours, the germ-tube produced an incipient haustorium; after 48 hours, some of the incipient haustoria began to be disorganized, while some one produced a vigorous haustorium; on the third day, the incipient or arrested haustoria became gradually disorganized; on the 5th day, nearly all the incipient haustoria showed complete arrest. In the present experiments, the author could neither observe the formation of the haustoria, nor even incipient haustoria, although the infection tube partly penetrated the wall of the epidermal cells. These different results may be caused by the biological characters of the conidia and the strains of the barley. In other plants which are distantly related to Gramineae, even the changes in the epidermal wall were not recognized.

B. Correlation of the development of the host plants to that of the powdery mildew

In the following experiments, the relation has been studied between the physiological condition of the host plants and the development of the powdery mildew. The physiological condition of the host plant can be divided for convenience into the following three stages in the development of its leaves.

Growing-stage—in this stage such leaves are included as from their youngest stage to the close of their growth. In the first half of this stage, their growth is most rapid, and in the latter half, much slower.

Matured-stage—growth is suspended and the leaves remain as they are. But in the first half, they may regain their growth as a result of favorable conditions of the environmental factors.

Senile-stage—in this stage the leaves become yellow in color from their tips and finally they turn yellowish brown.

1. Experiments with *Sphaerotheca fuliginea* parasitic on *Taraxacum ceratophorum*

Experiments A

These experiments were made to find the most favorable conditions of the host plant for infection by conidia.

I

On March 28, 1930 the seeds of *Taraxacum ceratophorum* were sown on moistened cotton in a Petri-dish (diam. 15 cm.). On April 7, the conidia of *Sphaerotheca fuliginea* were inoculated on each cotyledon with a needle. On April 9, the epidermis of the cotyledons was stripped with a razor, and examined. A small number of haustoria had already been produced. On April 26, the young perithecia appeared on the mycelial patches.

II

The Petri-dish was partitioned into four sections with glass strips and six seeds of *Taraxacum ceratophorum* were sown in each section at three days' intervals (Fig. 6).

The first sowing was made on May 11, as shown in the figure. On May 26, the seedlings in the four sections were inoculated at the same time with the conidia. On May 30, the seedlings in the three sections (1, 2 and 3) were infected, but in section 4, the seedlings did not show any sign of infection until June 1.

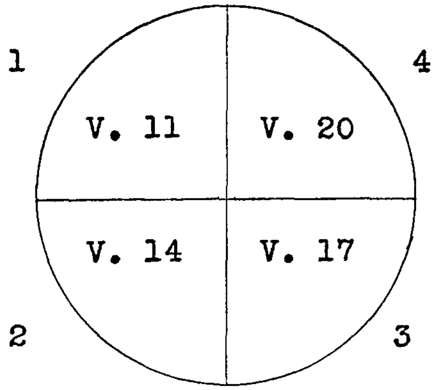


Fig. 6.

In experiments I and II, it was ascertained that the seedlings after about 7 days from germination began to be infected with the conidia.

III

On May 27, the leaves of three matured plants affected by the powdery mildew were all cut off except one central youngest leaf. On the same day, this youngest leaf was inoculated with the conidia, and each plant was covered with a large glass tube, whose upper opening was closed with a cotton plug. After three weeks, it was observed that infection had not taken place on any of these host plants. In field observations, it was also recognized that the youngest leaves in the rosette always remain unaffected until they reach a certain size.

IV

Two pots of the host plant which had been covered with the glass tube were put in a dark-box from April 16 to April 26, and the lid of the box was opened for two minutes every day during the day time. On April 20, the leaves of the host plant turned greenish-yellow in color, and these etiolated leaves were then inoculated with the conidia. But the infected spots did not appear even after 10 days from the inoculation.

A similar experiment was repeated. During five days from June 9, two other pots were put into the dark-box without any exposure to sunlight. On June 13, the etiolated leaves were inoculated with numerous conidia, and the pots were kept in the same box until June 16, when they were carried out on to the bench of a green house. In this case also no infection took place, showing that the etiolated leaves are resistant to the attack of the powdery mildew.

V

On June 1, 2 cm. long pieces were cut off from the tips of the five unaffected leaves of the host plant, and each piece was placed on moistened filter paper in separate Petri-dishes. Conidia were immediately sown on the leaves. On June 5, haustoria were found in the epidermal cells of all the leaves, besides, even conidia were produced in a few cases in small numbers.

To state briefly the results of the above experiments; it was shown that *Taraxacum ceratophorum* was not infected in the earlier half of the growing-stage of its development with the conidia of *Sphaerotheca fuliginea,* nor in the latter half of the senile-stage. The most favorable conditions for infection by the conidia were found in the matured-stage of the development of the host plant.

Experiments B

These experiments were made to find the most favorable conditions of the host plant for the formation of perithecia by *Sphaerotheca fuliginea.*

I

Taraxacum ceratophorum which was used as the host plant, was covered with similar glass tube as in the former experiments. The pot was watered daily, so that the air in the tube was kept saturated with moisture.

a. Experiment by single spore inoculation

TABLE 2

Results of experiments of single spore inoculation of *Sphaerotheca fuliginea* on *Taraxacum ceratophorum* as to the time required for the formation of perithecia.

Experiment No.	Date of inoculation	Date of appearance of spot	Date of appearance of perithecia	Incubation period	No. of days from appearance of spot to perithecia formation
I	1930 X. 19	XI. 6	XII. 16	19	40
II	1930 XII. 26	I. 4	I. 10	10	7
III	1931 I. 14	I. 21		8	
IV	1931 I. 14	I. 25	II. 2	12	13

In No's. II and IV, the growth of the host was checked soon after inoculation; while in No's. I and III, the growth was continued, especially so in No. III. The powdery mildew parasitic on No's. II and IV made a rather poor growth. In those on No's. I and III, the mycelial patches continued their growth, and the conidia were abundantly produced. But in No. III, when the diameter of the mycelial patch attained about 1 cm. its growth was checked, and it gradually changed to grayish-brown in color and finally disappeared. The affected leaf in No. III thus regained its normal healthy condition.

b. The influence of the environmental factors on the formation of perithecia

TABLE 3

Results of inoculation experiments with *Sphaerotheca fuliginea* on *Taraxacum ceratophorum* plants which were placed in abnormal conditions.

Exp. No.	Physiological condition of the host	Date of inoculation	Date of appearance of spot	Experiments	Date of appearance of perithecia	No. of days from appearance of spot to formation of perithecia
I	Good	IV. 6	IV. 13	Control	No formation of perithecia	—
II	Poor	IV. 6	IV. 16	Host plant was put in dark-box from IV. 16	IV. 30	14
III	Good	IV. 6	IV. 12	Host plant was put in dark-box from IV. 13	IV. 17	5
IV	Moderate	IV. 6	IV. 13	On IV. 16, midrib was wounded with needle	IV. 19	6
V	Good	IV. 26	V. 3	On V. 7, host plant was carried into glass house	V. 10	7
VI	Good	IV. 26	V. 2	On V. 27, host plant was withered	V. 29	27

As shown in the above table, on April 6, the host plants No's. I to IV were inoculated on the leaves with the conidia. After the spots had appeared on each plant, the experiments were begun.

No. I was left as a control under normal conditions. From the start, the host plant was in an excellent condition, and conidia were abundantly produced. After about two weeks, the mycelial patches began to disappear, and the affected leaves regained the normal healthy condition.

In No. II, the host plant was exposed to sun-light for two hours every day, and for the rest of the time it was put in the dark-box. As a result, the host plant was retarded in growth. This experiment was continued for 11 days, but perithecia were not formed during that time. On April 27, the pot was brought out of the box and placed on the bench of the green house. On April 30, when the condition of the host plant was somewhat recuperated small perithecia began to appear.

In No. III, an experiment similar to No. II was repeated from April 13. The leaves of the host plant continued to grow for about 3 days after being placed in the dark-box. In this case, conidia were abundantly produced. Later, the development of the host plant was retarded. On April 17, perithecia began to appear on the patch of mycelila.

In No. IV, the host plant had been in a moderately good condition. On April 16, the midrib of the affected leaf was wounded with a needle. On April 19, small perithecia were found.

In No's. V and VI, the hosts were inoculated with conidia on April 26. In No. V, the host plant and its powdery mildew were in good condition. On May 7, the plant was transferred to a glass house of about 12°C. from the green house. On May 10, perithecia were produced.

In No. VI, host plant and its powdery mildew were in similar condition as in No. V. Perithecia were not formed even after three weeks from the time of inoculation. On May 27, the glass tube was taken away from 1 p. m. to 2 p. m., when the host plant became withered from the excess of transpiration. . The next morning, it regained the normal conditions. On May 29, the perithecia appeared.

In the above experiments, attempts were made to ascertain the influence of light, temperature and moisture on the formation of perithecia. The interception of the light has been thought to accelerate the formation of perithecia, but this holds true only after the affected host plant has changed from its matured-stage to the first half of its senile-stage. When a host plant in the matured-stage is placed in the dark-box, events take three different courses of development. In the first course, the host plant soon begins to renew its growth returning to the growing-stage, when perithecia formation does not take place; in the second one, its physiological condition is decreased to minimum, when perithecia formation also does not take place; and in the third one, the host plant gradually enters senility and only in this case does perithecia formation take place. When the host plant is affected by a wound, unfavorable temperature or drought, the change in its physiological condition thus brought about causes similar results as in the case of the use of the dark-box.

c. Experiment with cut leaves

The tips of ten healthy leaves of the host plant were cut off in 2 cm. lengths, and each piece was placed on moistened filter paper in a Petri-dish. The cut end was covered with moistened cotton.

TABLE 4

Results of inoculation experiments with *Sphaerotheca fuliginea* on cut leaves of *Taraxacum ceratophorum* which were placed under abnormal conditions.

Exp. No.	Date of inoculation	Date of infection	Experiment	Observation on VI. 8
I II	VI. 1	VI. 3 "	Control, left in laboratory near the window	Conidia produced in small quantity
III IV	"	VI. 3 VI. 4	Petri-dish was brought into glass-house (13°C.) on VI. 5	Conidia produced abundantly
V VI	"	VI. 3 VI. 4	Petri-dish was put in dark-box from VI. 5, and exposed to sunlight for several minutes every day	Conidia not produced
VII VIII	"	VI. 4 "	Petri-dish was put in dark-box from VI. 5 to VI. 7, without exposing to sunlight	Mycelial spot disappeared
IX X	"	VI. 4 "	On VI. 5, midrib was wounded with needle ; then left in laboratory as in control	Conidia produced abundantly

All the leaves were changed to yellowish green in color on June 10, especially so in the leaves which were kept in the dark-box, and the perithecia were not produced on every leaf.

Summary of Series I Experiments

When affected plants of *Taraxacum ceratophorum* in the stage of late maturity growing in air of saturated humidity were placed in checked sunlight, or in a room of lower temperature, or were affected by a wound or by wilting, the formation of perithecia took place. But when the affected plants in the growing-stage were placed under similar conditions, perithecia were never produced. When those belonging to the stage of early maturity were placed under similar cnditions, the result was either positive or negative. If the plants begin to renew their growth returning to the growing-stage or if their physiological condition is suddenly caused to become very bad, perithecia formation does not take place. But, if they are gradually changed to the senile-stage, the perithecia formation takes place.

II

The following experiments were made on the bench of a green house; the host plant was not protected with a glass cover.

TABLE 5

Results of inoculation experiments with *Sphaerotheca fuliginea* on *Taraxacum ceratophorum* plants which were placed in dark-box or were wounded.

Exp. No.	Date of inoculation	Date of infection	Physiological condition of the host plant 3 days after infection	Experiment	Date of appearance of perithecia	No. of days from infection to formation of perithecia
I	V. 11	V. 14	Poor	Control	V. 22	9
II	,,	V. 15	,,	On V. 18 midrib of the leaves was wounded with needle	V. 21	7
III	,,	V. 15	,,		V. 19	5
IV	,,	V. 15	,,	Host plant was put in dark-box for 48 hours from V. 19	V. 21	7
V	,,	V. 15	,,		V. 24	10

Each plant of the five pots showed a poor physiological condition. The midrib of certain leaves of No's. II and III was wounded with a needle. No's. IV and V without wounding were kept in the dark-box for 48 hours. In No's. II, III and IV, the perithecia formation occurred sooner than in the case of the control. In No. V, the host plant and its powdery mildew were induced to grow by the interception of sunlight for two days. The formation of perithecia was more or less retarded by this abnormal growth.

TABLE 6

Results of the inoculation experiments with *Sphaerotheca fuliginea* on *Taraxacum ceratophorum* plants which were placed in the dark-box of different temperatures.

Exp. No.	Date of inoculation	Date of infection	Physiological condition of the host plant 3 days after infection	Experiment	Date of formation of perithecia	No. of days from infection to formation of perithecia
VI	V. 27	V. 30	Poor	Control	VI. 8	10
VII	,,	V. 29	Fair	Host plant was put in dark-box at room temperature	VI. 6	9
VIII	,,	V. 29	,,		VI. 3	6
IX	,,	VI. 1	Poor	Host plant was put in dark-box in green house	VI. 7	7
X	,,	V. 29	,,		VI. 8	11

On May 27, conidia were inoculated on the leaves of all the host plants. In this experiment, an attempt was made to show the influence of temperature on the formation of perithecia. The plants in No's. VII and VIII were placed in the dark-box at room temperature, and were exposed daily to sunlight for 3 hours from midday to 3 p. m. The temperature of the dark-box was as follows:

Date	Temperature When the pot was brought out from the dark-box	When the pot was kept in the dark-box
VI. 1	—	14°
,, 2	12°	12
,, 3	12	12
,, 4	14	14
,, 5	11	10
,, 6	12	—

In No. VII, the host plant continued abnormal growth for about 3 days after being placed in the dark-box, then the growth was retarded from about June 4, and on June 6, young perithecia appeared. In No. VIII, when the pot was put in the dark-box, the host plant was retarded in growth. Perithecia were more quickly produced than in the case of No. VII.

In No's. IX and X, the hosts were placed in the dark-box of the green house from June 4, and were exposed to sunlight for 3 hours every day. The temperature of this box was as follows:

Date	Temperature When the pot was brought out from the dark-box	When the pot was kept in the dark-box
VI. 4	—	20°
,, 5	14°	14
,, 6	16	15
,, 7	17	16
,, 8	20	—

The host plants were placed on the bench of the green house from the date of infection to June 4, that they might improve their physiological condition as they were much weakened. After they were placed in the dark-box, young perithecia were produced in 4 or 5 days.

TABLE 7

Results of the experiments on the influence of wilting on the formation of perithecia.

Exp. No.	Date of inocu- lation	Date of infec- tion	Growth of mycelia 3 days after infection	Experiment	Date of for- mation of perithecia	No. of days from infection to formation of perithecia
XI	VI. 13	VI. 18	Poor	Control	VI. 25	8
XII	,,	VI. 17	Good	The pot dried in green house	VI. 22	6
XIII	,,	VI. 16	Good	,,	VI. 22	7
XIV	,,	VI. 18	Poor	The pot dried out of doors	VI. 26	9
XV	,,	VI. 17	Poor	,,	VI. 26	10

The above experiments were carried out to study the influence of wilting on the formation of perithecia. In No's. XII and XIII, the pots were not watered until the leaves had drooped to the surface of the soil. In No's. XIV and XV, similar experiments were carried on out of doors, and the condition of these plants was more vigorous than that of the plants placed in the green house.

When the apical portion of the leaves of the plants under observation became yellowish green in color, the perithecia began to be formed. That is to say, when the host plant began to enter the first stage of senility in its development, the perithecia formation would begin to take place.

From the experiments of series II, the same conclusions are drawn as from series I.

2. Experiments with *Erysiphe Cichoracearum* parasitic on *Plantago major* var. *asiatica*.

In Oct. 1930, ten pots of *Plantago major* var. *asiatica* were transferred to the green house and three of them were inoculated with the conidia of *Erysiphe Cichoracearum* formed on the leaves of a host plant of the same species growing out of doors. In late November, perithecia appeared on those leaves. The conidia formed on these host plants were used in the following experiments.

Experiments A

These experiments were made to find the most favorable condition of the host plant for infection of conidia.

I

On Aug. 6, 1931, the old matured leaves of the plants growing in six pots were cut off leaving only two or three young leaves behind, and conidia were immediately inoculated on these leaves. No plants were infected.

On Aug. 11, a similar experiment was repeated on leaves from two other potted plants. The infection was again unsuccessful.

II

Two plants were put into the dark-box on Feb. 18, 1932; they were exposed to the sunlight for one minute every day. On Feb. 23, when their leaves became etiolated turning greenish yellow in color, they were inoculated with conidia, and were kept continually in the same condition. They were not infected.

On March 12, the etiolated leaves of the plant kept in the dark-box were inoculated with conidia. In this case, they were also not infected. The vital condition of the etiolated leaf may be similar to that of the latter half of the senile-stage.

III

Two pots of *Plantago major* var. *asiatica* were placed on the bench out of doors. On Nov. 10, 1932, the old leaves turning red in color were inoculated with conidia. This inoculation was also unsuccessful in infection.

As the result of the above 3 experiments, *Plantago major* var. *asiatica* may be said to be non-infectable in the earlier half of the growing-stage and in the latter half of the senile-stage.

Experiments B

These experiments were made to find the most favorable condition of the host plant for the development of *Erysiphe Cichoracearum.*

I

a. Experiment by single spore inoculation

In the single spore inoculation, the same method was employed as in the case of *Sphaerotheca fuliginea,* and each plant was covered with a large glass tube. This experiment was carried on in the green house, and seedlings were used as the host plant.

TABLE 8

Results of the inoculation experiments of single spore inoculation with *Erysiphe Cichoracearum* on seedlings of *Plantago major* var. *asiatica.*

Exp. No.	Date of inoculation	Date of infection	Results
I	X. 22, 1932	X. 30, 1932	A month after infection host plant withered, without producing perithecia
II	,,	Not infected	
III	,,	X. 29	About II. 18, 1933 infected leaves withered, without producing perithecia
IV	,,	Not infected	
V	,,	,,	
VI	XI. 6	,,	
VII	,,	,,	
VIII	,,	,,	
IX	,,	,,	
X	,,	XI. 17	3 weeks after infection host plant withered without producing perithecia
XI	XI. 14	XI. 21	Host plant was in vigorous condition, but perithecia were not produced
XII	,,	XII. 3	
XIII	,,	XI. 21	

In the following experiments, the pots from No. I to No. XV were put out of doors, and those from No. XVI to No. XXIV were placed in the green house. Matured plants were used as the host.

TABLE 9

Results of single spore inoculation experiments with *Erysiphe Cichoracearum* on matured plants of *Plantago major* var. *asiatica*.

Exp. No.	Date of inoculation	Date of infection	Results
I	VII. 2, 1932	Not infected	
II	,,	,,	
III	,,	,,	
IV	,,	,,	
V	,,	,,	
VI	VIII. 11	,,	
VII	,,	,,	
VIII	,,	,,	
IX	,,	,,	
X	,,	,,	
XI	IX. 5	,,	
XII	,,	,,	
XIII	,,	,,	
XIV	,,	,,	
XV	,,	,,	
XVI	X. 26	XI. 2, 1932	On II. 15, 1933, the host plant was still in vigorous condition, but perithecia had not been produced
XVII	,,	Not infected	
XVIII	,,	,,	
XIX	,,	XI. 2	On II. 15, host plant was in weakened condition, and perithecia had not been produced
XX	,,	Not infected	
XXI	XI. 8	,,	
XXII	,,	,,	
XXIII	,,	,,	
XXIV	,,	XI. 14	On II. 15, host plant was in vigorous condition, but perithecia had not been produced

Among nine infected plants, No's. XI, XII, XIII of Table 8 and No's. XVI and XXIV of Table 9 were in vigorous vital condition. They had progressed from the growing-stage to the matured-stage, and reached the senile-stage in the green house within about four months after the time of the infection. The perithecia were not produced on any of these infected plants. On the stock plant, the young perithecia had appeared in the open air in Oct. 1932. Perhaps, the form on *Plantago major* may belong to the heterothallic species.

b. Experiments by inoculation with many spores

In this experiment, the host plants were covered with large glass tubes.

In Sept. 25, 1933, leaves of potted mature *Plantago major* were inoculated with many spores. The stock plant was placed side by side with the infected in pots in the green house without cover. Perithecia appeared on the stock plant on Oct. 25. Some of the inoculated plants pots were infected on Oct. 5, but did not produce perithecia until December, for the host plants always remained in the previously attained stage of maturity.

Similar inoculation experiments were repeated on five additional pots:

	Date of inoculation	Date of infection
I	XI. 6	Not infected
II	XI. 16	XI. 22
III	XI. 18	XI. 23
IV	XI. 18	Not infected
V	XI. 18	XI. 22

The leaves of the infected plants continued vigorous growth under the influence of temperature and moisture in the large glass tubes. The mycelial patches began to disappear on Feb. 10, 1934, and finally the mycelial hyphae could not be seen on the leaves, although the yellowish green spots still remained. In the glass tubes the vital condition changed slowly and the plants did not reach the senile-stage before the mycelial patches disappeared.

In the above experiments, the reason why the perithecia were not produced may be that the plants were in unfavorable vital condition for the development of the parasite.

II

The following experiments were carried out in the green house; the host plant was not protected with a glass cover.

TABLE 10

Results of the inoculation experiments with *Erysiphe Cichoracearum* on *Plantago major* var. *asiatica* which was placed in the dark-box at different temperatures.

Exp. No.	Date of inoculation	Date of infection	Experiments
I II	II. 22, 1932 ,,	II. 24, 1932 II. 25	Control. On No. I, perithecia were not produced, while on No. II, they were produced in Oct.
III IV	,, ,,	II. 25 ,,	Host plant was kept in dark-box in green house from IV. 1 to IV. 3. Perithecia were not produced
V VI	,, ,,	*II. 24* ,,	Host plant was kept in dark-box in glass house from IV. 1 to IV. 3. In Oct. perithecia were produced on No. V, while on No. VI, they were not produced

After infection, all host plants were at first carefully taken care of in the green house. The vital condition of the host plants was more or less weakened as they had been kept in the dark-box. But perithecia were not produced on them through the summer. In October, perithecia were found on the matured leaves of No's II and V.

The experiment was repeated.

TABLE 11

Results of the inoculation experiments similar to the foregoing ones.

Exp. No.	Physiological condition of host plant	Experiments
I	Good	Control. Perithecia were not produced
II	,,	Host plant was kept in dark-box in green house. Perithecia were not produced after two months from inoculation
III	Poor	,,
IV	Moderate	Host plant was kept in dark-box in glass house. Perithecia were not produced after two months from inoculation

The control was kept continually on the bench of the green house. On Nov. 28, 1932, No's. II and III were put into the dark-box of the green house and were exposed to sunlight from midday to 2 p. m. every day. In No. IV, a similar experiment was carried out in the glass house instead of the green house. Perithecia were not produced in any cases.

The temperatures in the boxes placed in the green house and also in the glass-house were as follows:—

Date	When the pot was brought out from dark-box of green house	When the pot was put into dark-box of green house	When the pot was brought out from dark-box of glass house	When the pot was put into dark-box of glass house
XI. 28	—	29°	—	10°
,, 29	26°	23	8.5°	9.5
,, 30	25	23	8.5	8
XII. 1	29	31	10	11
,, 2	26	21	9	7
,, 3	28.5	29.5	8.5	8.5
,, 4	31	29	9.5	9
,, 5	29	30.5	8	9.5
,, 6	29	23	9	9
,, 7	26	—	8	—
,, 8	—	30	—	10
,, 9	27	—	9	—

On Dec. 9, after 12 days' inclosure in the dark-box, the leaves of the host plants turned yellowish green in color. In No's. II and III the pots were then brought out from the dark-boxes to the bench of the green house and in No. IV to the glass house to regain their normal condition. The perithecia could not be found on those leaves after two months.

The following facts may be set down as the results of the two series of experiments B. In the leaves of the host plants in experiment I, the senile-stage was very short while the growing-stage was long as they were covered with large glass tubes. Mycelial hyphae and conidia were abundantly produced on the leaves, but perithecia did not appear on any plants. In experiment I, a, by a single spore inoculation, perithecia were not produced on the leaves although the host plant was matured, showing that the fungus is most likely heterothallic in character. In experiment I, b, using inoculation with many spores, when the leaves had reached the most vigorous growing-stage, the mycelial hyphae were checked in growth and began to disappear.

In experiment II, in which the plants were not covered with glass tubes, and they were inoculated with many spores, the perithecia formation did not quickly take place. The perithecia were formed on the leaves which had reached the stage of senility, eight months after the infection.

3. Experiments on *Erysiphe graminis* parasitic on wheat

Experiment A

When the inoculation experiments were made on the several species and strains of wheat with the conidia of *Erysiphe graminis* f. sp. *Tritici,* the infection did not take place in the early young stage of the host.

The following experiments were made for the purpose of finding the most favorable stage of the host plant for the infection.

The seeds of *Triticum turgidum* were sown in six pots at three days' intervals from Jan. 7. These pots were placed in the green house side by side with affected *Triticum Spelta* and they were left to induce the natural infection. The results of the experiments are shown in the following table.

TABLE 12

Results of the inoculation experiments of *Erysiphe graminis* on the seedlings of *Triticum turgidum* which were sown at three days' intervals and left to induce natural infection.

Host	Date of sowing	Date of infection	No. of days from sowing to infection
Triticum turgidum	I. 7	I. 31	25
,,	I. 10	II. 3	25
,,	I. 13	II. 9	28
,,	I. 16	Not infected	
,,	I. 19	II. 15	28
,,	I. 22	II. 17	27

According to the experimental results shown in above table, the infection did not occur at the same time on the host plant of the different stages. In this case, the infection did not occur unless the host had passed about three weeks from the time of sowing. The conidia were produced on the second or third day after the appearance of the spot. Such phenomena were observed in every case on the first, second and third leaves and so on consecutively.

In July, 1931 *Triticum turgidum* planted in the pot reached the flowering stage. At this time, the plants were inoculated with numerous conidia. The uppermost leaf was infected after a week from the inoculation, but spots did not appear on the fully matured leaves on the same stalk.

Experiment B

In these experiments, the author observed on the relation of the incubation period and the physiological condition of the host plant.

I

The seeds of *Triticum turgidum* were laid on moistened filter paper in the large Petri-dish which was then placed in the green house at 14°–28°C. Three days later (Jan. 14), the seedlings grew to about 1 cm. in length. Then the seed was removed from the seedling which was quickly sterilized with 50% alcohol, and transferred to a test tube containing about 15 cc. of 2% sterilized agar. On Jan. 16, the conidia were inoculated on the first leaf with a sterilized platinum needle. On Jan. 25, newly formed conidia became visible on the surface of the inoculated leaf. In this experiment, the incubation period was 10 days. When the conidia were inoculated on the normal leaf, the incubation period was 3 or 5 days.

II

On Jan. 27, the seeds of *Triticum turgidum* were sown on moistened filter paper in a Petri-dish as in the former experiment. The cotyledonous leaves were inoculated with conidia on Jan. 31. After 24 hours, the epidermis was stripped off with a razor and was observed. It was found that almost all the conidia had germinated, but no infection had taken place. On Feb. 20, conidia were formed on the leaves of the host plant and many haustoria were produced. In this case, it is shown that the infection took place within 3 weeks from the time of inoculation.

III

The following experiments were made for the purpose of studying the development of the conidia inoculated on the leaves which are in a physiological condition unfavorable for infection.

On Feb. 10, seeds of *Triticum turgidum* were sown in a large Petri-dish, and after 4 days, these seedlings were transferred to test tubes as in experiment I. The cotyledonous leaves were inoculated with conidia on the next day. After 24 hours, the seedling was drawn out from the tube and the epidermis of the inoculated portion was stripped off with a razor. Small germ tubes were produced from the conidia. After 2 days from the inoculation, the germ tubes became gradually elongated and swollen up a little at their apices, whose contents presented a dense granular appearance. After 3 days, an appressorium was produced at the apex of the germ tube, but no penetration tube was yet produced. After 5 days, the appressorium firmly adhered to the surface of the epidermis and began to penetrate into the epidermal cell by sending out an infection tube. After 7 days, the infection tube penetrated into the epidermal cell and produced a globular vesicle containing granules. After 10 days, many finger-shaped haustoria were produced in the epidermal cells and young conidia were formed on the surface of the leaves.

By the above experiment, it was shown that for the penetration of the infection tube into the epidermal cell about 6 days were needed.

Seeds of *Triticum monococcum* var. *vulgare* and *T. dicoccum* var. *farum* were sown in pots on Oct. 19, 1931. On Nov. 10, the plants were inoculated with conidia from on *T. Spelta*. They were readily infected, but after a month, the affected leaves withered, and the host plant continued healthy growth. On Feb. 23, 1932, spores from on *T. Spelta* were abundantly sprayed on the leaves of both species, kept in green house. This experiment ended with a negative result. The leaves were too fully matured for infection.

Summary of Experiments on *Erysiphe graminis*

Up to the present time, reports have been published by several authors on the incubation period for infection of *Erysiphe graminis*. E. W. NEGER (24) recorded that from the time of the inoculation of the conidia to the production of the conidiophores it took 2 to 4 days, but the incubation period varies with the environmental factors as temperature, moisture and season. E. S. SALMON (35) remarked that the incubation period required 4 days under normal conditions and sometimes 5 days or even longer. The writer agrees that the period of incubation is varied by the influence of the environmental factors. Besides, when the host plants are in the different growing stages, the infection does not occur at the same time, although they are placed under almost similar conditions. Even in one and the same wheat plant, the spots do not appear at the same time on all leaves, but they are produced in order from below upwards. When the leaves reach the latter half of the growing-stage, they are infected quickly, and in this case, the incubation period is the shortest.

On the other hand, when the leaf reaches the senile-stage, the infection never takes place.

4. Experiments with *Microsphaera Alni* parasitic on *Picrasma quassioides*, *Sawadaea Tulasnei* on *Acer pictum*, and *Podosphaera tridactyla* on *Prunus triflora*.

In Aug. 1931, several pots of *Picrasma quassioides*, *Acer pictum*, and *Prunus triflora* were transferred to green house. Some of them were inoculated with conidia of *Microsphaera Alni*, *Sawadaea Tulasnei*, and *Podosphaera tridactyla*. The experiments of single spore inoculation were repeated again and again from 1931 to 1933, but unfortunately the plants were never infected. Perithecia were produced, however, on the stock plants in November.

Sawadaea Tulasnei on *Acer pictum* is noteworthy for the fact, that two forms of conidia, the micro- and the macro-, are produced in this species. In nature the macro-conidia begin to appear in early July, and the micro-conidia in late August. Two pots of

Acer pictum were inoculated with macro-conidia on Sept. 11. The infected spots appeared on both plants on Sept. 23 and 26. On this occasion, the macro-conidia were at first produced. Later, the micro-conidia appeared on the same mycelial patches of both plants on Oct. 3 and 7. It was determined under microscope that the macro- and micro-conidia were formed on the same mycelium. Perithecia were produced on both plants on Oct. 27 and 19. In this species, it seems to be necessary for the fungus to pass the micro-conidial stage in order for the perithecia formation to occur. The incubation period of this species was longer than that of the powdery mildews on the grasses.

5. Experiments with *Phyllactinia imperialis* parasitic on *Paulownia tomentosa*

On Sept. 26, 1931, two young plants of *Paulownia tomentosa* about 30 cm. in height were inoculated with conidia from a host plant of the same species growing in nature, and they were put in the green house. On Oct. 8, both plants were infected, and on Oct. 23, perithecia appeared on each leaf.

On Oct. 3, conidia were inoculated on the plants in other pots, and perithecia were produced on matured leaves after a month. But, on young leaves, the conidia only were produced. Later, the old affected leaves fell down without producing any perithecia. The natural infection by conidia took place on the young leaves, but perithecia were not produced on them, although they were put into a dark-box or caused to wither or were wounded. The old mycelial hyphae turned brown in color from the center of the white patches.

6. Field observation

Field observations on the relation between the host plants and powdery mildew are recorded in the following notes.

Erysiphe Galeopsidis on *Lamium album* var. *barbatum* appears in late June in nature in the vicinity of Sapporo, and perithecia are produced in the middle of summer. *Lamium album* var. *barbatum* sprouting in the very early spring, in early July plants attain the flowering stage, and in middle summer they gradually enter the senile-stage, when the perithecia are formed on the leaves.

Podosphaera leucotricha on *Malus baccata* var. *mandshurica* attacks its sprouts in late May. Some sprouts wither from its attack, but some others continue their growth. Conidia are abundantly produced in the latter case, and a small number of perithecia are formed in November. Generally, when hyperplasia is induced on the host plants by the stimuli of the powdery mildew, the perithecia formation is always retarded. This is probably due to the vital condition of the host plant which is restored to the growing-stage by an abnormal growth. *Sphaerotheca pannosa* on Rosa, and *Sph. Epilobii* on Epilobium belong to this category too.

When Erysiphaceae attacked the shoot, as for example, in the cases of *Podosphaera leucotricha* on *Malus pumila* var. *domestica*, *Sphaerotheca pannosa* on Rosa, *Microsphaera alphitoides* on Quercus, *Sawadaea Tulasnei* on Acer, and *Sphaerotheca Mors-Uvae* on Ribes, the apical part of the growing shoot is not always affected.

Also in the rust-fungi, when the sporidia are sprayed on the shoots of thir hosts, the sori are not formed on the apical part of the sprout. Similar cases are observed in Peronospora on *Stellaria media*, *Papaver somniferum*, *Spinacia oleracea*, etc. Two or three leaves on the upper part of the sprout were not always affected, although all other leaves were infected. It will be recognized that the results of the field observations and of the experiments entirely agree.

Summary of the results obtained in the experiments on the correlation between the developments of the host plant and the powdery mildew.

The physiological condition of the host plant could be treated as of three stages, growing, matured and senile. In the first half of the growing-stage and the second half of the senile-stage, the infection of the conidia and the mycelia growth did not take place. The most favorable condition for mycelia growth and conidia formation is found in the matured-stage, and that for the perithecia formation is in the stage of early senility. Perithecia formation is found only on the host plants which have made their full growth. The late maturity stage and early senility stage seem to be abridged or absent in the green house. The three stages of the host plants are influenced by environmental factors.

On the relation between the several species of the powdery mildew and certain environmental factors, viz., sunlight, temperature, and humidity, many experiments have been tried.

In 1914, G. M. REED (29) studied the influence of light on the infection of barley and wheat by the powdery mildew. The seedlings of barley and wheat which have been grown in the dark until the first leaf was about 2 to 3 cm. long, were inoculated with conidia of powdery mildew. Some of the plants which had been kept continuously in the dark were not infected. Also, on the seedlings which had been grown in the light, when they were kept continuously in the dark after the inoculation, no infection occurred. The effect upon the mildew of the absence of light is considered to be an indirect one and has to do with the primary effect upon the development of chlorophyll in the host cells.

In 1930, F. LAIBACH (21) noted that the influence of the sunlight on the conjugation of the sexual cells is very slight, because on *Lamium album* and *L. purpureum*, the perithecia are abundantly produced in mid-summer or in the green house in winter. The perithecia formation is also not distinctly influenced by the temperature. According to the results of his experiments carried out in different rooms of 3°–7°, 10°–12° and 18°–20°, in the low temperature room, 3°–7°, the incubation period was longer than in the other rooms, nevertheless the formation of perithecia took place in all rooms. The influence of high humidity on the vital function of the fungus is felt directly or indirectly through that of the host plant.

In the results of the above described experiments, checking the sunlight did not promote the formation of perithecia or the growth of mycelia, but when the host plants happened to grow vigorously, the perithecia formation was checked, and the growth of mycelia was increased. When the affected hosts were etiolated, the powdery mildew gradually disappeared. In the etiolated condition, the host plants could not be infected with conidia. The influence of temperature and moisture was similar to that of sunlight.

In the experiments on the influence of such factors as light, temperature, and humidity it is extremely difficult to distinguish the direct influence of those factors on the parasites themselves from their indirect action on the host plants.

III. Specialization and Resistance

For the purpose of determining the specialization of a powdery mildew in its relation to the resistance of its host plant, the following experiments have been made. Wheat was used as the host plant, and *Erysiphe graminis* DC. f. sp. *Tritici* MARCHAL was chosen as the parasite. This fungus is one of the seven specialized forms of *Erysiphe graminis* established by E. MARCHAL in 1902. In 1933, E. B. MAINS (17) reported two physiologic forms in *Erysiphe graminis* f. sp. *Tritici.* Axminister and Norka are resistant to form 1, while they are heavily infected by form 2. The fungus used in the present experiments was not tested to determine which form it belongs to.

1. Infection experiments with the conidia

In wheat, resistance and susceptibility to the powdery mildew have been hitherto studied by several authors.

In 1902, E. MARCHAL (23) remarked that *Triticum vulgare, T. Spelta, T. polonicum* and *T. turgidum* are susceptible species, while *T. durum, T. monococcum* and *T. dicoccum* are resistant.

In 1903, E. S. SALMON (33) reported that *Triticum vulgare* and *T. Spelta* were readily infected by the conidia on *T. vulgare.* He also studied the adaptation of parasitism in *Erysiphe graminis* parasitic on the species of Bromus and found the presence of the bridging species among certain species of the brome-grass.

In 1913, N. I. VAVILOV (43) reported observations on the field conditions. Thirty varieties of *Triticum vulgare,* 7 varieties of *T. compactum,* and 9 varieties of *T. Spelta* were found to be susceptible, while 10 varieties of *T. turgidum,* 15 varieties of *T. durum,* 3 varieties of *T. polonicum,* and 4 varieties of *T. monococcum* were determined to be resistant. Five varieties of *T. dicoccum* were proved to be either highly susceptible or resistant. In 1914, the same author

(44) noted that *T. vulgare* (with the exception of a few races), *T. compactum,* and *T. Spelta* belong to the susceptible hosts, while *T. durum, T. polonicum, T. turgidum,* and *T. monococcum* to the resistant. *T. dicoccum* has both susceptible and immune races. In 1918, the same author (45) reported that *Triticum sativum* in a broad sense is attacked by *Erysiphe graminis* f. *Tritici,* while some varieties of *T. dicoccum* are absolutely immune.

In 1909, 1912, 1916, and 1918, one hundred and sixty-one varieties belonging to the eight recognized types or species of Triticum were tested on the resistant character to *Erysiphe graminis* under green house conditions by G. M. REED (27, 28, 30, 31). The great majority of these varieties were highly susceptible to the wheat powdery mildew. It may be specially noted that *T. dicoccoides* KCKE., the wild wheat of Palestine, proved to be quite susceptible. In the distinctly resistant varieties are included *T. dicoccum* var. *Khapli, Russian Emmer* and *Spring Emmer,* and *T. vulgare* var. *caesium* and *pyrothrix.*

REED also tested various other species of Triticum, and *T. bicorne* and *T. caudatum* proved to be highly susceptible, while *T. triaristatum* and *T. triuncinale* proved to be resistant.

According to the papers above cited, in *Triticum polonicum* and *T. turgidum,* both lines of resistant and susceptible varieties seem to be included. Also, in *T. dicoccum* and *T. vulgare,* both varieties of distinctly susceptible and highly resistant characters are included. We have come to recognize that the degree of the susceptibility and resistance in different varieties of wheat to the infection by *Erysiphe graminis* f. sp. *Tritici* can not be stated in general terms.

Experiment 1

In the spring of 1922, many varieties of wheat, which were sent from Dr. D. FAIRCHILD, Bureau of Plant Industry, U. S. Department of Agriculture to Prof. K. MIYABE, were sown in the field of our University, and left to the natural infection. The degree of the infection caused by the powdery mildew is shown in the following table.

TABLE 13

Results of the natural infection of *Erysiphe graminis* on wheat sent from the Bureau of Plant Industry, U. S. Department of Agriculture.

Exp. No.	Varieties of wheat	Degree of infection	
		1922, VII. 20	1922, VIII. 1
1	Marquis (T. vulgare var. lutescens)	1	1
2	Little Club (T. compactum var. Humboldtii)	3	4
3	Haynes	1	1
4	Federation (T. vulgare var. alborubrum)	4	4
5	Kota	3	2
6	Pacific Bluestem	3	3
7	Early Baart (T. vulgare var. graecum)	1	2
8	Preston (T. vulgare var. erythrospermum)	0	0
9	Kanred	0	0
10	Turkey (T. turgidum var. iodurum)	0	0
11	Mammoth Red (T. vulgare var. erythrospermum)	0	0
12	Dawson's Golden Chaff (T. vulgare var. alborubrum)	0	0
13	Fulcaster	0	0
14	Poole (T. vulgare var. milturum)	0	0
15	Purple Straw (T. vulgare var. lutescens)	0	0
16	Pentad	0	0
17	Hybrid 128	0	0
18	Acme	0	0
19	Kubanka (T. durum var. hordeiforme)	0	0
20	Monad	0	0

Note, 0 = infection spots did not appear; 1 = infection spots appeared in minimum quantity; 4 = infection spots appeared in maximum quantity; 2 and 3 = infection spots in intermediate quantity.

From the above table, it may be seen that different degrees of resistance and susceptibility to the infection of the powdery mildew exist in the different varieties of *Triticum vulgare* growing in the field.

Experiment 2

The experiment was made to determine the specialization of the conidia. Conidia of *Erysiphe graminis* parasitic on *Triticum Spelta* were inoculated on the leaves of host plants belonging to the genera Hordeum, Triticum, Secale, Avena and Poa. The method used was to make a spore-suspension of the conidia, and spray them on the host plants in the green house by means of an atomizer.

TABLE 14

Results of the inoculation experiments on Hordeum, Triticum, Secale, Avena, and Poa with the conidia of *Erysiphe graminis* parasitic on *Triticum Spelta.*

Exp. No.	Host plants	Date of sowing	Date of inocu-lation	Date of infection	Date of ap-pearance of perithecia
1	Avena sativa (Belgium No. 12)	1926 XI. 3	1926 XII. 16	1926 0	1927 0
2	Hordeum sativum var. hexastichon (Marumi No. 15)	,,	,,	0	0
3	Hordeum sativum var. distichon	,,	,,	0	0
4	Avena sativa (Victoria No. 1)	,,	,,	0	0
5	Hordeum sativum var. vulgare (Mitsukigo No. 1)	,,	,,	0	0
6	Hordeum sativum var. vulgare (Sapporo rokkaku)	,,	,,	0	0
7	Secale cereale	,,	,,	0	0
8	Triticum Spelta	,,	,,	XII. 19	I. 16
9	Triticum compactum	,,	,,	XII. 18	I. 14
10	Triticum vulgare (Turkey Red)	,,	,,	,,	,,
11	Triticum dicoccum (Emmer)	,,	,,	0	0
12	Triticum monococcum	,,	,,	XII. 18	0
13	Triticum turgidum	,,	,,	XII. 19	I. 18
14	Triticum durum (Belotourka)	,,	,,	XII. 18	0
15	Poa pratensis	1932	1932 XI. 3	1932 0	1932 0

The writer made observations every day for two months after the sowing of the seeds. The susceptible species belonged to the single genus Triticum. The conidia, which were used in this experiment, evidently belonged to the race of *Erysiphe graminis* f. sp. *Tritici.* Conidia formed on *Triticum spelta* were employed in all the following experiments.

In the present experiment, *Triticum dicoccum* var. *Emmer* proved to be the only one immune variety among the wheat. In *T. monococcum* and *T. durum* (Belotourka), the infection spots gradually disappeared after the maturity of the host leaves.

Experiment 3

Wheat seeds, obtained from the Hokkaido Agricultural Experiment Station, were sown in pots in a green house, and the inoculation experiments were made using the same method as in experiment 2.

TABLE 15

Results of the inoculation experiments with conidia of *Erysiphe graminis* parasitic on *Triticum Spelta* on the varieties of wheat obtained from the Hokkaido Agricultural Experiment

Exp. No.	Varieties of Wheat	Date of inoculation	Date of infection	Degree of infection	
1	Triticum vulgare (Kota 6404)	1927 V. 28	VI. 1	VI. 8 4	VII. 5 4
2	T. vulgare (Sapporo No. 9)	VI. 5	VI. 7	1	3
3	T. vulgare (Marquis 4051)	"	"	1	2
4	T. Spelta (638)	V. 28	VI. 1	2	4
5	T. compactum (5036)	"	V. 31	3	4
6	T. turgidum (Alaska 3914)	"	VI. 1	3	2
7	T. Algerian (Macaroni 3862)	"	"	2	1
8	T. durum (Belotourka 3972)	"	V. 31	4	0
9	T. polonicum (1349)	"	"	3	0
10	T. monococcum (5725)	VI. 5	VI. 7	1	0
11	T. dicoccum (Emmer 3933)	"	0		
12	T. dicoccum (Khapli 6400)	"	0		

The seeds were sown on May 14, 1927.

In No's. 2, 3, 10, 11 and 12, the mycelial spot did not appear in the first inoculation. On June 5, they were again inoculated. Among them, in No's. 2, 3 and 10, the white mycelial patches were produced on June 7.

According to the observations on June 8, and July 5, *Triticum vulgare* (Kota 6404, Sapporo No. 9, and Marquis 4051), *T. Spelta* (638), *T. compactum* (5036), and *T. Algerian* (Macaroni 3862) proved to belong to the susceptible varieties, and *T. durum* (Belotourka 3972), *T. polonicum* (1349), and *T. monococcum* (5725) belonged to the resistant. After two months, in the former group, the leaves and stems turned yellow in color, while in the latter, they continued to show the normal heathy growth. *T. dicoccum* (Emmer 3933, and Khapli 6400) proved to be immune.

Experiment 4

Seventy-six varieties of wheat cultivated in this country were tested to determine the degree of their susceptiblity to *Erysiphe graminis* f. sp. *Tritici.*

The wheat seeds used in the experiments whose results are tabulated in tables 16 and 17 were distributed from the Hokkaido Agricultural Experiment Station.

In tables 18 and 19, are reported the results of the inoculation experiments using plants grown from seeds received from the Experiment Station of the Department of Agriculture and Forestry at Konosu.

In the experiments reported in table 20, the plants grown from seeds received from France and Italy were used.

Each variety was sown in five pots, and the inoculation experiments were made out of doors.

TABLE 16

Results of the inoculation experiments with the conidia of *Erysiphe graminis* f. sp. *Tritici* on the varieties of wheat obtained from the Hokkaido Agricultural Experiment Station.

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
	Spring wheat	1931	1931	1931	1931
1	Triticum vulgare var. graecum KÖRN. (Hokudai No. 2)	VI. 22	VII. 16	VIII. 2	VIII. 4 1
2	"	"	VII. 23	VII. 31	1
3	"	"	"	"	1
4	"	"	"	VII. 27	1
5	"	"	"	VII. 25	1
6	T. vulgare var. erythrospermum KÖRN. (Sapporo harukomugi No. 9)	"	VII. 16	VII. 23	VII. 27 1
7	"	"	"	VII. 22	1
8	"	"	"	VII. 23	1
9	"	"	"	"	1
10	"	"	"	"	1
11	T. vulgare var. ferrugineum KÖRN. (Wase komugi 3830)	"	"	VII. 20	4
12	"	"	"	"	4
13	"	"	"	"	4
14	"	"	"	"	4
15	"	"	"	"	4
16	T. vulgare var. lutescens KÖRN. (Ekishirazu)	"	"	"	4
17	"	"	"	"	4
18	"	"	"	"	4
19	"	"	"	"	4
20	"	"	"	"	4
21	T. vulgare var. velutinum KÖRN. (Minnesota No. 166)	"	"	"	3
22	"	"	"	"	3
23	"	"	"	"	3
24	"	"	"	"	3
25	"	"	"	"	3

TABLE 16. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
26	T. vulgare var. graecum KÖRN. (Early Baat)	VI. 22	VII. 16	VII. 20	VII. 27 3
27	,,	,,	,,	,,	3
28	,,	,,	,,	VII. 21	3
29	,,	,,	,,	VII. 20	3
30	,,	,,	,,	,,	3
31	T. vulgare var. milturum KÖRN. (Iga-chikugo X Oregon)	,,	,,	,,	4
32	,,	,,	,,	,,	4
33	,,	,,	,,	,,	4
34	,,	,,	,,	,,	4
35	,,	,,	,,	,,	4
36	T. monococcum var. Hornemanni KORN.	VII. 20	VIII. 3		VIII. 17 0
37	,,	,,	,,		0
38	,,	,,	,,		0
39	,,	,,	,,		0
40	,,	,,	,,		0
41	T. dicoccum var. farrum KÖRN.	,,	,,	VIII. 7	2
42	,,	,,	,,	VIII. 8	2
43	,,	,,	,,	VIII. 7	2
44	,,	,,	,,	,,	2
45	,,	,,	,,	VIII. 8	2
46	T. durum var. hordeiforme KÖRN. (Belotourka)	,,	,,	VIII. 5	4
47	,,	,,	,,	,,	4
48	,,	,,	,,	,,	4
49	,,	,,	,,	VIII. 6	4
50	,,	,,	,,	VIII. 5	4
51	T. durum var. melanopus KÖRN. (Algerian macaroni)	,,	,,	VIII. 6	4
52	,,	,,	,,	,,	3
53	,,	,,	,,	VIII. 5	3
54	,,	,,	,,	,,	3
55	,,	,,	,,	VIII. 7	3

TABLE 16. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
56	T. durum var. hordeiforme KÖRN. (Monad, C. I. No. 3320)	VII. 20	VIII. 3	VIII. 5	VIII. 17 4
57	,,	,,	,,	VIII. 6	4
58	,,	,,	,,	VIII. 7	4
59	,,	,,	,,	VIII. 6	4
60	,,	,,	,,	,,	4
61	T. polonicum var. chrysospermum KÖRN. (de Pologne ou d'Astrakan)	,,	,,	,,	3
62	,,	,,	,,	,,	3
63	,,	,,	,,	VIII. 5	4
64	,,	,,	,,	VIII. 6	3
65	,,	,,	,,	,,	3
66	T. turgidum var. pseudocervinum KÖRN. (Alaska)	,,	VIII. 4	,,	4
67	,,	,,	,,	VIII. 8	4
68	,,	,,	,,	,,	4
69	,,	,,	,,	VIII. 7	4
70	,,	,,	,,	,,	4
	Winter wheat				
71	T. vulgare var. graecum KÖRN. (1101-7-a)	VII. 20	VIII. 4	VIII. 6	4
72	,,	,,	,,	,,	4
73	,,	,,	,,	,,	4
74	,,	,,	,,	,,	4
75	,,	,,	,,	,,	4
76	T. vulgare var. erythrospermum KORN. (Turkey Red)	,,	,,	,,	4
77	,,	,,	,,	,,	4
78	,,	,,	,,	,,	4
79	,,	,,	,,	,,	4
80	,,	,,	,,	,,	4

TABLE 16. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
81	T. vulgare var. ferrugineum KÖRN. (Akakawa-aka No. 1)	VII. 20	VIII. 4	VIII. 6	VIII. 17 4
82	,,	,,	,,	,,	4
83	,,	,,	,,	,,	4
84	,,	,,	,,	,,	4
85	,,	,,	,,	,,	4
86	T. vulgare var. barbarossa KÖRN. (Bearded Velvet Chaff)	VIII. 5	VIII. 17	VIII. 19	VIII. 31 4
87	,,	,,	,,	,,	4
88	,,	,,	,,	,,	4
89	,,	,,	,,	,,	4
90	,,	,,	,,	,,	4
91	T. vulgare var. albidum KÖRN. (Martin No. 8)	,,	,,	,,	4
92	,,	,,	,,	,,	4
93	,,	,,	,,	,,	4
94	,,	,,	,,	,,	4
95	,,	,,	,,	,,	4
96	T. vulgare var. lutescens KÖRN. (Winter wheat, 4907)	,,	,,	,,	4
97	,,	,,	,,	,,	4
98	,,	,,	,,	,,	4
99	,,	,,	,,	,,	4
100	,,	,,	,,	,,	4
101	T. vulgare var. alborubrum KÖRN. (Dawson No. 1)	,,	,,	,,	4
102	,,	,,	,,	,,	4
103	,,	,,	,,	,,	4
104	,,	,,	,,	,,	4
105	,,	,,	,,	,,	4
106	T. vulgare var. milturum KÖRN. (Akasabi-shirazu No. 1)	,,	,,	,,	4
107	,,	,,	,,	,,	4
108	,,	,,	,,	,,	4
109	,,	,,	,,	,,	4
110	,,	,,	,,	,,	4

TABLE 16. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
111	T. compactum var. icterinum KÖRN. (Hokkaido Agr. Exp. Stat. No. 6355)	VIII. 5	VIII. 18	VIII. 20	VIII. 31 4
112	,,	,,	,,	,,	4
113	,,	,,	,,	,,	4
114	,,	,,	,,	,,	4
115	,,	,,	,,	,,	4
116	T. compactum var. erinaceum KÖRN. (Hokkaido Agr. Exp. Stat. No. 6356)	VIII. 6	,,	,,	4
117	,,	,,	,,	,,	4
118	,,	,,	,,	,,	4
119	,,	,,	,,	,,	4
120	,,	,,	,,	,,	4
121	T. compactum var. Wernerianum KÖRN. (Hokkaido Agr. Exp. Stat. No. 6354)	,,	,,	,,	4
122	,,	,,	,,	,,	4
123	,,	,,	,,	,,	4
124	,,	,,	,,	,,	4
125	,,	,,	,,	,,	4
126	T. compactum var. Wittmackianum KÖRN. (B. 28, 3. 1. 1. 1.)	,,	,,	VIII. 21	4
127	,,	,,	,,	,,	4
128	,,	,,	,,	,,	4
129	,,	,,	,,	,,	4
130	,,	,,	,,	,,	4
131	T. compactum var. creticum KÖRN. (Hokkaido Agr. Exp. Stat. No. 6357)	,,	,,	,,	4
132	,,	,,	,,	,,	4
133	,,	,,	,,	,,	4
134	,,	,,	,,	,,	4
135	,,	,,	,,	,,	withered
136	T. Spelta var. Dukamelianum KÖRN. (J. 4. 4. 1. 1. 1.)	,,	,,	,,	4
137	,,	,,	,,	,,	4
138	,,	,,	,,	,,	4
139	,,	,,	,,	,,	4
140	,,	,,	,,	,,	4

As shown in table 16, among the varieties of *Triticum vulgare*, Hokudai No. 2 and Sapporo Harukomugi No. 9 belong to the resistant varieties. *T. monococcum* var. *Hornemanni* was not infected although the inoculation experiments had been repeated on Aug. 3 and Aug. 17. *T. dicoccum* var. *farrum* proved to be resistant, although after two days from the inoculation, the haustoria were produced in the epidermal cells. In tables 14 and 15, *T. monococcum* was included in the resistant varieties, and two varieties of *T. dicoccum* proved to be immune. Therefore the next experiment was carried out.

TABLE 17

Results of inoculation experiments on *T. monococcum* and *T. dicoccum*.

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
1	T. monococcum var. vulgare	1931 X. 19	XI. 10	XI. 25	XII. 4 1
2	〃	〃	〃	XI. 16	1
3	〃	〃	〃	XI. 14	1
4	〃	〃	〃	〃	1
5	〃	〃	〃	withered	
6	T. dicoccum var. farrum	〃	〃	XI. 14	2
7	〃	〃	〃	XI. 12	2
8	〃	〃	〃	〃	2
9	〃	〃	〃	〃	3
10	〃	〃	〃	〃	2
11	T. monococcum var. Hornemanni	〃	Not germinated		
12	〃	〃	〃		
13	〃	〃	〃		
14	〃	〃	〃		
15	〃	〃	〃		

In the results of the above experiment, *Triticum monococcum* var. *vulgare* and *T. dicoccum* var. *farrum* proved to be resistant. In *T. dicoccum*, both resistant and immune strains were distinctly recognized. It was a disappointment that *T. monococcum* var. *Hornemanni* seeds did not germinate in this experiment.

TABLE 18

Results of the inoculation experiments with the conidia of *Erysiphe graminis* f. sp. *Tritici* on varieties of wheat of foreign origin received from the Experiment Station of the Department of Agriculture and Forestry at Konosu.

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
141	Tetsurei zairaishu	1931 VIII. 6	VIII. 18	VIII. 20	VIII. 31 2
142	,,	,,	,,	,,	2
143	,,	,,	,,	,,	3
144	,,	,,	,,	,,	3
145	,,	,,	,,	,,	2
146	Extra Kolben	,,	,,	,,	1
147	,,	,,	,,	,,	1
148	,,	,,	,,	,,	1
149	,,	,,	,,	withered	
150	,,	,,	,,	VIII. 22	1
151	Ritter	,,	,,	VIII. 20	4
152	,,	,,	,,	,,	4
153	,,	,,	,,	,,	4
154	,,	,,	,,	,,	4
155	,,	,,	,,	,,	4
156	Garnet Ot. 652	VIII. 21	IX. 3	IX. 9	IX. 19 4
157	,,	,,	,,	,,	4
158	,,	,,	,,	IX. 8	4
159	,,	,,	,,	IX. 5	4
160	,,	,,	,,	IX. 7	4
161	Huron Ot. 3	,,	,,	IX. 9	4
162	,,	,,	,,	IX. 8	4
163	,,	,,	,,	IX. 9	4
164	,,	,,	,,	,,	4
165	,,	,,	,,	,,	4

TABLE 18. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
166	Harvest Queen	VIII. 21	IX. 3	IX. 8	IX. 19 4
167	"	"	"	"	4
168	"	"	"	"	4
169	"	"	"	"	4
170	"	"	"	"	4
171	Hard Federation	"	"	"	4
172	"	"	"	"	4
173	"	"	"	"	4
174	"	"	"	"	4
175	"	"	"	"	4
176	Bunyip	"	"	"	4
177	"	"	"	"	4
178	"	"	"	"	4
179	"	"	"	"	4
180	"	"	"	"	4
181	White Odessa	VIII. 29	IX. 10	IX. 12	IX. 25 4
182	"	"	"	"	4
183	"	"	"	"	4
184	"	"	"	IX. 14	4
185	"	"	"	"	4
186	Martin	"	"	"	4
187	"	"	"	"	4
188	"	"	"	"	4
189	"	"	"	"	4
190	"	"	"	IX. 12	4
191	Russian No. 25	"	"	"	4
192	"	"	"	"	4
193	"	"	"	"	4
194	"	"	"	"	4
195	"	"	"	"	4

TABLE 18. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
196	Podolanka	VIII. 29	IX. 10	IX. 14	IX. 25 4
197	”	”	”	IX. 12	4
198	”	”	”	IX. 14	3
199	”	”	”	IX. 12	4
200	”	”	”	”	4
201	? Lwowianka	”	”	IX. 14	4
202	”	”	”	IX. 12	4
203	”	”	”	”	4
204	”	”	”	IX. 14	4
205	”	”	”	IX. 12	4
206	Gentile Rosso fam. 58	IX. 2	IX. 15	IX. 17	IX. 30 4
207	”	”	”	”	4
208	”	”	”	”	4
209	”	”	”	”	4
210	”	”	”	”	4
211	Altai 86	”	”	”	4
212	”	”	”	”	4
213	”	”	”	”	4
214	”	”	”	”	4
215	”	”	”	”	4
216	Altai 414	”	”	”	4
217	”	”	”	”	4
218	”	”	”	”	4
219	”	”	”	”	4
220	”	”	”	”	4
221	Russian No. 38	”	”		X. 5 0
222	”	”	(IX. 21)		0
223	”	”	”		0
224	”	”	”		0
225	”	”	”		0

TABLE 18. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
					IX. 30
226	Russian No. 61	IX. 2	IX. 15	IX. 17	2
227	,,	,,	,,	,,	2
228	,,	,,	,,	,,	2
229	,,	,,	,,	,,	3
230	,,	,,	,,	,,	2

Extra Kolben and *Russian No. 61* were the resistant varieties and *Russian* No. 38 proved to be immune. The last mentioned variety was not infected in spite of the twice performed inoculations on Sept. 15 and 21.

TABLE 19

Results of the inoculation experiments with the conidia of *Erysiphe graminis* f. sp. *Tritici* on common wheat, which are cultivated in this country and received from the Experiment Station of the Department of Agriculture and Forestry at Konosu.

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
		1931			IX. 30
231	Iwate-soshu No. 1 (Iwate)	IX. 2	IX. 15	IX. 17	4
232	,,	,,	,,	,,	4
233	,,	,,	,,	,,	4
234	,,	,,	,,	,,	4
235	,,	,,	,,	,,	4
					X. 5
236	Daruma No. 2 (Miyagi)	IX. 3	IX. 17	IX. 22	4
237	,,	,,	,,	,,	4
238	,,	,,	,,	,,	4
239	,,	,,	,,	,,	4
240	,,	,,	,,	,,	4

TABLE 19. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
241	Akita-zairaishu (Akita)	IX. 3	IX. 17	IX. 19	X. 5 4
242	,,	,,	,,	IX. 22	4
243	,,	,,	,,	,,	3
244	,,	,,	,,	,,	3
245	,,	,,	,,	,,	4
246	Waraide (Yamagata)	,,	,,	,,	4
247	,,	,,	,,	,,	4
248	,,	,,	,,	,,	4
249	,,	,,	,,	,,	4
250	,,	,,	,,	,,	4
251	Sunagawa-daruma (Fukushima)	IX. 9	IX. 23	IX. 28	X. 15 4
252	,,	,,	,,	IX. 29	4
253	,,	,,	,,	,,	4
254	,,	,,	,,	,,	4
255	,,	,,	,,	IX. 28	4
256	Shirasaya No. 2 (Ibaragi)	,,	,,	,,	4
257	,,	,,	,,	IX. 29	4
258	,,	,,	,,	,,	4
259	,,	,,	,,	,,	4
260	,,	,,	,,	IX. 28	4
261	Akaboro No. 1 (Tochigi)	,,	,,	IX. 26	4
262	,,	,,	,,	IX. 28	4
263	,,	,,	,,	IX. 26	4
264	,,	,,	,,	,,	4
265	,,	,,	,,	IX. 28	4
266	Nitta-wase (Gumma)	IX. 10	,,	IX. 29	X. 16 4
267	,,	,,	,,	,,	4
268	,,	,,	,,	IX. 28	4
269	,,	,,	,,	IX. 26	4
270	,,	,,	,,	IX. 29	4

TABLE 19. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
					X. 16
271	Aka-daruma-saki No. 1 (Saitama)	IX. 10	IX. 23	IX. 29	4
272	"	"	"	IX. 28	4
273	"	"	"	IX. 29	4
274	"	"	"	"	4
275	"	"	"	IX. 28	4
					X. 20
276	Saikan (Chiba)	IX. 18	X. 5	X. 8	4
277	"	"	"	"	4
278	"	"	"	"	4
279	"	"	"	"	4
280	"	"	"	"	4
281	Soshu (Tokyo)	"	"	"	4
282	"	"	"	"	4
283	"	"	"	X. 7	4
284	"	"	"	X. 9	4
285	"	"	"	X. 7	4
286	Ojima-wase (Tokyo)	"	"	X. 9	4
287	"	"	"	"	4
288	"	"	"	X. 8	4
289	"	"	"	"	4
290	"	"	"	"	4
291	Shiro-bozu (Kanagawa)	"	"	X. 9	4
292	"	"	"	"	4
293	"	"	"	X. 8	4
294	"	"	"	X. 9	4
295	"	"	"	"	4
					X. 26
296	Akakomugi (Toyama)	IX. 25	X. 7	X. 10	3
297	"	"	"	X. 11	3
298	"	"	"	X. 12	3
299	"	"	"	X. 11	3
300	"	"	"	X. 12	3

TABLE 19. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inocu- lation	Date of infection	Degree of in- fection
301	Nishimura (Fukui)	IX. 25	X. 7	X. 10	X. 26 4
302	,,	,,	,,	,,	4
303	,,	,,	,,	,,	4
304	,,	,,	,,	,,	4
305	,,	,,	,,	,,	4
306	Akage-gumbai (Yamanashi)	,,	,,	,,	4
307	,,	,,	,,	,,	4
308	,,	,,	,,	,,	4
309	,,	,,	,,	X. 9	4
310	,,	,,	,,	X. 10	4
311	Shibu-shirazu (Nagano)	,,	,,	,,	4
312	,,	,,	,,	,,	4
313	,,	,,	,,	,,	4
314	,,	,,	,,	X. 11	4
315	,,	,,	,,	X. 10	4
316	Aichi-akatake No. 1 (Aichi)	,,	,,	X. 12	4
317	,,	,,	,,	X. 11	4
318	,,	,,	,,	X. 10	4
319	,,	,,	,,	,,	4
320	,,	,,	,,	,,	4
321	Mihara (Hyogo)	,,	,,	X. 12	4
322	,,	,,	,,	X. 10	4
323	,,	,,	,,	X. 9	4
324	,,	,,	,,	X. 10	4
325	,,	,,	,,	,,	4
326	Shin-nakanaga (Hyogo)	IX. 29	X. 9	X. 17	X. 27 4
327	,,	,,	,,	X. 16	4
328	,,	,,	,,	,,	4
329	,,	,,	,,	X. 17	4
330	,,	,,	,,	X. 14	4

TABLE 19. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inocu-lation	Date of infection	Degree of in-fection
331	Ejima No. 1 (Shimane)	IX. 29	X. 9	X. 17	X. 27 4
332	〃	〃	〃	〃	4
333	〃	〃	〃	X. 14	4
334	〃	〃	〃	X. 16	4
335	〃	〃	〃	〃	4
336	Hatada-komugi No. 2 (Okayama)	〃	〃	〃	4
337	〃	〃	〃	〃	4
338	〃	〃	〃	X. 15	4
339	〃	〃	〃	X. 16	4
340	〃	〃	〃	〃	4
341	Wase-chinko (Hiroshima)	〃	X. 10	〃	4
342	〃	〃	〃	X. 13	4
343	〃	〃	〃	〃	4
344	〃	〃	〃	〃	4
345	〃	〃	〃	X. 14	4
346	Wase-komugi (Kagawa)	〃	〃	X. 15	4
347	〃	〃	〃	X. 18	4
348	〃	〃	〃	X. 16	4
349	〃	〃	〃	〃	4
350	〃	〃	〃	X. 17	4
351	Homan (Kochi)	〃	〃	〃	4
352	〃	〃	〃	X. 19	4
353	〃	〃	〃	X. 17	4
354	〃	〃	〃	〃	4
355	〃	〃	〃	X. 18	4
356	Ejima-shinriki (Fukuoka)	X. 5	X. 19	X. 21	X. 31 4
357	〃	〃	〃	〃	4
358	〃	〃	〃	〃	4
359	〃	〃	〃	〃	4
360	〃	〃	〃	〃	4

TABLE 19. (*Continued*)

Exp. No.	Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
361	Haya-komugi (Fukuoka)	X. 5	X. 19	X. 21	X. 31 4
362	,,	,,	,,	,,	4
363	,,	,,	,,	,,	4
364	,,	,,	,,	,,	4
365	,,	,,	,,	,,	4
366	Shiro-komugi No. 1 (Saga)	,,	,,	,,	4
367	,,	,,	,,	,,	4
368	,,	,,	,,	,,	4
369	,,	,,	,,	,,	4
370	,,	,,	,,	,,	4
371	Shiro-bumpu (Kumamoto)	,,	,,	,,	3
372	,,	,,	,,	,,	3
373	,,	,,	,,	,,	3
374	,,	,,	,,	,,	3
375	,,	,,	,,	,,	3
376	Sanshukotake (Kagoshima)	,,	,,	,,	4
377	,,	,,	,,	,,	4
378	,,	,,	,,	,,	4
379	,,	,,	,,	,,	4
380	,,	,,	,,	,,	4

(The words in brackets are the names of the prefectures).

Almost all varieties tabulated above proved highly susceptible to wheat mildew. Aka-komugi and Shiro-bumpu proved to be less susceptible than the others.

TABLE 20

Results of inoculation experiments with the conidia of *Erysiphe graminis* f. sp. *Tritici* on the species of Triticum which were sent from the Agricultural Experiment Stations in France and Italy.

Exp. No.	Species of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
381	Triticum Tumonia (France)	1931 X. 19	XI. 7	XI. 9	XII. 4 4
382	,,	,,	,,	XI. 10	4
383	,,	,,	,,	,,	4
384	,,	,,	,,	XI. 9	4
385	,,	,,	,,	,,	4
386	T. Tumonia (Italy)	,,	,,	XI. 10	4
387	,,	,,	,,	XI. 11	4
388	,,	,,	,,	XI. 10	4
389	,,	,,	,,	,,	4
390	,,	,,	,,	,,	4
391	T. abyssinicum (France)	,,	,,	XI. 11	3
392	,,	,,	,,	XI. 9	3
393	,,	,,	,,	,,	3
394	,,	,,	,,	XI. 10	3
395	,,	,,	,,	,,	3
396	T. boatum (Pays-Bas)	,,	XI. 11	0	
397	,,	,,	(XI. 23)	0	
398	,,	,,	,,	0	
399	,,	,,	,,	0	
400	,,	,,	,,	0	
401	T. Thaouder (Italy)	,,	XI. 7	XI. 11	XII. 4 3
402	,,	,,	,,	,,	3
403	,,	,,	,,	,,	3
404	,,	,,	,,	,,	3
405	,,	,,	,,	,,	3

The seeds of the above varieties were received from the Agricultural Experiment Stations in France and Italy. *Triticum boatum* proved to be immune, but this species is not numbered among the common wheats.

Summary of the inoculation experiments on
eighty-one varieties of wheat.

The results of the inoculation experiments with conidia produced on *Triticum Spelta* are as follows:

In *Triticum vulgare,* both susceptible and resistant varieties are included. Among the varieties of *T. vulgare* tested in these experiments, the most highly resistant and perfectly immune varieties could not be found.

In *T. turgidum, T. Spelta,* and *T. compactum,* the susceptible character was retained throughout all vegetative stages from the seedling to the ripening stage.

The seedlings of *T. polonicum,* and *T. durum* were highly susceptible, but in the ripening stage, they became highly resistant. Sometimes they are mistaken to be immune in the field observation.

T. monococcum and *T. dicoccum* proved to be resistant throughout all the stages, but *T. monococcum* var. *Hornemanni* still remains undetermined on account of the non-germination of its seed.

Russian No. 38, and *T. boatum* belonged to the immune varieties.

Experiment 5

As a result of further inoculation experiments, *Triticum dicoccum, Khapli 6400, Emmer 3933,* and *Russian No. 38* proved to be immune varieties. *T. monococcum* var. *Hornemanni* still remained undetermined. The following experiments were repeated for the ascertainment of these facts.

TABLE 21

Results of inoculation experiments on *Triticum dicoccum* with the conidia of *Erysiphe graminis* parasitic on *Triticum vulgare.*

Varieties of wheat	Date of sowing	Date of inoculation	Date of infection
T. dicoccum, Emmer 3933	VIII. 11	VIII. 24	0
T. dicoccum, Khapli 6400	,,	,,	0

In this experiment, the conidia on *Triticum vulgare* were used for inoculation.

TABLE 22

Showing the results of the inoculation experiments on *Triticum dicoccum* using the conidia of *Erysiphe graminis* parasitic on *Triticum Spelta*.

Varieties of wheat	Date of sowing		Date of inoculation	Date of infection	Treatment of the host plants
T. dicoccum, Emmer	a	XI. 17	II. 23	0	On stripped epidermis
	b	,,	,,	0	On epidermis wounded with needle
T. dicoccum, Khapli	a	I. 18	,,	0	On stripped epidermis
	b	,,	,,	0	On epidermis wounded with needle

In this experiment, the conidia formed on *T. Spelta* were inoculated on *T. dicoccum, Khapli* and *Emmer*. They were not infected even though the epidermis of the leaves had been stripped off with a razor or wounded with a needle.

TABLE 23

Results of inoculation experiments on *Triticum dicoccum* and *T. monococcum* using conidia of *Erysiphe graminis* parasitic on *Triticum dicoccum* var. *farrum*.

Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
T. dicoccum, Khapli	XII. 8	I. 18	0	
	,,	withered	0	
T. dicoccum, Emmer	XII. 17	I. 18	0	
	,,	,,	0	
T. monococcum var. Hornemanni	I. 9	II. 9	II. 15	(II. 23) 2
	,,	Not germinated		
Russian No. 38	II. 16	II. 26	0	
	,,	,,	0	

In this experiment, conidia from the fungus on *T. dicoccum* var. *farrum* were used for inoculation. After the inoculation, the pots were placed in the green house side by side with the pots of affected *T. dicoccum* var. *farrum* and left to natural infection. In this experiment, *T. monococcum* var. *Hornemanni* only was infected. The inoculation experiments were repeated thrice on *T. monococcum* var. *Hornemanni.*

TABLE 24

Results of the inoculation experiments on *Triticum monococcum* and *T. dicoccum* with the conidia of *Erysiphe graminis* parasitic on *Triticum vulgare.*

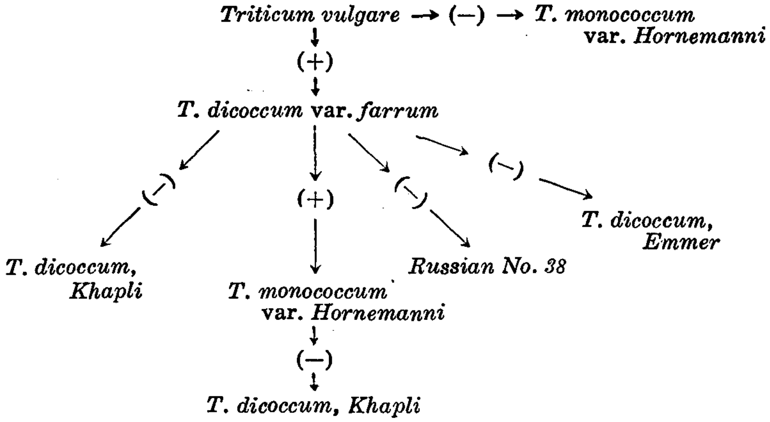
Varieties of wheat	Date of sowing	Date of inoculation	Date of infection	Degree of infection
T. monococcum var. Hornemanni	II. 16	II. 29	0	
T. dicoccum var. farrum	II. 22	,,	III. 5	(III. 16) 2

In this experiment, the conidia on *T. vulgare* (Ekishirazu) were used for inoculation. In this case, *T. monococcum* var. *Hornemanni* was not infected.

From the results of experiments 4 and 5 the relation of the conidia to the degree of infection on different varieties of *T. monococcum* and *T. dicoccum* is shown in the following table.

TABLE 25

Relation of the conidia to the degree of infection on *Triticum monococcum* and *T. dicoccum.*



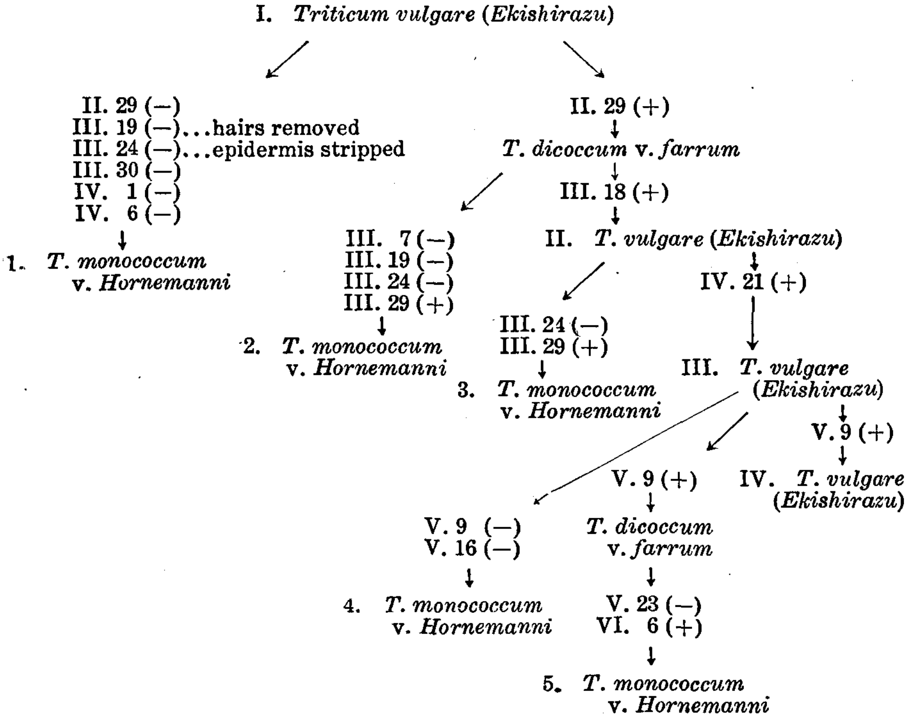
Triticum monococcum var. *Hornemanni* was not infected with the conidia formed on *T. vulgare*, but it was infected by the conidia formed on *T. dicoccum* var. *farrum*. Therefore, the next experiment was made.

Experiment 6

The present experiment was carried out by the procedure presented in the following diagram.

TABLE 26

Results of the inoculation experiments with the conidia of *Erysiphe graminis* parasitic on *Triticum vulgare* on *Triticum monococcum, T. dicoccum* and *T. vulgare.*



In this experiment, the affected stock wheat (*T. vulgare,* Ekishirazu) which served as the source of the conidia was always placed in an isolated room in the green house in order to prevent natural infection. The spore-masses were inoculated with a needle on certain parts of the leaves and sheaths of the wheat to be experimented upon, then the plants thus inoculated were covered for 24 hours with bell-jars.

T. vulgare (I) was a highly susceptible variety and the infection spots appeared in maximum quantity (4). The conidia produced on *T. vulgare* were inoculated on *T. monococcum* var. *Hornemanni* and on *T. dicoccum* var. *farrum.* In the former, the infection spots did not appear in spite of the repetition of the inoculation six times, even when in the second inoculation, the epidermal hairs of the leaves had been removed, and in the third inoculation, the epidermis had been stripped off with a razor. In *T. dicoccum* var. *farrum,* the infection spots appeared in intermediate quantity (2). The conidia formed on this host were inoculated on *T. monococcum* var. *Hornemanni* and on *T. vulgare* (II). In this case, both varieties were infected, and the degree of infection of the powdery mildew on *T. vulgare* (II) appeared to be intermediate (2). On *T. monococcum* var. *Hornemanni,* the infection spots appeared once in four times in minimum quantity (1). The conidia formed on *T. vulgare* (II) were inoculated on *T. monococcum* var. *Hornemanni* and *T. vulgare* (III). Both varieties were infected, and it was the maximum degree of infection which appeared on *T. vulgare* (III). Thus, the degree of infection on *T. vulgare* (III) returned to that on *T. vulgare* (I). The conidia on *T. vulgare* (III) were inoculated on *T. monococcum* var. *Hornemanni,* on *T. dicoccum* var. *farrum* and on *T. vulgare* (IV). *T. monococcum* var. *Hornemanni* was not infected. The other two varieties were infected. The maximum degree (4) of infection appeared on *T. vulgare* (IV). The conidia formed on *T. dicoccum* var. *farrum* caused the infection again on *T. monococcum* var. *Hornemanni.*

In the present experiments, conidia from the parasite on *T. vulgare* (I) and (III) did not infect *T. monococcum* var. *Hornemanni.* The last named variety was however infected by the conidia from the parasite on either *T. dicoccum* var. *farrum* or on *T. vulgare* (II), which had passed through *T. dicoccum* var. *farrum*. It was found that in order for the conidia on *T. vulgare* (Ekishirazu) to cause infection on *T. monococcum* var. *Hornemanni*, the fungus must pass *T. dicoccum* var. *farrum* as a host.

Experiment 7

In this experiment, the morphological characters of the conidia of *Erysiphe graminis* f. sp. *Tritici* used in experiment 6 were studied. The matured conidia were used for measurements.

TABLE 27

Measurements of the conidia produced on *T. vulgare* (I).

Length in Micron.

Class	31.2	32.4	33.6	34.8	36.0	37.2	38.4	39.6	40.8
Frequency	2	8	10	16	30	17	9	4	4

Width in Micron.

Class	13.2	14.4	15.6	16.8	18.0
Frequency	3	31	52	9	5

TABLE 28

Measurements of the conidia produced on *T. vulgare* (IV).

Length in Micron.

Class	28.8	30.0	31.2	32.4	33.6	34.8	36.0	37.2	38.4	39.6	40.8
Frequency	3	7	12	13	15	16	19	7	6	1	1

TABLE 28. (*Continued*)

Width in Micron.

Class	13.2	14.4	15.6	16.8	18.0	19.2	20.4
Frequency	2	26	43	22	5	1	1

TABLE 29

Measurements of the conidia produced on
T. dicoccum var. *farrum.*

Length in Micron.

Class	28.8	30.0	31.2	32.4	33.6	34.8	36.0	37.2	38.4	39.6
Frequency	1	3	10	14	28	13	12	10	8	1

Width in Micron.

Class	12.0	13.2	14.4	15.6	16.8	18.0
Frequency	1	7	28	41	18	5

From the above tables, one may learn that in the width of the conidia, they were almost the same in three cases, but in the length, a remarkable difference may be recognized. In the forms on *Triticum vulgare* (I) and (IV), the class of highest frequency was 36.0 μ. But in the latter, the conidia which are less than 36.0 μ in length, were more numerous than in *T. vulgare* (I). The form of conidia on *T. dicoccum* var. *farrum* was conspicuously smaller than of those on *T. vulgare.* When the conidia formed on *T. vulgare* had been transferred onto *T. dicoccum* var. *farrum,* the length of the conidia became conspicuously shorter, but when they had been retransferred onto *T. vulgare,* the forms of the conidia gradually returned to their original size.

On May 19, 1932, germination experiments with the conidia formed on *T. vulgare* (IV) and *T. dicoccum* var. *farrum* (II) were made in the hanging-drop cultures. As shown in figure 7, the germ tubes of the conidia on *T. dicoccum* var. *farrum* were shorter and larger than those on *T. vulgare;* in addition irregular branches were frequently formed at their apices.

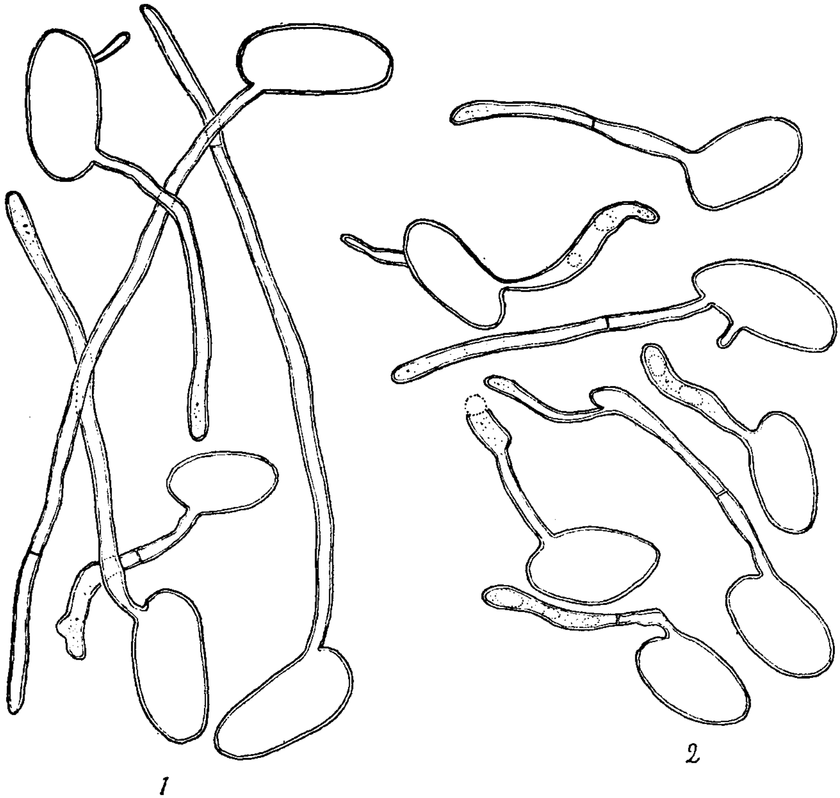


Fig. 7. Germination. (×550)

1. Germination of conidia of *Triticum vulgare* III, after 20 hours from the start of hanging-drop culture.
2. Germination of conidia of *T. dicoccum* var. *farrum,* after 20 hours from the start of hanging-drop culture.

Also, conidia formed on *T. vulgare* and *T. dicoccum* var. *farrum* were sown on the leaves of *T. dicoccum* var. *Khapli* which were placed on moistened filter paper in a Petri-dish. After 24 hours, the epidermis was stripped, and examined. Almost all conidia produced germ-tubes, and their length and size as well as their mode of branching were similar to those found in the former experiment.

Summary of experiments 5, 6 and 7

In 1904, E. S. SALMON (34) recognized the presence of a bridging form in *Erysiphe graminis* parasitic on Bromus. In order that the conidia on *Bromus racemosus* may cause infection on *B. commutatus,* they must pass on *B. hordeaceus.* In this case, the form on *B. hordeaceus* is the bridging form and *B. hordeaceus* is the bridging species. SALMON also noted that *Bromus tectorum* seems probably to be a bridging species, affording a means for the passage of the conidia on *B. arduennensis, B. hordeaceus, B. interruptus, B. commutatus* and *B. secalinus* to *B. sterilis.* Since then, no one has studied on this subject with *Erysiphe graminis.* In 1922, E. C. STAKMAN and M. N. LEVINE (42) noted that in the case of the cereal rust, the presence of a bridging species is very questionable. But from the results of the experiments above described the existence of a bridging form in the cereal mildew must be recognized. That is to say, the form on *T. dicoccum* var. *farrum* is the bridging form and *T. dicoccum* var. *farrum* is the bridging species between *T. vulgare* (Ekishirazu) and *T. monococcum* var. *Hornemanni.*

The morphological characters of the conidia on *T. vulgare* and those on *T. dicoccum* var. *farrum* are different; the former are longer than the latter, besides the germ-tubes of the former are more slender and longer than those of the latter.

When the conidia formed on *T. vulgare* (Ekishirazu) has been passed through *T. dicoccum* var. *farrum,* the power to infect *T. vulgare* (Ekishirazu) was weakened at first although this was the case for only a short time.

Experiment 8

In this experiment, tests were made on the influence of the hydrogen-ion concentration of the medium, in which the wheat seedlings were cultivated.

TABLE 30

Results of inoculation on wheat seedlings cultivated in different hydrogen-ion concentrations of the medium.

Host	Water culture media		Date of culture started	Date of inoculation	Number of spots	Height of wheat
T. vulgare (Ekishirazu)	Control Knop-solution (PH. 5.8-6)		IX. 28	IX. 29	X. 8 2	(Average) 17.93 cm.
	I	a	,,	,,	9	20.93
	PH. 3.6	b	,,	,,	1	19.77
	II	a	,,	,,	0	12.00
	PH. 5	b	,,	,,	1	13.53
	III	a	,,	,,	11	21.17
	PH. 6.8	b	,,	,,	5	22.50
	IV	a	,,	,,	12	17.43
	PH. 10	b	,,	,,	2	19.38
T. dicoccum, Khapli	Control Knop-solution (PH. 5.8-6)		IX. 28	IX. 29	0	24.25
	I	a	,,	,,	0	21.07
	PH. 3.6	b	,,	,,	0	19.65
	II	a	,,	,,	0	Withered
	PH. 5	b	,,	,,	0	19.20
	III	a	,,	,,	0	21.72
	PH. 6.8	b	,,	,,	0	25.47
	IV	a	,,	,,	0	22.13
	PH. 10	b	,,	,,	0	16.27

Young seedlings grown to about 4 cm. in length were cultured in Knop solution having different PH. values. Normal Knop solution (PH. 5.8–6.0) was used for the control. Modified Knop solution of PH. 3.6 was used for series I. The solution of PH. 5 was used for series II. Calcium biphosphoricum was added to the normal Knop solution for preparing the modified solution. Modified Knop solution of PH. 6.8 was used for series III, and for series IV that of PH. 10 was used. For the preparation of these solutions ash was mixed with normal Knop solutions. The cultures were started on Sept. 28. After 24 hours, the seedlings were inoculated with conidia formed on *T. vulgare* (Ekishirazu). *T. dicoccum,* Khapli was not infected and proved to be immune. The cultural solutions were renewed every two days, and after 2 weeks, the length of the seedlings was measured. In both kinds of wheat, they attained the greatest growth in the solution of PH. 6.8. In *Triticum vulgare*, the seedlings cultured in the medium of PH. 5, showed the least number of infected spots and the poorest growth in length.

2. Difference in characters between the susceptible and immune varieties of wheat

(1) Morphological differences

For investigation on the morphological difference of each variety of wheat in regard to susceptibility and immunity to the powdery mildew, the different characters were observed as shown in the following table.

TABLE 31

Morphological difference of the susceptible and immune wheat.

Varieties of wheat	Color of coleoptile	Color of leaves	Number of hairs in 1 sq. mm.		Degree of infection
			Upper	Under	
T. vulgare (Wase-komugi)	Light green	Light green	10	5	4—4
T. vulgare (Ekishirazu)	Light green	Light green	20	10	4—4
T. compactum (Hokkaido, Agr. Exp. Stat. No. 63)	Greenish brown	Green	10	5	3—4
T. Spelta var. Dukamelianum (J. 4. 4. 1. 1. 1.)	Greenish russet	Green	5	20	2—4
T. turgidum var. pseudocervinum (Alaska)	Light green	Deep green	20	40	3—2
T. durum var. hordeiforme (Belotourka)	Brownish green	Green	5	Trace	4—0
T. polonicum var. chrysospermum (de Pologne ou d'Astrakan)	Light green	Deep green	10	Trace	3—0
T. dicoccum var. farrum	Greenish Hay's russet	Deep green	50	55	2—0
T. monococcum var. vulgare	,,	,,	30	20	1—0
T. monococcum var. Hornemanni	Greenish russet	,,	50	100	2—0
T. dicoccum, Khapli, 6400	,,	Green	5	20	0
T. dicoccum, Emmer, 3933	Greenish Hay's russet	Deep green	15	15	0

The coleoptiles of *Triticum dicoccum, T. monococcum,* and *T. Spelta* are greenish russet or greenish Hay's russet in color, those of *T. compactum* and *T. durum* are brownish green, and the rest are light green. At first, the reddish pigment is found diffused in the cell sap of the subepidermal cells. In this stage, the portion containing the pigment has the property of partial immunity. After about 2 weeks from the germination, the pigment is changed to purplish red in color. The diffused pigment assumes globular shapes in a certain limited number of cells. The pigment becomes then insoluble to water. In this stage, the coleoptile loses the resistant character.

The hairs in an area of 1 sq. mm. were counted under microscope using the square micrometer by means of Leitz's Ultropark. The marginal part of the middle portion of the leaf was used for the counting. The basal cell of the hair is always free from the haustorium, besides the hairs check the adherence of water drops on the epidermis. Therefore, the strains having numerous hairs show the tendency of resistance to the powdery mildew. Also the incubation period for the conidial infection is shorter in the case of the strains having fewer hairs than in those having numerous hairs. In *T. vulgare, T. compactum, T. Spelta, T. turgidum, T. durum* and *T. polonicum,* only a few hairs are produced. *T. dicoccum* var. *farrum* and *T. monococcum* have numerous hairs. But this character has no relation to their immunity. In *T. dicoccum,* varieties *Khapli* and *Emmer,* the hairs are far less than those of the susceptible form of *T. dicoccum* var. *farrum.*

The structure of the matured leaf blades of wheat was fully described by J. PERCIVAL (26) in 1921. In 1931, HELEN HART (15) published a paper on the relation between the structure of wheat and the rust. According to her, most of the tissues of wheat in the seedling stage are thin-walled chlorenchyma, with numerous intercellular spaces and the epidermis is then a thin, delicate and easily ruptured cellulose-walled membrane. The rust susceptible tissue in the leaf blade occupies the area between the parallel vascular bundles and extends from the lower to the upper epidermis. The girders of sclerenchyma that accompany some of the vascular bundles separate each collenchyma area from its neighboring area. The width of the area varies in different varieties of wheat and in different species of Triticum.

In *Erysiphe graminis*, the mycelial hyphae on the leaf surface send haustoria into the epidermal cells. As a consequence, the characters of the epidermal cells have a close relation to the penetration of the infection tube. The characters of the epidermal cells are determined by the number of vascular bundles and by the environmental factors. The leaf epidermis just above the vascular bundles in both the upper and lower surfaces is composed of thick-walled cells with thick cuticular layer, especially so in the large vascular bundles.

The infected spots of *Erysiphe graminis* on wheat become elongated along the veins. The production of haustoria is limited to the thin-walled epidermal cells. The creeping mycelial hyphae send haustoria into the cells of the valley of the epidermis, and in this part, the cuticular layer does not develop so well. In the sheath, the same characters were recognized as those in the leaf blade. The development of the thick-walled cells of the epidermis with thick cuticular layer is influenced by the temperature, moisture, light, nutrition, etc. When the wheat is grown under unfavorable conditions, the thin-walled epidermal cells become predominant, thus making the plant susceptible to the attack of the powdery mildew.

The seeds of *T. vulgare* (*Wase-komugi*) were sown on moistened cotton in a glass dish, and it was covered with a bell-jar, and placed on the table of the laboratory. When the seedlings had grown to 10 cm. in length, they were inoculated with conidia. On the third day after the inoculation, white patches began to appear on the leaves at the inoculated portions. These patches become elongated along the veins. After a week, the stripped epidermis from the affected leaf was examined. All epidermal cells were thin-walled. In this stage, haustoria were seen even in the epidermal cells on both sides of the vascular bundles. After three weeks, the mycelial hyphae spread over the surface of the leaf. In this stage, under the abnormal condition, the haustoria were sometimes found in the epidermal cells on both sides of the bundles, besides also even in those of the midrib. This fact was also observed in the specimens collected at Sorachi, in the Province of Ishikari, Hokkaido, in 1931, when the wet weather had continued for a long time.

The relative development of the thin-walled and thick-walled epidermal cells is determined by the relative number of vascular bundles in a certain area. In the cross section of the leaf the distance was measured from a central vessel in a vascular bundle to that of the neighboring bundle.

TABLE 32

Results of the measurements of the distance from a central vessel in a vascular bundle to that of the neighboring bundle in cross-sections of leaves of susceptible and immune wheat.

A. Highly susceptible varieties	*Triticum vulgare* (Ekishirazu)	252-280 μ
	T. Spelta (J. 4. 4. 1. 1. 1.)	238-266 μ
	T. turgidum (Alaska)	224-252 μ
	T. compactum (Hokkaido, Agr. Exp. Stat. No. 63)	210-252 μ
B. Less susceptible varieties	*T. durum* (Belotourka)	210-238 μ
	T. Polonicum (de Pologne ou d'Astrakan)	168-210 μ
	T. dicoccum var. *farrum*	168-238 μ
C. Resistant varieties	*T. monococcum* var. *vulgare*	169-210 μ
	T. monococcum var. *Hornemanni*	154-196 μ
D. Immune varieties	*T. dicoccum, Khapli* 6400	210-252 μ
	T. dicoccam, Emmer 3933	168-182 μ

In group A, the distance between two vascular bundles is the longest and the number of thin-walled epidermal cells is the largest. In group B, they are less than in the group A. In group C, they are less than those in group B. In group D, in *T. dicoccum, Khapli,* the distance is great, and in *T. dicoccum, Emmer* it is short; these species being immune, these characters have no important significance.

As the results of the morphological studies, the characters, as shown in the following note were recognized on each variety of wheat. In the highly susceptible varieties, the number of epidermal hairs and thick-walled epidermal cells are scanty. In the resistant varieties, the number of hairs and the thick-walled epidermal cells are numerous. In the less susceptible varieties, the number of hairs are less than those of the resistant. In the immune varieties, no morphological differences could be found. On the whole it can be said that the degree of susceptibility to the powdery mildew of different varieties of wheat can be determined by their morphological characters.

(2) Difference of the infection spots.

The difference in the characters of the infection spots on *Triticum vulgare* (Ekishirazu), *T. turgidum* (Alaska), *T. compactum* (Hokkaido, Agr. Exp. Stat. No. 6355), *T. durum* (Belotourka), *T. monococcum* var. *Hornemanni, T. monococcum* var. *vulgare, T. dicoccum* var. *farrum* and *T. abyssinicum* were studied. In the highly susceptible varieties, as in *T. vulgare* (Ekishirazu), *T. Spelta, T. turgidum* and *T. compactum,* the affected leaves became greenish yellow in color within a month after infection. At that time, the circumference of the mycelial spot was fringed with a light green color. But in *T. vulgare* and *T. Spelta* these color changes did not so evidently appear. In the less susceptible varieties, the fringe of the light green color gradually turned to brown. In *T. monococcum* var. *vulgare* and *T. monococcum* var. *Hornemanni,* the brownish margin plainly appeared.

(3) Mechanical difference.

The phenomenon of plasmolysis was observed in the epidermal cells of the leaf of susceptible and immune varieties of wheat. The sugar solution of ½–3 mol was used for the measurement. The stripped epidermis of the leaf was mounted in a sugar solution and was observed under the microscope in the dark field. The results are shown in the following table:—

TABLE 33

Results of plasmolysis in the epidermal cells of the susceptible and immune wheat.

Sugar sol. Mol. / Varieties of wheat	½	1	1½	2	3
T. dicoccum, Khapli	Did not appear	After 30 m.	After 18 m.	After 7 m.	Immediately
T. vulgare (Ekishirazu)	After 60 m.	After 10 m.	Immediately		

This experiment was made on wheat which had grown for a month after sowing. When 1.5 mol sugar solution was used, the plasmolysis appeared immediately in *T. vulgare,* the susceptible variety, but in *T. dicoccum,* the immune variety, 3 mol solution had to be used to have a similar result.

(4) Chemical difference

a. Staining

The dyes are generally classed in the natural and artificial groups. For the latter group the author examined the reactions induced by the several basic and acid dyes in immune and susceptible varieties of wheat.

Acid dyes

1.	Orange G.	Clove-oil solution.
2.	Bismarck brown	Alcoholic solution.
3.	Congo red	Alcoholic solution.
4.	Aceto Methyl blue.	
5.	Fuchsin	Alcoholic solution.
6.	Aceto Carmine.	
7.	Anilin blue	Alcoholic solution.

Basic dyes

1.	Crystal violet	Alcoholic solution.
2.	Giemsa's stain + NaOH	
3.	Methyl green	Alcoholic solution.
4.	Safranin	Alcoholic solution.
5.	Thionin	Alcoholic solution.
6.	Light green	Alcoholic solution.

After 20–30 minutes from the treatment with the above dyes, the experimental material was observed under the microscope. When the stripped epidermis of *T. dicoccum, Khapli* was treated with Congo red the epidermal cells were not stained, while those of *T. vulgare* (Ekishirazu) were stained light red. When Bismarck brown was used, the epidermal cells of *T. dicoccum, Khapli* were stained orange in color, but those of *T. vulgare* stained light orange. When the other dyes were used, no difference could be recognized between the two varieties, both being stained to an equal degree and presenting a similar reaction.

b. Hydrogen-ion concentration

A. M. HURD (19, 20) reported on the relation of the hydrogen-ion concentration of the leaves and stems of the resistant and susceptible varieties of wheat to stem rust and other disease. She determined the H-ion concentration using expressed juice obtained from various parts of the leaves and stems in different growing stages. Her results are as follows:—

A. Seedlings 2 weeks old, limed soil.

		Cut 9 a.m. PH.		Cut 1 p.m. PH.
Khapli (R)	a	5.96		5.97
	b	6.92		
Little club (S)	a	6.00		6.04
	b	5.97		
Kanred (S)		6.04	a	6.13
			b	6.12
Turkey (S)		6.08	a	6.16
			b	6.13

B. Seedlings 5 weeks old, unlimed soil.

	Cut 9 a.m. PH.	Cut 1 p.m. PH.
Khapli (R)	5.97	5.98
Little club (S)	5.73	5.80
Turkey (S)	5.85	5.99

She noted that the hydrogen-ion concentration did not correlate on either resistant or susceptible characters. The present author used the method of J. SMALL (39, 40) (Hydrogen-ion concentration in plant cells and tissues, Chapter VIII). The following indicator solutions were used for the experiment.

Brom-thymol blue 0.02% (6.0–7.6)
  Mono Na. salt in 20% alcoholic solution.
Brom-cresol purple 0.04% (5.2–6.8)
  Mono Na. salt in 20% alcoholic solution.

Triticum vulgare (Ekishirazu), *T. durum* (Belotourka) and *T. dicoccum, Khapli* were sown on May 21. After 7 days, the H-ion concentration of the epidermal cells of the three varieties was measured. After that, they were measured for a month once every five days. The H-ion concentration of the living protoplasm of the epidermal cells of the leaves could not be measured accurately because the protoplasm caused plasmolysis before the epidermal cells were stained to any perceptible extent. The thick-walled epidermal cells were more or less stained by the indicator solution, but the PH. value could not be very well determined on account of the cells being stained light in color. The guard-cells of the stomata were stained exceedingly well, and these cells are not infected by the powdery mildew.

The H-ion concentration of the haustoria in the epidermal cells was measured 10 minutes after the treatment by the solution. The PH. value was about 5.8–6.0. The PH. value of the conidia, germ tubes and mycelial hyphae was similar to that of the haustoria.

In addition, Methyl Red alcoholic solution (20%) was used as an indicator solution. The results were similar to those of the former experiments.

As the results of chemical tests, the difference of the epidermal cells of the susceptible and resistant varieties of wheat in regard to the staining reaction is that in *T. dicoccum, Khapli,* cells are not stained by Congo red, but they are stained orange color by Bismarck brown, and in *T. vulgare,* they are stained light red by Congo red and light orange by Bismarck brown. Also, the measurement of the hydrogen-ion concentration of the living protoplasm of the epidermal cells could not be determined by Small's method.

Summary of the section on specialization and resistance

1. The immune and susceptible characters of wheat to the infection by *Erysiphe graminis* f. sp. *Tritici* were determined by infection experiments. The characters differ more or less in different species and varieties. In susceptible varieties of wheat, the degree of susceptibility differs greatly in different varieties.

2. The highly or less susceptible characters are more or less changed by the environmental factors. In wheat cultivated in the field, the haustoria did not form in the thick-walled epidermal cells on both sides of the vascular bundles, but when the plants were grown in the laboratory, the haustoria were produced in those cells. The resistant characters of the protoplasm in the living cells did not change even though the plants were cultivated in Knop-solution of different hydrogen-ion concentrations. The osmotic pressure in the

epidermal cells of *T. vulgare* was lower than that of *T. dicoccum, Khapli.*

3. The susceptible and resistant varieties are distinguished by the difference in the morphological characters of the leaf. In the less susceptible variety, numerous hairs are produced on the surface of the leaves and the epidermis is composed of numerous thick-walled cells. The highly susceptible variety has less hairy epidermis, whose wall is much thinner to a great extent. But, in the immune varieties, no significance could be assigned to the morphological characters as in the cases of the resistant and susceptible varieties.

4. In the course of the infection experiments, the writer found that the conidia on *T. vulgare* (Ekishirazu) did not infect *T. monococcum* var. *Hornemanni* unless they were passed through *T. dicoccum* var. *farrum*. *T. dicoccum* var. *farrum* proved to be a bridging species.

Systematic Part

Erysiphaceae are to be found widely throughout the tropical and temperate zones. In this country, which ranges from Lat. 21°45′ N. to Lat. 50°55′ N. numerous species have been found. For the investigation of both the conidial and perithecial stages of the fungi, Sapporo in the island of Hokkaido is most favorably situated.

The species reported in the present paper are as follows:

Erysipheae	Cystotheca	2 species
	Sphaerotheca	6 species
	Podosphaera	4 species
	Erysiphe	7 species
	Uncinula	23 species
	Typhulochaeta	1 species
	Sawadaea	3 species
	Microsphaera	17 species
Phyllactinieae.........	Phyllactinia	9 species
	Uncinulopsis	1 species
Leveilluleae...........	Leveillula	1 species
	Total	74 species

Among the above species, those considered as new species are nine in number; namely, *Microsphaera Ligustri* HOMMA on *Ligustrum ovalifolium; M. Coryli* HOMMA on *Corylus heterophylla* var. *japonica, Corylus mandshurica* and *Corylus Sieboldiana*; *M. Abeliae* HOMMA on *Abelia spatulata*; *M. Viciae-unijugae* HOMMA on *Vicia unijuga* and *Vicia Tanakae; Sawadaea Negundinis* HOMMA on *Acer Negundo; Uncinula bifurcata* HOMMA on *Quercus serrata*; *U. Picrasmae* HOMMA on *Picrasma quassioides*; *U. Betulae* HOMMA on *Betula Ermanii* var. *subcordata,* and *Betula Tauschii*; and *U. Nishidana* HOMMA on *Sterculia platanifolia*; those species whose names are revised by the new combination are six; viz., *Sphaerotheca japonica* (SALM.) HOMMA, *Sawadaea Tulasnei* (FUCK.) HOMMA, *Microsphaera pseudo-Lonicerae* (SALM.) HOMMA, *Phyllactinia Fraxini* (DC.) HOMMA, *Phyl. Pyri* (Cast.) HOMMA, and *Phyl. quercus* (MÉR.) HOMMA.

The genus Typhulochaeta is the only endemic genus in this country, and *Typhulochaeta japonica* is found widely in Honshu and Kyushu.

The total number of the specimens examined by the present author is 3090, of which those belonging to Cystotheca are 142, to Sphaerotheca 615, to Podosphaera 93, to Erysiphe 872, to Uncinula 391, to Typhulochaeta 14, to Sawadaea 92, to Microsphaera 559, to Phyllactinia 282, to Uncinulopsis 27, and to Leveillula 3. The host plants of these specimens belong to 427 species. A large number of these specimens of the Erysiphaceae of Japan which are presereved in the Herbarium of our University were kindly placed in the writer's hand by Prof. K. MIYABE for the preparation of the present paper.

The powdery mildews parasitic on Humulus, Acer, Lamium, Galeopsis and Lithospermum were first recorded under the collective name of *Mucor Erysiphe* by LINNAEUS in his "Species Plantarum" in 1753 (106). Later, A. P. DE CANDOLLE (58), E. FRIES (66), L. H. LÉVEILLÉ (101), and others classified them into many genera by the characters of the perithecial stages. In 1870, A. DE BARY (5) reported the result of his studies on the parasitism of Erysiphaceae. The species belonging to this family were found to send haustoria into the epidermal cells of host plants. At that time, mycologists recognized them as external parasites. But in 1899, E. PALLA (25) investigated the parasitism of the genus Phyllactinia, in which he found special hyphal branches from the creeping mycelium entering into the intercellular spaces of the mesophyll tissue of the leaf through the stomata. The inner hyphae send haustoria into the surrounding parenchyma cells. By these characters, the family Erysiphaceae was divided into two subfamilies of Erysipheae and Phyllactinieae. In 1900, E. S. SALMON (32) published his monograph of Erysiphaceae, in which he followed the opinion of PALLA.

On the other hand, in 1809, the genus Oidium was first established as a member of Mucedinaceae by H. F. LINK. (104). In 1817, Oidium on grass was included in the genus Acrosporium by C. G. NEES (121). In 1824, LINK (105) published several new species in Oidium. In 1829, E. FRIES (66) noted eight species of Oidium in which he recognized *Oidium leucoconium* as the conidial stage of *Erysiphe pannosa* and also *Oidium Erysiphoides* as that of many other species of Erysiphaceae. This report is the first record on the relation of the conidial and perithecial stages of Erysiphaceae. In 1837, M. A. LIBERT recognized *Oidium monilioides* LINK as the conidial stage of *Erysiphe graminis*.

In 1880, P. A. SACCARDO (137) emended the characters of Oidium LINK in Michelia II, p. 15. In 1886, the same author (138) enumerated 37 species of Oidium which were divided into two groups, according to the size of the spores, viz. Microsporae and Macrosporae. According to him, the species belonging to Macrosporae include only the conidial stages of Erysiphaceae. In 1907, G. LINDAU (103) noted twenty European species of Oidium, most of which he considered as the conidial stages of Erysiphaceae.

As to the conidial stage of *Phyllactinia corylea*, L. R. and C. TULASNE (177) remarked in 1861 that it must be separated from Oidium because of morphological differences. In 1900, N. PATUILLARD and P. HARIOT (128) established the new genus Ovulariopsis, on the ground that the conidia are clavate and are produced in a chain or solitary on the apex of the conidiophore. *Ovulariopsis erysiphoides* was described as the conidial stage of *Phyllactinia corylea*. On the form of Ovulariopsis occurring on *Morus alba*, in 1903, G. DELACROIX (7) recognized a new species and described it under the name of *Ovulariopsis moricola*. In 1904, E. S. SALMON (144) noted that *Ovul. erysiphoides* and *Ovul. moricola* belong to the conidial stage of *Phyllactinia corylea*. But, at the present time, *Ovul. moricola* is recognized as the conidial stage of *Phyllactinia moricola*.

In 1902, G. SCALIA (155) described Oidiopsis as a new genus of Mucedinaceae. This genus like Ovulariopsis is a perfect inner parasite, the mycelial hyphae spreading in the intercellular spaces of the mesophyll tissue of the leaves and forming haustoria in the surrounding cells. The conidiophores are produced as branches from the inner mycelium coming out through the stomata and there forming conidia on their apices. *Oidiopsis sicula* on *Asclepias curassavica* was described by SCALIA as a new species representing his new genus. In 1905, SALMON (146) studied the conidial stage of *Erysiphe taurica*, and recognized that it belongs to Oidiopsis. In the next year, the same author (147) transferred the genus Oidiopsis from Mucedinaceae to Erysiphaceae, on which he founded a new subfamily Oidiopsideae. *Erysiphe taurica* was thus renamed *Oidiopsis taurica*. Erysiphaceae have been divided by him into three subfamilies, Erysipheae, Phyllactinieae and Oidiopsideae. In 1914, K. SAWADA (149) tried to classify the Erysiphaceae of Formosa by the characters of their conidial stage. In 1921, G. ARNAUD (49) announced that Oidiopsis is the generic name proposed for the conidial stage, and should not be used for the perfect perithecial stage. For this reason, he proposed Leveillula as the name of the genus.

At the present time, the relation of the perithecial and conidial stages of Erysiphaceae is as follows:

	Perithecial stage		Conidial stage
	Erysiphaceae		Mucedinaceae
Subfam.	Erysipheae	Genus	Oidium
,,	Phyllactinieae	,,	Ovulariopsis
,,	Leveilluleae	,,	Oidiopsis

Historical survey of the Japanese Erysiphaceae

Cystotheca Wrightii parasitic on an evergreen oak was described by BERKELEY and CURTIS in 1858 (50). This was the first record of the Japanese Erysiphaceae. It was collected in the Loo-Choo Islands by CHARLES WRIGHT in April 1855, in the North Pacific Exploring Expedition under Commodore Rodgers.

In 1887, E. TANAKA (170) noted on the parasitic fungi in general, and he used therein for the first time the name "Udonko", meaning the "floury powder", for the powdery mildew in this country. In 1890, *Cystotheca Wrightii* on *Quercus myrsinaefolia* (Shira-kashi) was referred to by the same author (171) in his paper published under the name of "On the collection of fungi".

In 1891, K. SHIRAI (157) noted on the Koshu-grape mildew disease (*Oidium Tuckeri*) which had appeared in the vicinity of Katsunuma in the province of Kai. In 1892, the same author (158) reported the powdery mildew of *Nicotiana Tabacum* in his publication on the parasitic diseases in Saitama Prefecture. In 1897 Sphaerotheca on *Arctium Lappa* was noted by the same author (159).

In 1901, S. KUSANO (197) studied the haustoria of the powdery mildew, and he said that the common powdery mildew send haustoria into the epidermal cells of the host plants, while in the genus Phyllactinia, the mycelium spreads in the intercellular space among the mesophyll cells of the leaf and it has a tendency to approach the vascular bundles, owing to the phenomenon of chemotropism. In 1902, the same author (98) recorded that the conidia of the powdery mildew may pass the winter in the warmer region in the Province of Izu. In the same year, he (99) wrote on *Cystotheca Wrightii* parasitic on *Quercus glauca* (Aragashi) in his paper on "The parasitic fungi collected in the Chugoku district".

In 1900, E. S. SALMON (32) published "The monograph of Erysiphaceae", in which the species attributed to Asia are 25 in number and the varieties 3. The Japanese species and varieties therein mentioned are as follows: *Podosphaera Oxyacanthae, P. Oxyacanthae* var. *tridactyla, P. leucotricha*; *Sphaerotheca Humuli, S. Humuli* var. *fuliginea*; *Uncinula Salicis, U. Salicis* var. *Miyabei* (n. var.), *U. Aceris, U. clandestina, U. necator, U. Clintonii, U. polychaeta, U. australiana, U. Fraxini* (n. sp.),*U. Sengokui* (n. sp.) ; *Microsphaera Berberidis, M. Alni, M. grossulariae; Erysiphe Polygoni, E. Cichoracearum, E. Galeopsidis, E. graminis; Phyllactinia corylea.* There are 2 new species and 1 new variety. Most of these Japanese materials had been sent by Prof. MIYABE to Prof. SALMON. In the same year, (141) a species of Uncinula on *Quercus glandulifera* was first described as *Uncinula septata* SALM. In the same year too, "The Erysiphaceae of Japan" was published by SALMON (142). The materials were sent from Prof. K. MIYABE and Dr. S. HORI to him. The species included in that paper were:

Erysiphe 4 species; Podosphaera 2 species, 1 variety; Sphaerotheca 1 species, 1 variety; Microsphaera 3 species; Uncinula 6 species, 1 variety; and Phyllactinia 1 species. The total number is 17 species and 3 varieties. In 1905, the same author (145) published "The Erysiphaceae of Japan, II". In this paper, he made an enumeration of the former materials, as well as the specimens which had been subsequently sent to him from Prof. K. MIYABE, Dr. S. HORI, Dr. S. KUSANO, Mr. N. NAMBU and Mr. Y. TAKAHASHI. The species and varieties of the new materials are as follows:

Podosphaera 1 species, 1 variety; Sphaerotheca 2 species, 1 variety; Erysiphe 4 species; Microsphaera 3 species; Uncinula 12 species; and Phyllactinia 1 species. The total number is 23 species and 2 varieties. The host plants numbered 94 species. The species which were included in "The Erysiphaceae of Japan, III" by SALMON (148) in 1908 are as follows:

Podosphaera 2 species; Sphaerotheca 2 species, 2 varieties; Erysiphe 4 species; Microsphaera 3 species, 3 varieties; Uncinula 14 species; and Phyllactinia 1 species.

The total number is 26 species and 5 varieties. The new species and varieties therein described are *Uncinula simulans, Sphaerotheca Mors-Uvae* var. *japonica, Microsphaera Alni* var. *Yamadai* and *M. Alni* var. *pseudo-Lonicerae.* In 1902, the "Supplemental notes on the Erysiphaceae" was published by the same author (143). He discussed in it the several species of *Uncinula* and *Sphaerotheca* of Japan.

In 1900, P. and H. SYDOW (165) published the "Fungi novi Japonici", in which they reported on *Uncinula Kusanoi* n. sp. and *Oidium japonicum* n. sp. In 1909, the same authors (166) noted on *Erysiphe Polygoni, Uncinula Miyabei, U. Salicis* and *Phyllactinia corylea* in the "Micromycetes japonici". In 1913, in the paper entitled "Ein Beiträge zur Kenntnis der parasitischen Pilzflora des nordlichen Japan", 12 species and 1 variety of Erysiphaceae were reported by the same authors (165). *Uncinula Salmoni* SYDOW is a new species. In 1914, the same authors (168) published "Zweiter Beiträge zur Kenntnis der parasitischen Pilzflora des nordlichen Japan". In this paper, they noted on *Microsphaera Yamadai* n. comb., *Uncinula Delavayi* and *Cystotheca lanestris.* The above materials which were reported by SYDOW are specimens which were sent to them by Mr. M. MIURA.

In 1901, P. HENNINGS (77) published "Fungi japonici, I.", reporting in it on *Erysiphe communis, Microsphaera japonica* (n. sp.), *Sphaerotheca Castagnei* and *Phyllactinia suffulta* var. *moricola* (n. var.). In 1902, the same author (78) published his "Fungi japonici, II". The species reported therein are as follows: *Sphaerotheca Kusanoi* (n. sp.), *Sph. Phteirospermi* (n. sp.), *Sph. Humuli; Erysiphe Polygoni, E. Pisi* var. *Desmodii* (n. var.) ; *Microsphaera sambucicola* (n. sp.) ; *Uncinula Shiraiana* (n. sp.), *U. Zelkowae* (n. sp.), *U. clandestina* form. *japonica* (n. form.), *U. Salicis, U. verniciferae* (n. sp.) ; *Phyllactinia suffulta.* The above two papers are reports on specimens which had been sent to Prof. HENNINGS from Prof. K. SHIRAI. In 1903, 2 species of Erysiphe, 2 species of Uncinula, 1 species of Microsphaera and 1 species of Phyllactinia were reported in "Fungi japonici, III" by P. HENNINGS (79). In 1905, the same author (80) noted on *Sphaerotheca Castagnei, Erysiphe Cichoracearum, E. Polygoni, Microsphaera Mougeotii, Uncinula Clintonii* and *Phyllactinia suffulta* in "Fungi japonici, V".

In 1902, T. NISHIDA (124) wrote on *Uncinula Salicis, U. polychaeta* and *Phyllactinia corylea* in "The list of fungi collected in the Etchu Province".

In 1904, N. NAMBU (119) reported on *Microsphaera Alni, Uncinula Kusanoi, U. Aceris* and *Phyllactinia corylea* in "The parasitic fungi collected in the vicinity of Tokyo". In 1906, the same author

(120) published a paper under the name of "A list of parasitic fungi", in which he reported on *Sphaerotheca Humuli, Erysiphe Cichoracearum, Microsphaera Alni, Uncinula septata* and *Oidium erysiphoides.*

In 1901, T. YOSHINAGA (181) noted on *Cystotheca Wrightii, Erysiphe Polygoni, Phyllactinia suffulta* and *Oidium erysiphoides* in "Some fungi from Tosa Province". In 1904 (182), he published the third part of the above paper, in which *Sphaerotheca Castagnei, Microsphaera Mougeotii* and *Uncinula Clintonii* were described.

In 1905, K. YOSHINO (183) reported the following species:

Sphaerotheca 2 species, 1 variety; Podosphaera 1 species; Erysiphe 3 species; Microsphaera 1 species; Uncinula 4 species; Phyllactinia 1 species; and Cystotheca 1 species.

In 1907, I. MIYAKE (115) described *Uncinula Mori* (n. sp.) parasitic on *Morus bombycis.*

In 1914, a paper under the title of "Studies on the Oidium stages of Erysiphaceae" was published by K. SAWADA (149). In this paper, he published the new genus Sawadaea MIYABE, and he attempted the classification of Erysiphaceae according to the characters of the conidial stage. *Erysiphe Polygoni* was changed to the name *Microsphaera Polygoni,* and *Oidium subspiralis* SALM. was proved to be the conidial stage of *Phyllactinia subspiralis* (SALM.) SAWADA. In 1916, *Phyllactinia subspiralis* was separated from the genus Phyllactinia, and a new genus *Uncinulopsis* was established (151). In 1919, the same author (152) published his "Desc. catalog. Formosan fungi". He therein described 14 species, among which there was 1 new species, *Erysiphe Cinnamomi* SAWADA. In 1927, "Studies on the Oidium stages of Erysiphaceae in Formosa" was published by the same author (153). In this paper, he recorded 6 new species, *Erysiphe Tabaci, E. Plantaginis, Oidium Leonuri-sibiricae, Oid. Leucas-javanicae, Oid. Lactucae-debilis* and *Oid. Sonchi-arvensis,* and also made notes on *Erysiphe graminis* and *Oid. crystallinum.* In 1930, a paper "On the systematic investigation of Phyllactinia in Formosa" was published by the same author (38), in which he described 6 new species and 1 new combination of Phyllactinia, and 9 new species of Ovulariopsis. These species are as follows: *Phyllactinia Actinidiae-latifoliae, Phyll. Actinidiae-formosanae, Phyll. Broussonetiae-Kaempferi, Phyll. Sapi, Phyll. kakicola, Phyll. Pyri-serotinae, Phyll. moricola, Ovulariopsis Alni-formosanae, Ovul. Asclepiadis-curassavicae, Ovul. Ampelopsidis-heterophyllae, Ovul. Ampelopsidis-ciliatae, Ovul.*

Cephalanthi, Ovul. Caricae, Ovul. Macarangae, Ovul. Salicis- Warburgi, and *Ovul. Broussonetiae-papyriferae.* In 1933, SAWADA (154) published 1 species of Uncinula, 7 species of Phyllactinia, 2 species of Oidiopsis, 5 species of Oidium and 9 species of Ovulariopsis in Formosa. Amongst these species, *Oidiopsis Capsici, Oidiop. Papaveris, Oidium Emiliae-sonchifoliae, Oid. Heliotropii-indici, Oid. Cephalanthi,* and *Oid. Rosae-indicae* were added as new to science.

In 1915, S. ITO (89, 90) published a paper under the title of the "On Typhulochaeta, a new genus of Erysiphaceae", in which *Typhulochaeta japonica* S. ITO and HARA parasitic on *Quercus serrata* was described as a new species.

In 1915, K. HARA (73) reported on *Typhulochaeta japonica, Uncinula septata* var. *curvispora* (n. var.), *U. geniculata* var. *carpinicola* (n. var.), *U. necator* var. *Actinidiae* (n. var.), and *Microsphaera Alni* forma *Quercus-glanduliferae* (n. form.). In 1919, C. TANAKA (173) published the diagnoses in English of HARA's new species and varieties, viz. *Uncinula curvispora, U. geniculata* var. *carpinicola, U. necator* var. *Actinidiae* and *Microsphaera Alni* form. *Quercus-glanduliferae.* In 1921, K. HARA (74) reported on *Microsphaera Euonymi-japonicae* (SALM.) HARA.

In 1924, K. TOGASHI (174) noted 6 species of *Erysiphaceae* in "Fungi collected in the Islands of Rishiri and Rebun, Hokkaido".

Erysiphaceae LÉV.

The species of this family are parasitic on living flowering plants. Hyphae are usually white or sometimes brown colored, septate, branched and much interwoven as superficial mycelium. This family is divided into three subfamilies by the character of the parasitism. They are Erysipheae, Phyllactinieae, and Leveilluleae. In Erysipheae, the mycelium is superficial, sending haustoria into the epidermal cells of the host plants. In Phyllactinieae, the mycelium is subsuperficial, passing mycelial branches through the stomata into the intercellular spaces of the mesophyll, sending haustoria into the parenchyma cells, and forming conidia and perithecia on the superficial mycelium. In Leveilluleae, the mycelium is endophytic, forming haustoria in the surrounding cells of the leaf tissue, forming conidia on the conidiophores issuing from the stomata and forming perithecia on the superficial mycelium.

Conidia (Oidium, Ovulariopsis and Oidiopsis) are produced concatenately; they are large, one-celled, hyaline, ellipsoidal or clavate, borne on the conidiophores which branch either from the external or internal hyphae; conidiophores are hyaline, simple, thin walled, erect or bent at the base.

Perithecia are sessile, single, seated on the mycelium, membranaceous, at first colorless, then yellow, finally becoming dark brown, globose or globose-depressed, sometimes concave or lenticular, with walls several-layered; appendages arising from special, equatorial or basal portion of the perithecium, and they are either similar to the mycelial hyphae or different showing definite forms, colorless or brown. Asci are produced singly or in groups from the base of the perithecial cavity; they are colorless, subglobose, oblong or ovate, usually pedicellate. Ascospores are simple, colorless, ellipsoidal or ovate, thin-walled, each ascus holding 2–8 spores. Paraphyses absent.

Subfam. Erysipheae PALLA

Mycelium is wholly ectophytic, sending haustoria into the epidermal cells of the host plants. Conidia (Oidium) are produced in a chain on conidiophores arising from the external hyphae.

Key to the genera of the subfam. Erysipheae

1. Ascus single 2
   Asci several 3
2. Special hairs produced from the creeping brown mycelium, appendages wanting or very scarce, matured conidia produced in a chain, barrel-shaped .... *Cystotheca* (288)
   Appendages simple and hypha-like, matured conidia arise in a chain, elongate-ellipsoidal .... *Sphaerotheca* (295)
   Appendages dichotomously branched at the apex, matured conidia arise in a chain, subglobose or ellipsoidal .... *Podosphaera* (313)
3. Appendages simple 4
   Appendages branched 5
4. Appendages more or less like the mycelial hyphae, matured conidia produced solitary or in a chain .... *Erysiphe* (320)
   Appendages uncinulate at the apex, matured conidia solitary.... *Uncinula* (343)
   Appendages clavate, conidia not yet known .... *Typhulochaeta* (369)
5. Appendages simple, dichotomously or trichotomously branched, uncinulate at the apex, matured conidia arise in a chain and have two forms... .... *Sawadaea* (370)
   Appendages dichotomously branched several times at the apex, matured conidia solitary .... *Microsphaera* (376)

Cystotheca BERK. & CURT.

Mycelium is hypophyllous, superficial and persistent, grayish or blackish brown colored when matured, producing hairy branches from the mycelium; haustoria are formed in the epidermal cells; matured conidia are produced in a chain, barrel-shaped; perithecia are subglobose and brown in color, composed of two layers, which are easily separated from each other when pressed; asci are solitary; spores are 6–8 in number. This genus includes 2 species.

The present genus was first described by BERKELEY and CURTIS (50) in "Characters of new fungi, collected in the North Pacific Exploring Expedition by CHARLES WRIGHT". It is represented by a single species of *Cystotheca Wrightii.* The type specimen was collected in the Loo-Choo Islands in April 1855 (coll. no. 422). The genus was included in *Perisporiaceae.* In this report nothing was noted on the host plant of this specimen, but fortunately a part of the type specimen, which was kindly given by Dr. FARLOW to Dr. MIYABE, has been preserved in our Herbarium. In addition, the sketches of the original type preserved in the CURTIS collection in the FARLOW Herbarium, which were drawn by Prof. S. ITO, were kindly placed in the author's hand. Judging from these materials, the host plant of this specimen is evidently *Quercus stenophylla* BL. although a co-type which is deposited in Kew Herbarium was erroneously identified as *Quercus acuta* by v. HÖHNEL (178). The present genus was also included in Perisporiaceae by SACCARDO (138) and ENGLER (64).

On the other hand, in 1886, HARKNESS described *Sphaerotheca lanestris* parasitic on a deciduous oak, *Quercus agrifolia* NÉE. In 1900, SALMON gave a full description and observation on *Sph. lanestris* in his Monograph of Erysiphaceae.

In 1901, P. HENNINGS (77) gave a full account of *Cystotheca Wrightii* on *Quercus myrsinaefolia* collected in the Tokyo Bot. Gard. in Dec. 1897, by KUSANO. HENNINGS recognized it as a new family under the name of Cystothecaceae, by the presence of a peculiar cellular sac enveloping a single ascus.

In 1909, *Sphaerotheca lanestris* was transferred to the genus Cystotheca under the name of *Cystotheca lanestris* (HARK.) by Dr. MIYABE, and it was published by IDETA (87) in Japanese Phytopathology p. 226 (Japanese).

In 1911, SACCARDO (140) too renamed it as *Cystotheca lanestris* (HARK.) SACC.

In 1912, v. HÖHNEL (178) noted that "Die Gattung *Cystotheca* mit *Sphaerotheca* zusammenfällt, *Cystotheca* ist daher eine *Erysiphee* und die Aufstellung der Familie der Cystothecaceen ist eine irrtümliche. Diese meine Angaben wurden durch die Untersuchung des Original-Exemplares von *Cystotheca Wrightii* aus dem Herbarium in Kew, die ich 1909 vornahm, völlig bestätigt. Ich nannte nun den Pilz *Sphaerotheca Wrightii* (BERK. et CURT.), v. H.".

In 1915, SAWADA (150) discussed this genus in the Transactions of the Sapporo Nat. Hist. Soc. V, p. 204–209 (Japanese). According to his paper, the conidia are of Oidium type, including the well-developed fibrosin bodies, the inner wall of the perithecium easily separates from the outer, the appendages are produced from the basal portion of the perithecium, and 8 spores are included in an ascus. Because of these characters, he insists that Cystotheca must be included in Erysiphaceae and treated as synonymous to Sphaerotheca.

In 1917, the genus Cystotheca was included in Sphaerotheca as its synonym, by THEITZEN and SYDOW (173).

On the comparison of *Sphaerotheca lanestris* and *Cystotheca Wrightii,* the mycelial hyphae are seen to be densely compacted in both species, grayish to blackish brown in color and the haustoria are subglobose, extending into the epidermal cells; the matured conidia are produced in a chain; and they have special hairy bodies branched from the creeping mycelium; appendages on the perithecia are either completely lacking or sparingly produced, besides the inner wall of the perithecium easily becomes free from the outer. As these two species have these characters in common, the author has come to the conclusion that they must be included in the same genus. In the two genera Cystotheca and Sphaerotheca, in the form of the conidia, the former is of a barrel shape and the free end of the apical conidium has a tendency to become apiculate or obtusely pointed, while the latter is ellipsoidal; besides, in Cystotheca, numerous special hairs are produced from the creeping mycelium throughout all stages, and in Sphaerotheca such hairs are never seen. The inner perithecial wall of Cystotheca becomes very easily separated from the outer, and appendages are lacking or very scanty.

From the above mentioned differing characters, we have come to the conclusion that the genus Cystotheca ought to be kept distinct from Sphaerotheca.

The genus Cystotheca is allied to Perisporiaceae in respect to the fact that the special hairs are abundantly produced from the creeping mycelium and the mycelia of *Cystotheca Wrightii* are blackish brown in color, but the other characters coincide with Erysiphaceae rather than with Perisporiaceae.

Key to the species of the genus Cystotheca

1. Mycelium and hairs dark chocolate brown or blackish brown colored when mature, and parasitic on evergreen orks.................... C. *Wrightii* (291)
2. Mycelium and hairs grayish brown colored when mature, and parasitic on deciduous oaks.. C. *lanestris* (292)

Cystotheca Wrightii BERK. & CURT.

(Pl. VII. figs. 1, 2)

Proceed. Amer. Acad. IV, p. 130, 1858–1859; SACC. Syll. Fung. I, p. 72, 1882, XVI, p. 407, 1902, and Ann. Myc. VIII, p. 343, 1910; P. HENN. in ENGL. Bot. Jahrb. XXVIII, p. 273, 1901. (TANAKA, Bot. Mag. Tokyo, IV, p. 298, 1890; Ideta, Pract. Phytopath. p. 170, 1901, and Jap. Phytopath. p. 226, 1911; KUSANO, Bot. Mag. Tokyo, XVI, p. 203, 1902; YOSHINAGA, Bot. Mag. Tokyo, XVIII, p. 31, 1904; YOSHINO, Bot. Mag. Tokyo, XIX, p. 207, 1905; SHIRAI, List, p. 28. 1905; SHIRAI & MIYAKE, List, p. 191, 1917).

Syn. *Sphaerotheca Wrightii* (BERK. & CURT.) V. HÖHNEL, Zeitsch. f. Gärungsphys. I, p. 46, 1912. (SHIRAI & HARA, List, p. 371, 1929).

Sphaerotheca Wrightii (BERK. & CURT.) HARA, Dendropath. p. 4, 1923.

Sphaerotheca phytoptophila (not KELL. & SWING.) TAI et WEI Sinensia, III, p. 99, 1932.

Oidium japonicum SYD. Mém. d. l'Herb. Boiss. p. 6, 1900.

Hypophyllous, mycelium persistent, forming dense mass, at first pale brown in color, gradually turning to dark chocolate brown, producing sickle-shaped hairs; matured conidia borne in a chain, barrel-shaped, swollen at the center, the free end of the terminal one obtusely pointed, including the well-developed fibrosin bodies, 25.2–36.0 × 15.6–22.8 μ; perithecia gregarious, deep brown colored, imbedded in the mycelial mass, 62.4–72.0 μ in diameter, inner wall is easily separated from the outer, colorless and formed of large hexagonal cells, 13.2–18.0 × 12.0–15.6 μ, outer wall cells 15.6–18.0

× 9.6–14.4 μ in size; appendages none; ascus 1, subglobose or ellipsoidal, stalked, hyaline, 76.8–91.2 × 54.4–57.6 μ; spores 6–8 in number, ellipsoidal, 19.2–24.0 × 12.0–15.6 μ.

Hab. On leaves of *pasania cuspidata* OERST. (Shii). Honshu—Sagami.

On *Quercus acuta* THUNB. (Aka-gashi). Honshu—Musashi. Shikoku—Iyo.

On *Quercus glauca* THUNB. (Aragashi). Honshu—Musashi, Kazusa, Awa, Sagami, Suruga, Izu, Shinano, Mino, Yamashiro, Settsu, Bizen, Aki, Inaba. Kyushu—Buzen, Hizen, Higo. Loo-Choo Isl.—Hanechi, Yaeyama. Formosa—Daihoku.

On *Quercus myrsinaefolia* BL. (Shira-kashi). Honshu—Rikuzen, Musashi, Hitachi, Kozuke, Echigo, Mino, Bizen, Inaba. Kyushu—Higo.

On *Quercus stenophylla* MAKINO (Urajiro-gashi). Honshu—Musashi. Loo-Choo Isl.—(Apr. 1855, C. WRIGHT, U. S. Pac. Ex. no. 422, type).

Distrib. Japan (Honshu, Shikoku, Kyushu, Loo-Choo and Formosa) and China.

Remarks. *Cystotheca Wrightii* on *Quercus stenophylla* was first collected in this country by CHARLES WRIGHT in the Loo-Choo Islands in 1855. It was the first record of Erysiphaceae from Japan.

This species is parasitic on ever-green oaks and is very common in the warmer parts of this country. This fungus can be recognized at a glance by the dark chocolate-brown colored mycelial mass, which appears on the under surface of the leaves of the host plants. By this mycelial color, it is easily distinguished from *Cystotheca lanestris*. Besides the mycelial hairs are deeper brown and broader in width, assuming a sickle shape.

In 1912, this species was transferred to *Sphaerotheca* by v. HÖHNEL (178). In 1923, K. HARA (75) without knowing of v. HÖHNEL's action, also renamed it *Sphaerotheca Wrightii*. Truly, in a certain species of Sphaerotheca, as in *Sph. Mors-Uvae,* the mycelium assumes a dark brown color as in the case of Cystotheca, and they are both monoascus. But, in Sphaerotheca special shaped hairs are never found on the mycelium and the inner perithecial wall is not easily separated from the outer as it is in Cystotheca, in which appendages are either entirely wanting or very rarely present. Besides they are distinguishable from each other by the forms of their conidia.

From the above mentioned characters, the present author considers it better to retain this fungus in Cystotheca than to transfer it into Spaerotheca.

Cystotheca lanestris (HARKN.) MIYABE

(Pl. VII, fig. 3)

In IDETA, Jap. Phytopath. p. 226, 1909; MIYAKE, Bot. Mag. Tokyo, XXVII, p. 40, 1913.

Syn. *Sphaerotheca lanestris* HARKN. New Calif. Fungi, p. 20, 1886; TRACY and GALLOWAY, Journ. Myc. IV, p. 34, 1888; SACC. syll. Fung. IX, p. 364, 1891; ELL. & EVERH. N. Amer. Pyren. p. 9, 1892; SALM. Monogr. Erysiph. p. 74, 1900, and Bull. Torr. Bot. Club, XXIX, p. 95, 1902. (SALM. Ann. Myc. III, p. 252, 1905, and VI, p. 11, 1908; SHIRAI, List, p. 94, 1905; SHIRAI & MIYAKE, List, p. 627, 1917; SAWADA, Agr. Exp. Stat. Formosa, Bull. XIX, p. 159, 1919; IDETA, Jap. Phytopath. (Suppl. I) p. 204, 1925; SHIRAI & HARA, List, p. 371, 1927).

Sphaerotheca Kusanoi P. HENN. & SHIRAI, in ENGL. Bot. Jahrb. XXIX, p. 147, 1901; SACC. Syll. Fung. XVI, p. 402, 1902. (SHIRAI, List, p. 94, 1905; SHIRAI & MIYAKE, List, p. 627, 1917).

Cystotheca tenuis MIYABE & TAKAHASHI, in IDETA, Pract. Phytopath. p. 170, 1901. (Shirai, List, p. 28, 1905; SHIRAI & MIYAKE, List, p. 191, 1917).

Cystotheca lanestris (HARKN.) SACC. Ann. Myc. IX, p. 249, 1911; SACC. Syll. Fung. XXII, p. 20, 1913. (SYD. Ann. Myc. XII, p. 161, 1914).

Oidium ventricosum HARKN. New Calif. Fungi, p. 20, 1886; SACC. Syll. Fung. IX, p. 364, 1891.

Hypophyllous, mycelium persistent, forming dense mass, grayish brown in color, the mycelial hyphae 4.8–5.6 μ in width, the mycelial hairs slender, flexuous and long; matured conidia produced in a chain, barrel-shaped and the free end of the apical one is rounded or obtusely pointed, granulate, vacuolate, including the well-developed fibrosin bodies, 26.4–36.0 × 12.0–22.8 μ in size; perithecia globose, 98.0–108.0 μ in diameter; cells, those of the inner wall 12.0–16.8 μ, the outer wall 12.0–14.4 μ, the inner wall is composed of hexagonal cells, hyaline, and the outer wall dark brown in color; appendages scanty, interwoven with the mycelial hyphae, or hyaline or pale brown in color, frequently wanting; ascus 1, elongate-ellipsoidal, with a short stalk, 116.0–130.0 × 70.8–74.4 μ; spores always 8, ovate or ellipsoidal, 22.8–27.5 × 13.2–15.2 μ.

Hab. On leaves of *Quercus acutissima* CARR. (Kunugi). Honshu—Tamba.

On *Quercus aliena* BL. (Nara-gashiwa). Kyushu—Higo.

On *Quercus crispula* BL. (Mizunara). Hokkaido—Ishikari. Honshu—Uzen, Shimozuke, Suruga. Kyushu—Bungo, Higo.

On *Quercus dentata* THUNB. (Kashiwa). Hokkaido—Ishikari. Honshu—Rikuchu.

On *Quercus major* NAKAI (Oba-konara). Hokkaido—Ishikari.

On *Quercus serrata* THUNB. (Konara). Hokkaido—Oshima, Iburi, Ishikari. Honshu—Mutsu, Rikuchu, Rikuzen, Ugo, Iwaki, Hitachi, Musashi, Kazusa, Kozuke, Sagami, Echigo, Etchu, Kaga, Suruga, Izu, Shinano, Tamba, Settsu, Mimasaka, Oki. Shikoku—Iyo.

Distrib. Japan (Hokkaido, Honshu, Shikoku and Kyushu), and North America.

Remarks. The present species was first described as *Sphaerotheca lanestris* by HARKNESS in 1886. SALMON, ELLIS and EVERHART used this specific name. In 1902, P. HENNINGS (78) named it as *Sph. Kusanoi* P. HENN. & SHIRAI, from a specimen which was collected by KUSANO on Mt. Myogi, in Prov. Kozuke, on *Quercus serrata.* Although it was not possible for the present writer to examine its authentic specimen, it was possible to study this species parasitic on the same host, from specimens that had been collected in every part of this country. All the specimens thus examined had similar characters and were found to be identical with *Cyst. lanestris.* In 1901, MIYABE and TAKAHASHI described it (in manuscript) as *Cystotheca tenuis* parasitic on *Quercus crispula* and *Q. acutissima,* and it was published by IDETA (86) in his Practical Phytopathology (Japanese), not accompanied by a diagnosis of the fungus. In 1909, *Sphaerotheca lanestris* was transferred to the genus Cystotheca by MIYABE (87) and it was called *Cystotheca lanestris* (HARKN.) MIYABE. This name was published by Ideta in his Japanese Phytopathology in the same year. In 1911, SACCARDO (140) used the same name *Cystotheca lanestris* (HARKN.) SACC. for the fungus, based on the character of the perithecium, the inner wall of which can be separated readily from the outer.

On the Oidium stage of this species, in 1886, HARKNESS described it as follows: "*Oidium ventricosum;* segment swelling in the center and becoming barrel-shaped, 34–38 × 20–22 μ, and filled with numerous round or elliptic bodies, 5–6 × 2–4 μ, which are freely discharged from the end, as the joints separate". The writer examined the conidia in the Japanese materials and observed the same facts. The conidia of *Cystotheca lanestris* are easily distinguished from those of the species of Sphaerotheca, and the special formed hairs are abundantly produced from the creeping mycelium. From these two characters together with the easily separable character of the outer and inner walls of the perithecium, the present fungus ought to be treated as a species belonging to the Cystotheca.

In the present species, the mycelial hyphae form a very dense mass, presenting a grayish brown color when mature. The hyphae are more slender than those of *Cystotheca Wrightii.* The fungus is always parasitic on the under surface of the leaves of deciduous Quercus, and is widely distributed in all parts of this country. The hairs are light brown in color, slender, flexuous, aseptate, thin-walled and equal to a mycelium in width, reaching 135 μ in length. The inner wall of the perithecium is composed of colorless and fine hexagonal cells which are more or less larger than those of the outer wall. The outer wall is dark brown in color and obscurely reticulate. The appendages are sparingly produced from the basal portion of the perithecium. They are hyaline or pale brown, interwoven with the mycelial hyphae, so that it is difficult to distinguish between them.

This species somewhat resembles *Sphaerotheca pannosa* and *Erysiphe graminis* at first sight, but *Sphaerotheca pannosa* never produces hair-like bodies from the superficial mycelium, the two layers of the perithecial wall are not separable, and *Erysiphe graminis* has many asci.

Sphaerotheca LÉV.

Mycelium persistent or evanescent; matured conidia are produced in a chain, subglobose, ellipsoidal or elongate-ellipsoidal, and include well-developed fibrosin bodies; perithecia globose, appendages simple or vaguely branched, brown or dark-brown colored, several septate; ascus 1; ascospores 6–8 in number.

In Japan six species are known so far in this genus.

This genus is distinguished from Erysiphe by its single ascus, and from Cystotheca by the lack of special hairs on the mycelium. Of *Sphaerotheca pannosa,* the perithecial stage has not yet been found in this country, in spite of careful search for several years, but there is no doubt that the powdery mildew of our rose plant belongs to the species judging from the characters of its Oidium and mycelium.

Key to the species of the genus Sphaerotheca

I. Mycelium becoming gray or pale brown colored when mature ..*S. pannosa* (311)
II. Mycelium becoming brown or deep-brown colored when mature.
  a. Cells of the outer wall of the perithecium small, 12.0—26.4×9.6—19.2 μ.
    1. Diameter of the perithecia 70—112 μ..................*S. Humuli* (296)
    2. Diameter of the perithecia 64.8—86.4 μ................*S. Epilobii* (300)
  b. Cells of the outer wall of the perithecium irregular and always larger, 19.2—55.2×10.8—36.0 μ ....*S. fuliginea* (301)
III. Mycelium becoming blackish-brown or black colored when mature.
    1. Diameter of the perithecia 94—126 μ ....*S. Mors-Uvae* (309)
    2. Diameter of the perithecia 74—98 μ...................*S. japonica* (310)

Sphaerotheca Humuli (DC.) Burr.

(Pl. VII, figs. 4, 5, 6, 7)

Bull. Ill. State Lab. Nat. Hist. II, p. 400, 1887; Ell. & Everh. N. Amer. Pyren. p. 5, 1892; Salm. Monogr. Erysiph. p. 45, (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 87 (p.p.), 1902; Neger, Kryptg. Fl. d. Mark Brand. VII, p. 106 (p.p.), 1905; Jørst. Erysiph. Norway, p. 14 (p.p.), 1925; Školić, Erysiph. Croat. p. 34, 1926; Tai & Wei, Sinensia, III, p. 97, 1932. (Pamm. Journ. Myc. IV, p. 36, 1888; Tracy & Galloway, Journ. Myc. IV, p. 34, 1888; Griff. Bull. Torr. Bot. Club, XXVI, p. 143, 1899; Salm. Bull. Torr. Bot. Club, XXVII, p. 445 (p.p.), 1900, Ann. Myc. III, p. 252, 1905, and VI, p. 11, 1908; Shirai, List, p. 93, 1905; Lawrence, Journ. Myc. XI, p. 107, 1905; Nambu, Bot. Mag. Tokyo, XX, p. 252, 1906; Jaap, Ann. Myc. IX, p. 333, 1911; Ideta, Japanese Phytopathology, p. 201, 1911, and Japanese Phytopathology (Suppl. I), p. 202, 1923; Sydow, Ann. Myc. XI, p. 113, 1913; Miyake, Bot. Mag. Tokyo, XXVIII, p. 38, 1914; Sawada, Agric. Experiment Station, Formosa Spec. Bull. IX. p. 42, 1914; Shirai & Miyake, List, p. 625 (p.p.), 1917; Togashi & Hiratsuka, Transact. Sapporo Nat. Hist. Society, XVI, p. 74, 1924; Shirai & Hara, List, p. 375 (p.p.), 1927; Miura, South Manch. Rwy. Co. Agr. Rep. XXVII, p. 115, 1928.)

Syn. *Erysiphe Humuli* DC. Fl. Fr. VI, p. 106, 1815.

Erysiphe Sanguisorbae DC. Fl. Fr. VI, p. 108, 1815.

Erysibe macularis Schlecht. Fl. Berol. II, p. 168, 1824; Rabenh. Deutschl. Krypt. Fl. I, p. 231 (p.p.), 1844.

Erysiphe fuliginea Fr. Syst. Myc. III, p. 238 (p.p.), 1829.

Erysiphe horridula Rabenh. Deutschl. Krypt. Fl. I, p.235, (p.p.), 1844.

Sphaerotheca Castagnei LÉV. Ann. Sci. Nat. III, 15, p. 139 (p.p.), 1851; KICKX, Fl. Crypt. Fland. I, p. 375 (p.p.), 1867; COOKE, Handb. Brit. Fung. II, p. 645 (p.p.), 1871; COOKE & PECK, Journ. Bot. I, p. 11, 1872; QUÉL. Champ. Jur. Vosg. p. 533 (p.p.), 1875; SACC. Syll. Fung. I, p. 4 (p.p.), 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 27 (p.p.), 1884; ELL. & EVERH. N. Amer. Pyren. p. 8 (p.p.), 1892; JACZEW. Bull. l'Herb. Boiss. IV, p. 725 (p.p.), 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 83 (p.p), 1897; MAGNUS, Erysiph. Tirol. p. 6 (p.p.), 1898; KLIKA, Erysiph. Czechosl. p. 38 (p.p.), 1924. (FUCK. Symb. Myc. p. 78 (p.p.), 1869–70; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 142 (p.p.), 1899; P. HENN. in Engl. Bot. Jahrb. XXVIII, p. 271, 1901; YOSHINAGA, Bot. Mag. Tokyo, XIX, p. 34, 1905).

Sphaerotheca Niesslii THÜM. Verh. k. k. zool.-bot. Gesell. Wien. XXIX, p. 524, 1880; SACC. Syll. Fung. I, p. 4, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 28, 1884.

Sphaerotheca fugax PENZ. et SACC. Att. R. Instit. Ven. VI, 2, p. 10, 1884; SACC. Syll. Fung. Addit. ad. I–IV, p. 1, 1886, and IX, p. 365, 1891; MAGNUS, Erysiph. Tirol. p. 6, 1898.

Sphaerotheca Humuli (DC.) SCHRÖT. in Cohn's Krypt. Fl. Schles. III, p. 231 (p.p.), 1893. (RANOJEVIC, Ann. Myc. VIII, p. 355, 1910).

Oidium botryoides CES. in Kl. Herb. viv. Myc. no. 1671, Bot. Zeit. p. 302, 1852; SACC. Syll. Fung. XXII, p. 1250, 1913.

Oidium erysiphoides FR. Syst. Myc. III, p. 432 (p.p.), 1829; SACC. Syll. Fung. IV, p. 41 (p.p.), 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 79 (p.p), 1907.

Amphigenous, also on stems, petioles and fruits, mycelium persistent or evanescent; matured conidia produced in a chain, vacuolate, including the well developed fibrosin bodies, 25.2–36.0 × 13.2–22.4 μ; perithecia gregarious or scattered, 70–112 μ in diameter, globose or depressed-globose; cells 12.0–26.4 × 9.6–19.2 μ in size; appendages 9–19 in number, irregular in length, about 168–448 μ, 1–4 septate, dark-brown colored throughout their length or light brown colored towards the apex, simple, very rarely branched; ascus 1, oblong, with or without stalk, 52.8–103.2 × 42.8–88.8 μ, (on Geranium, 91.2–120.0 × 50.8–76.8 μ); spores 6–8 in number, ellipsoidal or oblong, 16.8–26.4 × 10.4–19.2 μ.

Hab. On leaves and stems of *Corydalis ochotensis* TURCZ. (Tsuru-kikeman). Hokkaido—Ishikari. Honshu—Rikuchu.

On *Astilbe Thunbergii* MIQ. (Akashoma). Honshu—Etchu.

On *Astilbe Thunbergii* MIQ. var. *congesta* Boiss. (Toriashishoma). Honshu—Uzen, Echigo.

On *Agrimonia pilosa* LEDEB. (Yezo-Kinmizuhiki). Hokkaido—Oshima, Shiribeshi, Iburi, Ishikari, Kitami, Hidaka, Kushiro. Honshu—Rikuchu.

On *Aruncus silvester* KOSTEL. var. *americana* MAXIM. (Yamabuki-shoma). Hokkaido—Kurile Isls. Etorofu Isl., Shiribeshi, Ishikari, Tokachi, Kushiro. Honshu—Rikuchu, Echigo.

On *Aruncus silvester* KOSTEL, var. *vulgaris* MAXIM. (Yezo-Yamabuki-shoma). Saghalien—Odomari. Hokkaido—Ishikari.

On *Filipendula ciliata* KUDO (Akabana-shimotsuke). Hokkaido—Ishikari, Kushiro.

On *Filipendula kamtschatica* MAXIM. (Oni-shimotsuke). Saghalien—Airoppu, Shiraraka, Nayashi, Makunkotan, Nupuripo, Manue, Ochiai, Tominai, Chikahoro, Aba, Konuma, Kurokawa. Hokkaido—Kurile Isls. Shikotan Isl., Etorofu Isl., Shimushir Isl., Kunashiri Isl., Oshima, Iburi, Ishikari, Kitami, Tokachi, Kushiro. Honshu—Rikuchu.

On *Filipendula palmata* MAXIM. (Urajiro-shimotsuke). Saghalien—Gorojikoff.

On *Fragaria chiloensis* DUCH. var. *ananassa* BAILEY (Seiyo-Ichigo). Honshu—Musashi.

On *Fragaria negrecta* LINDEM. (Yezo-kusa-ichigo). Hokkaido—Tokachi.

On *Potentilla centigrana* MAXIM. (Hime-hebi-ichigo). Hokkaido—Ishikari.

On *Potentilla fragarioides* L. var. *Sprengeliana* MAXIM. (Kijimushiro). Hokkaido—Shiribeshi, Ishikari, Tokachi, Hidaka.

On *Potentilla Freyniana* BORNM. (Mitsuba-tsuchiguri). Hokkaido—Ishikari.

On Sanguisorba canadensis L. var. *media* MAXIM. *(Usubeni-waremoko).* Honshu—Iwaki.

On *Sanguisorba officinalis* L. (Waremoko). Hokkaido—Ishikari. Honshu—Mutsu, Rikuzen, Musashi, Shimotsuke. Shikoku—Tosa. Kyushu—Higo.

On *Sanguisorba officinalis* L. var. *carnea* REGEL (Yezo-waremoko). Hokkaido—Ishikari, Hidaka.

On *Sanguisorba tenuifolia* Fisch. var. *alba* TRAUTV. & MEY. (Nagabono-shirobana-waremoko). Saghalien—Odomari, Konuma, Ehorokofunai, Uenchishi, Ochiai, Alexandrowsk, Shisuka, Kitanayoshi, Abe. Hokkaido—Kurile Isls. Etorofu Isl., Shiribeshi, Iburi, Ishikari, Kitami, Tokachi, Kushiro. Honshu—Mutsu, Rikuchu.

On *Spiraea prunifolia* S. & Z. var. *plena* SCHNEID. (Shijimibana). Honshu—Rikuchu.

On *Spiraea Thunbergii* SIEB. (Yukiyanagi). Honshu—Mutsu, Rikuchu.

On *Geranium erianthum* DC. (Chishimafuro). Hokkaido—Kitami, Tokachi.

On *Geranium nepalense* SWEET. var. *Thunbergii* KUDO (Gennoshoko). Hokkaido—Oshima, Shiribeshi, Ishikari. Honshu—Echizen, Shinano.

On *Geranium sibiricum* L. (Ichige-furo). Hokkaido—Ishikari, Kitami.

On *Geranium yezoense* FR. & SAV. (Yezo-furo). Hokkaido—Kurile Isls. Etorofu Isl., Kunashiri Isl., Ishikari.

On *Geranium yezoense* FR. & SAV. var. *nipponicum* NAKAI (Hakusan-furo). Honshu—Shinano.

On *Polemonium coeruleum* L. var. *laxiflorum* MIYABE & MIYAKE (Karafuto-hanashinobu). Saghalien—Ambetsu.

On *Clerodendron trichotomum* THUNB. (Kusagi). Hokkaido—Ishikari. Honshu—Bichu.

On *Veronica Grayi* MIYABE & KUDO (Yezo-ruri-toranoo) . Saghalien—Ambetsu.

On *Veronica sibirica* L. (Yezo-kukaiso). Hokkaido—Ishikari.

On *Veronica virginica* L. var. *japonica* NAKAI (Kukaiso). Honshu—Hoki.

On *Melothria japonica* MAXIM. (Suzumeuri). Honshu—Echigo, Etchu.

On *Lactuca Scariola* L. var. *integrata* GRENIER & GODRON. (Ryuzetsuna). Honshu—Etchu.

Distrib. Japan (Saghalien, Hokkaido including Kurile Islands, Honshu, Shikoku, Kyushu and Formosa), Manchuria, China, Europe, North America and South Africa.

Remarks. This species which is well-known as hop-mildew in Europe and America, where it causes great damage to the cultivated hop, has not yet been found on either wild or cultivated hop-plant in this country. This remarkable fact can only be explained by the absence in this country of the specialized form which attacks the species of Humulus. The present species is however, most common and destructive on the following host plants; Corydalis, Astilbe, Agrimonia, Aruncus, Filipendula, Fragaria, Potentilla, Sanguisorba, Spiraea, Geranium, Veronica, Polemonium, Clerodendron, Melothria and Lactuca.

Compared with *Sphaerotheca fuliginea*, the outer wall cells of the perithecium of this fungus are smaller in size and, besides, the conidia of this species are not produced as abundantly as in *Sphaerotheca fuliginea.*

The form on *Aruncus silvester* var. *vulgaris* has remarkably well-developed fibrosin bodies in the ascospores.

The form on *Geranium nepalense* var. *Thunbergii* (Zenibako, Nov. 1, 1925, Y. HOMMA), has a very large-sized ascus, 91.2–120.0 × 50.4–76.8 μ; besides, this fungus causes hyperplasy on the upper part of the stem. The author at first thought it to be a new species, but from the examination of many specimens which were collected in different parts of this country, she has come to the conclusion that it is better to consider it as a special abnormal form of the species.

In the form on *Spiraea Thunbergii,* the appendages are frequently branched in the lower half and the perithecia are smaller, being 52.8–55.2 × 42.4–48.0 μ.

The form on *Veronica sibirica,* (Mt. Moiwa, Oct. 6, 1924, H. TAKASUGI), is very interesting, as it frequently includes two asci in a perithecium, one of which is smaller than the other when mature. The size of the asci when single in a perithecium is 72.0–81.6 × 52.6–62.4 μ and when there are two it is 52.8–75.6 × 43.2–58.8 μ. A careful examination of the specimens of this fungus on the present host gathered in different places in the vicinity of Sapporo and also the specimens on *Veronica virginica* in the American Exsiccatae, has failed, however, to reveal such an occurrence. This character may be abnormal, but it is interesting as it shows an intermediate character between Sphaerotheca and Erysiphe.

Sphaerotheca Epilobii **(WALLR.) SACC.**

(Pl. VII, figs. 8, 9)

Syll. Fung. I, p. 4, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 27, 1887; ELL. & EVERH. N. Amer. Pyren. p. 8, 1892; SCHRÖT. in Cohn's Krypt. Fl. Schles. III, p. 232, 1893; MAGNUS, Erysiph. Tirol. p. 9, 1898. (GRIFF. Bull. Torr. Bot. Club, XXVI, p. 143, 1899; RANOJEVIC, Ann. Myc. VIII, p. 356, 1910).

Syn. *Alphitomorpha Epilobii* WALLR. Ann. Wett. Ges. IV, p. 243, 1819.

Erysiphe Epilobii LK. in WILLD. Sp. Pl. VI, p. 102, 1824.

Erysiphe macularis SCHLECHT. Fl. Berol. II, p. 168, 1824; RABENH. Deutschl. Krypt. Fl. I, p. 231 (p.p.), 1844.

Podosphaera Epilobii DE BARY, Beitr. Morph. Phys. Pilze, I, xiii, p. 48, 1870, and Hedw. X, p. 68, 1871.

Sphaerotheca Humuli BURR. in SALM. Monogr. Erysiph. p. 45 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 87 (p.p.), 1902; NEGER, Krypt. Fl. d. Mark Brand. VII, p. 106 (p.p.), 1905; JØRST. Erysiph. Norway, p. 14 (p.p.), 1925. (SALM. Bull. Torr. Bot. Club, XXVII, p. 445 (p.p.), 1900; SHIRAI & MIYAKE, List, p. 625 (p.p.), 1917; SHIRAI & HARA, List, p. 370 (p.p.), 1927).

Sphaerotheca Castagnei LÉV. Ann. Sci. Nat. III, 15, p. 139 (p.p.), 1851; KLIKA, Erysiph. Czechosl. p. 38 (p.p.), 1924. (FUCK. Symb. Myc. p. 79 (p.p.), 1869–70).

Torula Epilobii CORDA, Icon. Fung. IV, p. 23, 1840.

Oospora Epilobii (CORDA) SACC. et VOGL. Syll. Fung. IV, p. 12, 1886.

Oidium Epilobii (CORDA) LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 81, 1907, and IX, p. 726, 1910.

Amphigenous, also on stems and fruits, mycelium persistent, densely white powdery at first, finally turning to blackish brown; matured conidia borne in a chain, vacuolate, granulate, including the well-developed fibrosin bodies, ellipsoidal in shape, 25.2–30.0 × 13.2–16.8 μ; perithecia gregarious, small, 64.8–86.4 μ in diameter; cells 15.6–26.4 × 12.0–14.4 μ in size; appendages 9–15 in number, deep brown colored throughout their length or hyaline at the upper part, simple, 2–3 septate, about 126–294 μ long and 7.2μ wide at the base and the apical part 3.2 μ; asci small, ellipsoidal, without stalk, thick-walled, 55.2–86.4 × 33.6–56.4 μ; spores 7–8 in number, usually 8, oblong or ellipsoidal, 14.4–19.2 × 9.6–10.8 μ in size.

Hab. On leaves and stems of *Epilobium Behringianum* HAUSSKU. (Tarao-akabana). Saghalien—Mt. Shiretori. Hokkaido—Kurile Isls. Shimushir Isl., Iburi, Tokachi.

On *Epilobium cephalostigma* HAUSSKU. (Iwa-akabana). Saghalien—Mt. Suzuya, Konuma. Hokkaido—Shiribeshi, Ishikari.

On *Epilobium glandulosum* LEHM. (Karafuto-akabana). Saghalien—Ushoro, Obedomari, Manue, Alexandrowsk, Kita-nayoshi, Konuma. Hokkaido—Kurile Isls. Etorofu Isl., Shiribeshi, Ishikari, Kushiro.

On *Epilobium montanum* L. (Yezo-akabana). Hokkaido—Iburi, Ishikari.

On *Epilobium palustre* L. (Yanagi-akabana). Saghalien—Tominai.

On *Epilobium pyrricholophum* FR. & SAV. (Akabana). Kyushu— Bungo.

Distrib. Japan (Saghalien, Hokkaido including Kurile Islands, Honshu and Kyushu), Europe and North America.

Remarks. This species is readily distinguished from *Sphaerotheca Humuli* by the smaller size of the perithecia. In 1900, SALMON (32) stated that "*Erysiphe Epilobii* is identical with certain forms of *S. Humuli.* No sufficient distinguishing characters have been given in any diagnosis of this form, and it is evident that, as a general rule, specimens have been referred to '*S. Epilobii*' merely from their occurrence on species of *Epilobium*". But, in this fungus, the size of the perithecia, asci and ascospores is less than the measurements of those of *S. Humuli,* and the appendages become narrow at the apical portion. Compared with *S. fuliginea* the wall cells of the perithecium in the present species are smaller in size.

Sphaerotheca fuliginea (SCHLECHT.) POLLACCI

(Pl. VII, figs 10, 11, 12, 13, 14, 15)

R. Ist. Bot. Univ. Pavia, p. 8, 1905; SACC. Syll. Fung. XXII, p. 20, 1913; KLIKA, Erysiph. Czechosl. p. 39, 1924; ŠKORIĆ, Erysiph. Croat. p. 35, 1926.

Syn. *Alphytomorpha fuliginea* SCHLECHT. Berl. Ges. Nat. Freund. Verh. I, p. 47, 1819.

Erysiphe fuliginea (WALLR.) FR. Syst. Myc. III, p. 238 (p.p.), 1829.

Erysiphe communis FR. Syst. Myc. III, p. 239 (p.p.), 1829; MAGNUS, Erysiph. Tirol. p. 15 (p.p.), 1898.

Erysiphe fusca FR. Syst. Myc. III, p. 242, 1829.

Erysibe lamprocarpa RABENH. Deutschl. Krypt. Fl. I, p. 232 (p.p.), 1844.

Erysibe communis RABENH. Deutschl. Krypt. Fl. I, p. 232 (p.p.), 1844.

Erysibe circumfusa RABENH. Deutschl. Krypt. Fl. I, p. 232 (p.p.), 1844.

Sphaerotheca Castagnei LÉV. Ann. Sci. Nat. III, 15, p. 139 (p.p.), 1851; KICKX, Fl. Crypt. Fland. I, p. 375 (p.p.), 1867; COOKE, Handb. Brit. Fung. II, p. 645 (p.p.), 1871; SACC. Syll. Fung. I, p. 4 (p.p.), 1882; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 400, 1887; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 27 (p.p.), 1884; ELL. & EVERH. N. Amer. Pyren. p. 8 (p.p.), 1892; JACZEW. Bull. l'Herb. Boiss. IV, p. 725 (p.p.), 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 83 (p.p.), 1897; MAGNUS, Erysiph. Tirol. p. 6 (p.p.), 1898. (FUCK. Symb. Myc. p. 79 (p.p.), 1869–70; PAMM. Journ. Myc. IV, p. 36, 1888; GALLOW. Journ. Myc. IV, p. 33, 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 142 (p.p.), 1899; RANOJ. Hedw. XLI, p. 102, 1902; SHIRAI, List, p. 93, 1905; P. HENN. in ENGL. Bot. Jahrb. XXXIV, p. 600, 1905; SHIRAI & MIYAKE, List, p. 625, 1917).

Sphaerotheca detonsa KICKX, Fl. Crypt. Fland. I, p. 375, 1867; SACC. Syll. Fung. I, p. 4, 1882.

Podosphaera Castagnei (LÉV.) DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 48, 1870.

Sphaerotheca Drabae JUEL, Bot. Notis. p. 9, 1890; SACC. Syll. Fung. IX, p. 365, 1891.

Sphaerotheca Calendulae (MALBR. & ROUM.) MALBR. & ROUM. Bull. Soc. Myc. France, IV, p. xxxii, 1888; SACC. Syll. Fung. IX, p. 366, 1891.

Sphaerotheca Humuli (DC.) SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 231 (p.p.), 1893. (P. HENN. in ENGL. Bot. Jahrb. XXIX, p. 148, 1901).

Sphaerotheca Humuli (DC.) BURR. var. *fuliginea* (SCHLECHT.) SALM. Monogr. Erysiph. p. 49, 1900, and Bull. Torr. Bot. Club, XXIX,

p. 89, 1902; LAWRENCE, Journ. Myc. XI, p. 107, 1905; TAI & WEI, Sinensia, III, p. 98, 1932. (MATSUM. Ind. Plant. Jap. I, p. 174, 1904; SHIRAI, List, p. 94, 1905; SALM. Bull. Torr. Bot. Club. XXVII, p. 446, 1900, Ann. Myc. III, p. 252, 1905, and VI, p. 11, 1908; MIYAKE, Bot. Mag. Tokyo, XXVI, p. 53, 1912, XXVII, p. 38, 1913, and XXVIII, p. 38, 1914; SYD. Ann. Myc. XI, p. 113, 1913; DOIDGE, Roy. Soc. South Afr. V, p. 239, 1915; SHIRAI & MIYAKE, List, p. 627, 1917).

Sphaerotheca fuliginea (FR.) LIND, Danish Fung. p. 160, 1913.

Sphaerotheca fuliginea (SCHLECHT.) SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 37, 1914; HARA, Shizuoka, Agr. Rep. CCCLXIV, p. 4, 1928. (SAWADA, Agr. Exp. Stat. Formosa, Bull. XIX, p. 150, 1919; IDETA, Jap. Phytopath. (Suppl. I), p. 203; 1923; TOGASHI, Jap. Journ. Bot. II, p. 78, 1924; SHIRAI & HARA, List, p. 370, 1927; MIURA, South Manch. Rwy. Co. Agr. Rep. XXVII, p. 116, 1928).

Sphaerotheca Phteirospermi P. HENN. et SHIRAI, in ENGL. Bot. Jahrb. XXIX, p. 147, 1901; SACC. Syll. Fung. XVI, p. 402, 1902. (SHIRAI, List, p. 94, 1905; SHIRAI & MIYAKE, List, p. 629, 1917).

Sphaerotheca fuliginea (SCHLECHT.) LIND, (emend JØRST.), in JØRST. Erysiph. Norway, p. 27, 1925.

Oidium erysiphoides FR. Syst. Myc. III, p. 432 (p.p.), 1829; SACC. Syll. Fung. VI, p. 41 (p.p.), 1888; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 79 (p.p.), 1907.

Amphigenous, on petioles and stems, mycelium persistent or evanescent, forming white patches at first; matured conidia produced in a chain, subglobose, ellipsoidal or elongate-ellipsoidal, including the well-developed fibrosin bodies, 25.2–44.4 × 13.2–22.4 μ in size; perithecia gregarious or scattered, dark brown colored when mature, globose or depressed globose, 70.0–112.0 μ in diameter; cells evident, large size, 19.2–55.2 × 10.8–36.0 μ; appendages variable in number and length, 5–21 in number, rarely 2, some shorter than diameter of the perithecia, while some 8 times longer, brown colored throughout or hyaline in the upper half or gradually becoming a light color, mostly simple, rarely 1 or 2 branched, aseptate or 1–5 septate; asci hyaline, broadly ovate or subglobose, without stalk, 57.6–100.8 × 40.0–81.6 μ; spores 5–8 in number, usually 8, subglobose, broadly oblong or ellipsoidal, 14.4–25.2 × 10.8–18.0 μ.

Hab. On leaves and stems of *Fatoua pilosa* GAUD. var. *subcordata* BUREAU. (Kuwakusa). Honshu—Musashi. Shikoku—Tosa. Kyushu—Hizen, Higo.

On *Saxifraga fusca* MAXIM. (Kurokumoso). Hokkaido—Ishikari.

On *Saxifraga reflexa* Hook. f. (Yamahanaso). Hokkaido—Ishikari.

On *Phaseolus radiatus* L. var. *aurea* Prain (Azuki). Honshu—Etchu, Echizen, Kaga.

On *Acalypha australis* L. (Enoki-gusa). Hokkaido—Ishikari. Honshu—Etchu.

On *Impatiens Balsamina* L. (Hosenkwa). Honshu—Musashi, Echigo, Etchu. Shikoku—Tosa. Kyushu—Higo, Osumi.

On *Impatiens Noli-tangere* L. (Ki-tsurifune). Saghalien—Odomari, Akashiki, Chikahoro. Hokkaido—Shiribeshi, Ishikari, Kitami, Tokachi, Kushiro, Honshu—Echigo.

On *Impatiens Textori* Miq. (Tsurifune). Hokkaido—Ishikari. Honshu—Musashi, Shimozuke.

On *Halorrhagis micrantha* R. Br. (Arinotogusa). Hokkaido—Ishikari. Honshu—Etchu.

On *Cynanchum yezoense* Nakai (Oh-kamomezuru). Honshu—Echigo.

On *Cynanthum caudatum* Maxim. (Ikema). Honshu—Etchu.

On *Ajuga ciliata* Bunge (Kaijindo). Hokkaido—Ishikari.

On *Ajuga yezoensis* Maxim. (Nishikigoromo). Hokkaido—Ishikari.

On *Clinopodium chinensis* Kuntze (Kurumabana). Hokkaido—Ishikari.

On *Clinopodium chinensis* Kuntze var. *macrantha* Makino (Miyama-to bana). Hokkaido—Ishikari.

On *Nepeta Glechoma* Benth. (Kakidoshi). Honshu—Yamashiro.

On *Nepeta subsessilis* Maxim. (Misogawaso). Hokkaido—Kushiro.

On *Euphrasia Maximowiczii* Wettst. (Tachi-kogomegusa). Saghalien—Toyohara.

On *Lagotis glauca* Gaerth. (Uruppuso). Hokkaido—Kurile Isls. Shimushir Isl.

On *Pedicularis euphrasioides* Steph. (Chishima-shiogama). Hokkaido—Kurile Isls. Ketoi Isl.

On *Pedicularis japonica* Miq. var. *Maximowiczii* Nakai (Yezono-yotsuba-shiogama). Hokkaido—Kurile Isls. Ushishiru Isl.

On *Pedicularis resupinata* L. (Shiogama-giku). Saghalien—Kitanayoshi, Tominai.

On *Phteirospermum japonicum* Kanitz. (Ko-shiogama). Hokkaido—Oshima. Honshu—Rikuchu, Musashi. Shikoku—Tosa.

On *Dicliptera japonica* Makino (Haguroso). Honshu—Musashi, Echizen.

On *Benincasa hispida* Cogn. (Toga). Honshu—Echigo.

On *Cucumis Melo* L. (Makuwa-uri). Hokkaido—Ishikari. Honshu—Musashi. Kyushu—Higo.

On *Cucumis sativus* L. (Kiuri). Hokkaido—Ishikari. Honshu—Musashi, Etchu.

On *Cucurbita moschata* Duch. var. *Toonas* Makino (Tonasu). Hokkaido—Ishikari. Honshu—Musashi, Yamashiro.

On *Cucurbita moschata* Duch. var. *melonaeformis* Makino (Kikuza-tonasu). Honshu—Echigo. Kyushu—Hizen, Higo.

On *Lagenaria vulgaris* Ser. (Hyotan). Hokkaido—Ishikari. Kyushu—Hizen.

On *Adenocaulon bicolor* HOOK. var. *adhaerescens* MAKINO (Nobuki). Hokkaido—Iburi, Ishikari, Hidaka, Kushiro. Honshu—Rikuchu.

On *Arctium Lappa* L. (Gobo). Hokkaido—Iburi, Ishikari. Honshu—Rikuchu, Musashi, Echigo, Etchu. Shikoku—Tosa. Kyushu—Higo.

On *Arnica sachalinensis* A. GR. (Oh-usagigiku). Saghalien—Makunkotan.

On *Aster pinnatifidus* MAKINO (Yugagiku). Honshu—Rikuchu, Kaga.

On *Aster tataricus* L. f. (Shion). Honshu—Etchu.

On *Bidens bipinnata* L. (Sendangusa). Honshu—Musashi. Shikoku—Tosa.

On *Bidens pilosa* L. (Ko-sendangiku). Honshu—Musashi.

On *Bidens pilosa* L. var. *albiflora* MAXIM. (Shiro-sendangusa). Shikoku—Tosa.

On *Bidens radiata* THUILL. (Yezo-no-taukogi). Hokkaido—Kushiro.

On *Bidens tripartita* L. (Taukogi). Honshu—Echigo.

On *Cacalia auriculata* DC. var. ochotensis KOM. (Karafuto-mimikomori). Saghalien—Shiretori, Chikahoro. Hokkaido—Kitami.

On *Cacalia auriculata* DC. var. *kamtschatica* KOIDZ. (Mimikomori). Saghalien—Konuma. Hokkaido—Tokachi.

On *Cacalia hastata* L. var. *glabra* LEDEB. (Yobusumaso). Saghalien—Odomari. Hokkaido—Ishikari, Kushiro.

On *Cacalia hastata* L. var. *pubescens* LEDEB. (Oh-yobusumaso). Saghalien—Makunkotan, Alexandrowsk, Ambetsu.

On *Carpesium abrotanoides* L. var. *Thunbergianum* MAKINO (Yabutabako). Hokkaido—Ishikari.

On *Carpesium triste* MAXIM. (Gankubi-yabutabako). Hokkaido—Shiribeshi, Ishikari.

On *Cirsium arvense* Scop. var. *setosum* LEDEB. (Yezo-no-kitsune-azami). Hokkaido—Ishikari.

On *Cirsium Buergeri* MIQ. var. *Albrechtii* NAKAI (Yezo-yama-azami). Hokkaido—Kitami.

On *Cirsium Grayanum* NAKAI (Maruba-no-hire-azami). Hokkaido—Ishikari, Kushiro.

On *Cirsium pendulum* FISCH. (Taka-azami). Hokkaido—Kushiro.

On *Cirsium Weyrichii* MAXIM. (Yezo-azami). Saghalien—Chikahoro. Hokkaido—Ishikari.

On *Cosmos bipinnatus* CAV. (Kosumosu). Honshu—Etchu.

On *Dahlia variabilis* DESF. (Daria). Honshu—Etchu.

On *Erigeron acre* L. var. *hirsutum* FR. SCHM. (Yezo-mukashiyomogi). Honshu—Mino.

On *Erigeron canadensis* L. (Hime-mukashiyomogi). Hokkaido—Ishikari. Honshu—Musashi, Echigo, Etchu.

On *Eupatorium Fortunei* TURCZ. var. *simplicifolium* NAKAI (Hiyodoribana). Honshu—Echigo.

On *Gerbera Anandria* SCH. BIP. (Sembonyari). Hokkaido—Ishikari. Honshu—Etchu.

On *Helianthus annuus* L. (Himawari). Hokkaido—Ishikari. Honshu—Musashi.

On *Helianthus tuberosus* L. (Kikuimo). Honshu—Etchu.

On *Lactuca dentata* MAKINO var. *Thunbergii* MAKINO (Nigana). Honshu—Musashi.

On *Lactuca denticulata* MAX. var. *typica* MAXIM. (Yakushiso). Hokkaido—Ishikari.

On *Lactuca laciniata* MAKINO (Aki-no-nogeshi). Honshu—Rikuchu, Musashi, Echigo, Etchu, Echizen, Kaga.

On *Lactuca laciniata* MAKINO f. *indivisa* MAKINO (Hosobano-aki-no-nogeshi). Hokkaido—Ishikari.

On *Lactuca Raddeana* MAXIM. (Yama-nigana). Hokkaido—Ishikari, Kushiro. Honshu—Rikuchu, Rikuzen, Izu, Yamashiro.

On *Lactuca sibirica* BENTH. (Yezo-murasaki-nigana). Saghalien—Oioro, Konuma.

On *Ligularia sibirica* CASS. var. *speciosa* DC. (Oh-otakarako). Saghalien—Nayoshi, Makunkotan, Kami-Arumudan.

On *Petasites japonica* MIQ. (Fuki). Honshu—Echigo.

On *Saussurea manshurica* KOM. (Yanone-azami). Saghalien—Akashiki, Ambetsu.

On *Senecio Cineraria* DC. (Shirotai-giku). Hokkaido—Ishikari.

On *Senecio nemorensis* L. var. *Fuchsii* KOCH. (Hosoba-kion). Saghalien—Ambetsu.

On *Siegesbeckia pubescens* L. (Menamomi). Hokkaido—Ishikari. Honshu—Rikuzen, Musashi, Echigo, Etchu, Kaga. Shikoku—Tosa. Kyushu—Higo.

On *Sonchus oleraceus* L. (Nogeshi). Hokkaido—Ishikari. Honshu—Echizen.

On *Taraxacum ceratophorum* DC. (Yezo-tampopo). Hokkaido—Ishikari, Tokachi.

On *Taraxacum officinale* WEB. (Tampopo). Honshu—Musashi. Shikoku—Iyo.

Distrib. Japan (Saghalien, Hokkaido including the Kurile Islands, Honshu, Shikoku, Kyushu and Formosa), Manchuria, China, Europe, South Africa and North America.

Remarks. This species is a very common powdery mildew parasitic on numerous annual and perennial herbs in this country. The mycelial hyphae on these host plants present a snowy white appearance during summer, when conidia are abundantly formed, but when the perithecia begin to be produced in autumn, they turn from pale brown to dark brown in color. It has such a wide range in host plants, that naturally there is more or less variation in the size and number of both ascigenous and conidial stages.

Sphaerotheca fuliginea can easily be distinguished from *S. Humuli* by the larger size of the outer wall cells of the perithecium. As to the mildew on *Cucurbitaceae,* in 1900, SALMON (32) said, "although so many authors have referred the fungus on *Cucurbita* and *Cucumis* to '*S. Castagnei*', it seems very probable that a mistake has been made in the identification and that the fungus in question is an *Erysiphe.* In the first place, although one finds in herbaria very numerous examples of a fungus in the conidial (*Oidium*) stage on leaves of *Cucurbita* and *Cucumis* referred to *S. Castagnei,* in my experience no specimens in the perithecial stage are to be found in herbaria on these hosts. It is evident, therefore, that for some reason it has been the practice among mycologists to name any *Oidium* on *Cucurbita* and *Cucumis, S. Castagnei* LÉV. There can be no doubt also that this fungus on cucurbitaceous plants is extremely slow in producing perithecia, and the only example I have seen in this condition was gathered in the late summer at Reigate, England, in 1898. This as already mentioned, proved to be *Erysiphe Cichoracearum*"...."Further, not only are wrong host-plants for a certain species thus given, but as a natural consequence our knowledge of the geographical distribution of the species in question becomes erroneous. For instance, 'WINTER records the occurrence of '*Sphaerotheca Castagnei*' in foliis *Cucurbitacearum*' from the island of St. Thomas, Africa, an occurrence extremely interesting not only geographically, but also climatically, as the island is on the equator. In the present confusion it is impossible to say whether the fungus was really '*S. Castagnei*' in a perithecial stage, or whether, as is more probable it was not merely an Oidium which had been referred to *S. Castagnei* in accordance with the usual custom". We have collected many specimens on Cucurbita and Cucumis too; almost all of them were in the conidial stage (Oidium), and the only one specimen on *Cucurbita moschata* var. *Toonas* which was collected by Prof S. ITO (Kotoni, Prov. Ishikari, Sept. 17, 1925) had numerous fine perithecia. The character of this fungus is as follows: amphigenous, mycelium persistent; perithecia gregarious, subglobose, 84–98 μ in diameter; cells 27.2–31.2 × 15.6–16.8 μ wide; appendages about 9 in number, flexuous, deep brown colored from middle downward, 2 or 3 septate, reaching 182 μ in length; ascus 1, subglobose, 64.8–70.8 × 55.2–57.6 μ; spores 6–8 in number, oblong or ellipsoidal, 16.3–21.0 × 10.8–13.6 μ. These characters show that the fungus is *Sphaerotheca fuliginea.*

The matured conidia on Cucurbita and Cucumis are produced in a chain, ellipsoidal or elongate ellipsoidal, vacuolate, including well-developed fibrosin bodies, 31.2–33.6 × 19.2–21.6 μ. The presence of the well-developed fibrosin bodies in the conidial cells is an important character in the genus Sphaerotheca; while in the genus Erysiphe, the fibrosin bodies are in the form of granules. As far as the specimens collected in this country are concerned, they are all referable to *S. fuliginea* and none to *Erysiphe Cichoracearum*.

The fungus on *Taraxacum ceratophorum*, is smaller than others in both conidial and perithecial stages; conidia are 25.2–28.8 × 13.2–15.2 μ in size; perithecia 70–84 μ in diameter; asci 57.6–66.0 × 40.0–48.0 μ; spores 16.8–18.0 × 10.8–12.0 μ in size; but the cells of the outer wall of the perithecium have form and size similar to those of others. It appeared to the writer at first to be a new species from the minute size of conidia and perithecia, but, according to SALMON in the specific range of the species, the forms having far smaller perithecia (50 μ) are included.

The fungus on *Phteirospermum japonicum*, P. HENNINGS (77) in 1902 described as *Sphaerotheca Phteirospermi* n. sp. (Mt. Takao, Prov. Musashi, Oct. 8, 1899, S. KUSANO). According to his description, the perithecia are 60–70 μ in diameter; asci 50–65 × 45–55 μ; spores 6–8 in number, 15–18 × 12–14 μ in size. The measurement of the co-type specimen, which was kindly given to us by Prof. Kusano, showed that the perithecia are 70–91 μ in diameter, the cells of the outer wall 24.0–31.2 × 14.4–28.8 μ wide; the asci 69.6–86.4 × 51.6–67.2 μ; the spores 19.2–20.8 × 14.4–16.8 μ. The writer found that in size the perithecia and asci respectively are larger than the original description. On the other hand, examination of the specimens collected in different localities on the same host resulted as follows: perithecia are 74.4–91 μ in diameter; cells 19.2–33.6 × 16.8–19.2 μ; asci 69.6–87.6 × 52.8–60.0 μ; spores 16.0–19.2 × 12.8–14.4 μ. From these comparative studies, this fungus seems to be a normal *S. fuliginea*.

On *Bidens pilosa, Clerodendron trichotomum* and *Siegesbeckia orientalis*, the appendages are frequently branched at the base or at about midway of their length. *Acalypha australis, Dicliptera japonica, Halorrhagis micrantha, Petasites japonica, Cosmos bipinnatus, Dahlia variabilis, Aster pinnatifidus*, and *Helianthus annus* are new hosts to this species.

Sphaerotheca Mors-Uvae (SCHWEIN.) BERK. & CURT.

(Pl. VII, fig. 16)

Grevillea, IV, p. 158, 1876; SACC. Syll. Fung. I, p. 5, 1882; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 399, 1887; ELL. & EVERH. N. Amer. Pyren. p. 7, 1892; SALM. Monogr. Erysiph. p. 70, 1900, Bull. Torr. Bot. Club, XXIX, p. 93, 1902; NEGER, Krypt. d. Mark Brand. VII, p. 107, 1905; LIND, Danish Fung. p. 160, 1913; JØRST. Erysiph. Norway, p. 36, 1925; ŠKORIĆ, Erysiph. Croat, p. 36, 1926; HOMMA, Engei, XIX, p. 5, 1927. (GALLOW. Journ. Myc. IV, p. 34, 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 143, 1899; LAWR. Journ. Myc. XI, p. 107, 1905; REHM, Ann. Myc. XII, p. 170, 1914).

Syn. *Erysiphe Mors-Uvae* SCHWEIN. Syn. Fung. Am. Bor. p. 270, 1834.

Sphaerotheca Mors-Uvae (SCHWEIN.) BERK. & CURT. f. *Grossulariae* KLIKA, Erysiph. Czechosl. p. 42, 1924.

Amphigenous, mostly hypophyllous, on young shoots and surface of the fruits; mycelium persistent, white at first, turning to blackish brown when the perithecia are formed; matured conidia borne in a chain, vacuolate, including the well-developed fibrosin bodies, subglobose or ellipsoidal, 25.2–28.8 × 16.8–20.0 μ; perithecia gregarious, 94–126 μ in diameter, globose or subglobose; cells 14.4–21.6 × 10.8–16.8 μ in size; appendages 3–4 in number, simple or irregularly branched at the apex, several-septate, brown colored throughout, 33.6–74.4 μ in length; ascus 1, elongate-ellipsoidal, very short stalked, 81.6–100.8 × 50.4–69.6 μ; spores are always 8 in number, elongate-ellipsoidal or elongate-oblong, 20.4–25.2 × 9.6–12.0 μ.

Hab. On leaves, stems and fruits of *Ribes Grossularia* L. (Maru-suguri). Hokkaido—Ishikari, Kitami, Tokachi.

Distrib. Japan (Hokkaido), Manchuria, Europe and North America.

Remarks. This species which is known as the American-Gooseberry mildew is now distributed on the wild and cultivated gooseberry in almost every country where it is grown, causing great injury to the plant.

In 1834, SCHWEINITZ gave the name *Erysiphe Mors-Uvae* to this species on wild Ribes, endigenous in the United States. In 1900, it was reported from Ireland by MASSEE and BRENAN. In 1902, P. HENNINGS reported it from Russia. In 1904, it reached Denmark. In 1905, it was reported from Sweden by Eriksson; at about the same time the fungus appeared in Norway, Italy (reported by POLLACCI) and Germany (noted by ADERHOLD). In 1906, SALMON reported its occurrence in several places in England, and FREEMAN and KÖCK reported it from Austria. In 1908, LEMCKE reported it from Czechoslovakia. In France the fungus may have been present from the year 1906, but the report of its occurrence was not heard until 1913. In 1914, it was reported to occur in Manchuria, where the fungus seems to have been present since 1912. On June 1927, our attention was first drawn to its occurrence in the vicinity of Sapporo where it presented already the appearance of an epidemic. Since then the fungus has spread in several districts of Hokkaido causing great damage.

This species occurs on the fruits, leaves and apical parts of new shoots. Small white patches are produced at first on them and then the patches are covered with a white powder. Finally the mycelium becomes blackish brown in color, when the perithecia are abundantly produced on it. The conidia are very similar in form to those of *Sphaerotheca pannosa,* but more or less larger; also, in *S. pannosa* the mycelium never changes to blackish brown when mature, but becomes brownish gray in color.

Sphaerotheca japonica (SALM.) HOMMA, comb. nov.

(Pl. VII, fig. 17)

Syn. *Sphaerotheca Mors-Uvae* (SCHWEIN.) BERK. & CURT. var. *japonica* SALM. Ann. Myc. VI, p. 2, 1908; SACC. Syll. Fung. XXII, p. 19, 1913; (SALM. Ann. Myc. VI, p. 11, 1908; SHIRAI & MIYAKE, List, p. 629, 1917; HARA, Dendropath. p. 6, 1923; SHIRAI & HARA, List, p. 371, 1927).

Hypophyllous, mostly on upper part of the new branches; mycelium persistent, densely pannose, yellowish-brown or dark brown colored, septate, branched; perithecia gregarious, more or less imbedded in the mycelial hyphae, globose or depressed-globose, 74–98 μ in diameter; appendages 6–9 in number, irregular in length, shorter than diameter of perithecia or reaching to 304 μ, dark brown throughout when mature, 2 or 3 septate, very rarely irregularly branched;

ascus 1, subglobose, thick walled, 44.8–52.8 × 36.0–38.4 μ; spores immature.

Hab. On leaves and stems of *Stephanandra incisa* ZABEL. (Kogome-utsugi). Honshu—Rikuchu.

Distrib. Japan (Honshu).

Remarks. The mycelium of this fungus is blackish-brown colored, forming a dense mycelial mass on the apical part of the branches. Frequently it occurs on the under-surface of the leaves. The perithecia are small; their outer wall cells are blackish-brown in color and very obscure. The asci are the smallest in the genus Sphaerotheca.

In 1900, SALMON described the fungus in question under the name of *Sphaerotheca Mors-Uvae* var. *japonica,* which was collected on *Stephanandra flexuosa* (*S. incissa*) in Prov. Rikuchu, Sept. 26, 1906, and July 7, 1907, by K. OKUMURA. Compared with *Sphaerotheca Mors-Uvae* the present species has smaller perithecia and asci. Moreover, the mycelial hyphae in *S. Mors-Uvae* are straight, smooth and thick walled, more or less shining, while in this fungus they are thin walled, flexuous and many branched. The present author has come to the conclusion that the present species had better be elevated to the specific rank rather than to be considered as a variety of *S. Mors-Uvae*

Sphaerotheca pannosa (WALLR.) LÉV.

(Pl. VII, fig. 18)

Ann. Sci. Nat. III, 15, p. 138, 1851; KICKX, Fl. Crypt. Fland. I, p. 374, 1867; COOKE, Handb. Brit. Fung. II, p. 645, 1871; QUÉL. Champ. Jur. Vosg. p. 533, 1875; SACC. Syll. Fung. I, p. 3, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 26, 1884; RAHM, Hedw. XXIV, p. 70, 1885; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 398, 1887; ELL. & EVERH. N. Amer. Pyren. p. 6, 1892; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 230, 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 726, 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 82, 1897; MAGNUS, Erysiph. Tirol. p. 5, 1898; SALM. Monogr. Erysiph. p. 65, 1900, and Bull. Torr. Bot. Club, XXIX, p. 91, 1902; NEGER, Krypt. Fl. d. Mark Brand. VII, p. 105, 1905; LIND, Danish Fung. p. 161, 1913; Doidge, Roy. Soc. South Afr. V, p. 237, 1915; KLIKA, Erysiph. Czechosl. p. 40, 1924; JØRST. Erysiph. Norway, p. 34, 1925; ŠKORIĆ, Erysiph. Croat. p. 36, 1926. (FUCK. Symb. Myc. p. 77, 1869–70; PAMM. Journ. Myc. IV, p. 37, 1888; TRACY & GALLOW. Journ. Myc. IV, p. 34, 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 143, 1899; RANOJ. Hedw. XLI, p. 102, 1902, and Ann. Myc. VIII, p. 355, 1910; LAWR. Journ. Myc. XI, p. 108, 1905; SHIRAI, List, p. 94, 1905; IDETA, Jap. Phytopath. p. 200, 1911; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 44, 1914; DOIDGE, Roy. Soc. South Afr. V, p. 239, 1915; SHIRAI & MIYAKE, List, p. 629, 1917; SHIRAI & HARA, List, p. 371, 1927; HARA, Agr. Rep. Shizuoka, CCCLXIV, p. 5, 1928; MIURA, South Manch. Rwy. Co. Agr. Rep. XXVII, p. 119, 1928).

Syn. *Alphitomorpha pannosa* WALLR. Berl. Ges. Nat. Verh. I p. 43, 1819.

Erysibe pannosa SCHLECHT. Fl. Berol. II, p. 170, 1824; RABENH. Deutschl. Krypt. Fl. I, p. 230, 1844.

Erysiphe pannosa FR. Syst. Myc. III, p. 236, 1829.

Erysiphe pannosa MÉRAT. Nouv. Fl. Paris, p. 76, 1837, and Syn. Nouv. Fl. Paris, p. 84, 1837.

Podosphaera pannosa DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 48, 1870.

Oidium leucoconium DESM. Ann. Sci. Nat. XIII, p. 102, 1829; FR. Syst. Myc. III, p. 432, 1829; SACC. Syll. Fung. IV, p. 41, 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 82, 1907; SAWADA, Depart. Agr. Govern. Research Inst. Formosa, no. 61, p. 80, 1933.

Amphigenous, on stems, especially shoots, mycelium persistent, forming white powdery masses throughout the summer and in late autumn turning to gray; matured conidia produced in a chain, including the well-developed fibrosin bodies, vacuolate, ellipsoidal or oblong, 20.8–24.0 × 13.2–16.0 μ.

"Perithecia more or less (usually completely) immersed in the persistent mycelium, globose to distinctly pyriform, 85–120 μ in diameter, usually about 100 μ, cells obscure, about 10 μ wide; appendages few, often obsolate, very short, tortuous, pale brown, septate; asci broadly oblong to globose, 88–115 μ, averaging 100 × 60–75 μ; spores 8, 20–27 × 12–15 μ". (Salm. Monogr. Erysiph. p. 66).

Unfortunately we could not collect the perithecial stages of this species, so that the ascogenous stage is noted from the description of SALMON.

Hab. On leaves and stems of *Rosa acicularis* LINDL. var. *Gmelini* C. K. SCHN. (Oh-takane-ibara). Hokkaido—Tokachi.

On *Rosa chinensis* JACQ. Hokkaido—Ishikari.

On *Rosa multiflora* THUNB. (Nobara). Hokkaido—Shiribeshi, Ishikari.

On *Rosa Marretii* LÉV. (Karafuto-ibara). Hokkaido—Kitami.

On *Rosa sp.* (Cult.). Hokkaido—Ishikari, Kitami. Honshu—Rikuzen, Musashi.

Distrib. Japan (Hokkaido, Honshu and Formosa), Manchuria, Europe, South Africa and North America.

Remarks. *Sphaerotheca pannosa* is very common on cultivated and wild roses, attacking their shoots, young leaves and petioles. The conidia are abundantly produced from summer to late autumn. In summer, the host plants are entirely covered with white powder. After the fall of leaves in autumn, dense velvety, mycelial masses remain here and there surrounding the shoots. This mycelium differs from the summer mycelium, by being smooth, shining, almost aseptate and about 4.8 μ in width. A part of the stem, which is attacked by this fungus suffers from hyperplasy, and several layers of loose angular-cylindrical cells are formed under the epidermal layer.

The perithecial stage of this fungus has not yet been collected in this country, in spite of the careful search for it for several years.

Oidium belonging to Sphaerotheca

On *Draba borealis* DC. var. *kurilensis* FR. SCHM. (Yezo-inunazuna). Hokkaido—Kurile Isls. Etorofu Isl.

On *Euphorbia Sieboldiana* MORR. & DECNE (Natsutodai). Saghalien—Chikahoro.

On *Heliotropium indicum* L. (Nambanruriso). Formosa— Kagi.

In 1933, the new specific name of *Oidium Heliotropii-indicii* SAW. was given for this fungus by SAWADA. (Depart. Agr. Govern. Research Inst. Formosa, Japan, No. 61, p. 80, 1933).

On *Plectranthus inflexus* VOHL. (Yama-hakka). Hokkaido—Ishikari.

On *Senecio sonchifolia* MOENCH (Usubeni-nigana).

Oidium Emiliae-sonchifoliae SAWADA (According to SAWADA, Depart. Agr. Govern. Research Inst. Formosa, Japan, No. 61, p. 79, 1933)

Podosphaera KUNZE

Mycelium persistent or evanescent; matured conidia produced in a chain 4–5 in number, ellipsoidal or subglobose, vacuolate and including well-developed fibrosin bodies; perithecia globose, dark-brown; appendages produced from the apical or basal part of the perithecium, apices dichotomously divided 2–6 times, deep brown colored from middle downward; ascus 1; ascospores 8 in number. The species of this genus found in Japan are 4 in number, which can be divided into two sections. In one of them (Tridactyla section), the appendages are produced erectly from the upper portion of the perithecium, and in the other (Oxyacanthae section), they are produced from the basal part.

Key to the species of the genus Podosphaera

I. Tridactyla section.
Appendages arise vertically from the upper part of the perithecium.
1. Appendages usually not branched or rarely a few times dichotomously branched....................................*P. leucotricha* (314)
2. Appendages dichotomously branched 3—5 times at the apex...*P. tridactyla* (315)

II. Oxyacanthae section.
Appendages produced from the basal part of the perithecium.
1. Appendages forming true spirals at the lower half of their length ....*P. spiralis* (317)
2. Appendages straight..............................*P. Oxyacanthae* (318)

Podosphaera leucotricha (Ell. & Everh.) Salm.

(Pl. VII, fig. 19)

Monogr. Erysiph. p. 40, 1900, and Bull. Torr. Bot. Club, XXIX, p. 86, 1902; Neger, Krypt. Fl. d. Mark Brand. VII, p. 110, 1905; Lind, Danish Fung. p. 161, 1913; Doidge, Roy. Soc. South Afr. V, p. 237, 1915; Klika, Erysiph. Czechosl. p. 45, 1924; Jørst. Erysiph. Norway, p. 41, 1925; Škorić, Erysiph. Croat. p. 38, 1926. (Salm. Bull. Torr. Bot. Club, XXVII, p. 445, 1900, and Ann. Myc. VI, p. 11, 1908; Matsum. Ind. Plant. Jap. I, p. 162, 1904; Ideta, Jap. Phytopath. p. 198, 1911, and Jap. Phytopath. (Suppl. I), p. 205, 1925; Sawada, Agr. Exp. Stat. Formosa, Bull. IX, p. 46, 1914; Shirai & Miyake, List, p. 469, 1917; Hara, Dendropath. p. 8, 1923; Shirai & Hara, List. p. 287, 1927).

Syn. *Sphaerotheca leucotricha* Ell. & Everh. Journ. Myc. IV, p. 58, 1888; Sacc. Syll. Fung. IX, p. 365, 1891.

Sphaerotheca Mali Burr. in Ell. & Everh. N. Amer. Pyren. p. 6, 1892; Magnus, Ber. Deutsch. Bot. Gesell. XVI, p. 333, 1898; Grout, Bull. Torr. Bot. Club, XXVI, p. 374, 1899.

Oidium farinosum COOKE, Grevillea, XVI, p. 10, 1887; SACC. Syll. Fung. X, p. 520, 1892; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 83, 1907.

Amphigenous, mostly epiphyllous, also on shoots and especially on the apical part of branches; mycelium persistent or evanescent; matured conidia borne in a chain, vacuolate, granulate, including the well-developed fibrosin bodies, ellipsoidal, 25.2–28.8 × 15.6–19.2 μ; perithecia small, gregarious, 70.8–81.6 μ in diameter, blackish-brown, globose or subglobose; cells indistinct, 13.2–16.8 × 10.8–14.4 μ wide; erect appendages produced at the upper part of the perithecium, straight or more or less curved, apex always simple or very rarely dichotomously branched, dark-brown colored almost throughout their length, rarely hyaline at the apex, 224–367 μ long, 3–8 septate; ascus 1, globose or subglobose, without stalk, 54.2–69.6 × 49.2–64.8 μ; spores 8, oblong or ovate, 21.6–24.0 × 12.0–16.8 μ.

Hab. On leaves and stems of *Malus baccata* BORCKH. var. *mandschurica* SCHNEID. (Yezo-no-koringo). Hokkaido—Ishikari.

On *Malus pumila* MILL. var. *domestica* SCHNEID. (Seiyo-ringo). Hokkaido—Ishikari. Honshu—Mutsu.

Distrib. Japan (Hokkaido, Honshu and Formosa), Manchuria, Europe, South Africa, Australia and North America.

Remarks. *Podosphaera leucotricha* had been included in the genus Sphaerotheca by many authors, but, in 1900, SALMON placed it in Podosphaera because of the fact that the appendages are rarely dichotomously divided at the apex.

In the present species, two forms of appendages are known, one the apical, and the other the basal type. The former type is produced from the apical part of the perithecium and it is always simple, and erect, but very rarely dichotomously divided at the apex. The latter is produced from the basal part of the perithecium and it is similar in form to the mycelial hyphae.

Podosphaera tridactyla (WALLR.) DE BARY

(Pl. VII, fig. 20)

Beitr. Morph. Phys. Pilz. I, xiii, p. 48, 1870; SACC. Syll. Fung. I, p. 2, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 28, 1884; SCHRÖT. in COHN'S Krypt. Fl. Schles. III, p. 233, 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 744, 1896; PRILL. Malad. Pl. Agr. II, p. 33, 1897;

MAGNUS, Erysiph. Tirol. p. 10, 1898; NEGER, Krypt. Fl. d. Mark Brand. VII, p. 110, 1905; LIND, Danish Fung. p. 161, 1913; KLIKA, Erysiph. Czechosl. p. 45, 1924; JØRST. Erysiph. Norway, p. 50, 1925; ŠKORIĆ, Erysiph. Croat. p. 39, 1926. (YOSHINO, Bot. Mag. Tokyo, XIX, p. 206, 1905; IDETA, Jap. Phytopath. p. 199, 1911, and Jap. Phytopath. (Suppl. I), p. 207, 1923; SYD. Ann. Myc. XI, p. 113, 1913; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 47, 1914, and XIX, p. 162, 1919; HARA, Dendropath. p. 7, 1923; SHIRAI & HARA, List, p. 287, 1927).

Syn. *Alphitomorpha tridactyla* WALLR. Fl. Crypt. Germ. II, p. 753, 1833.

Erysibe tridactyla RABENH. Deutschl. Krypt. Fl. I, p. 237, 1844.

Erysibe Brayana RABENH. Deutschl. Krypt. Fl. I, p. 237, 1844.

Podosphaera Kunzei LÉV. Ann. Sci. Nat. III, 15, p. 135 (p.p.), 1851; KICKX, Fl. Crypt. Fland. I, p. 376, 1867; COOKE, Handb. Brit. Fung. II, p. 647, 1871; COOKE & PECK, Journ. Bot. I, p. 11, 1872; QUÉL. Champ. Jur. Vosg. p. 534, 1875. (FUCK. Symb. Myc. p. 77, (p.p.) 1869–70).

Erysiphe tridactyla TULASNE, Selecta Fung. Carpolog. I, p. 201, 1861.

Podosphaera Oxyacanthae (not DE BARY) BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 412, (p.p.), 1887. (STEVENS, Journ. Myc. XIII, p. 69, 1907).

Podosphaera Oxyacanthae (DC.) DE BARY var. *tridactyla* (WALLR.) SALM. Monogr. Erysiph. p. 36, 1900, and Bull. Torr. Bot. Club, XXIX, p. 85, 1902. (SALM. Bull. Torr. Bot. Club,XXVII, p. 445, 1900, Ann. Myc. III, p. 251, 1905, and VI, p. 11, 1908; MATSUM. Ind. Plant. Jap. I, p. 162, 1904; LAWR. Journ. Myc. XI, p. 107, 1906; SHIRAI, List, p. 71, 1905; SHIRAI & MIYAKE, List, p. 469, 1917).

Oidium erysiphoides FR. Syst. Myc. III, p. 432 (p.p.), 1829; SACC. Syll. Fung. IV, p. 41 (p.p.), 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 79 (p.p.), 1907.

Amphigenous, mostly epiphyllous; mycelium evanescent, at first forming a thin effused film; matured conidia borne in a chain, vacuolate, including the well-developed fibrosin bodies, subglobose or ellipsoidal, 16.8–32.4 × 10.8–18.0 μ; perithecia small, 84–98 μ in diameter; cells 13.2–15.6 μ wide; appendages produced from the upper part of the perithecium, erect, often fasciculate, 2–5 in number, straight or more or less curved, 154–175 μ in length, aseptate or 1–3 septate, deep brown colored to half their length or more, dichotomously branched 4–6 times at the apex, usually 5 times, primary or secondary branches are longer than the others, the apex of the ultimate branches more or less recurved; ascus 1, oblong, with a short stalk, 60.0–70.8 × 53.6–57.6 μ; spores 8, ellipsoidal or elongate-ellipsoidal, 19.2–26.4 × 12.0–14.4 μ.

Hab. On leaves of *Prunus Armeniaca* L. var. *Ansu* MAXIM. (Anzu). Honshu—Musashi.

On *Prunus Buergeriana* MIQ. (Inu-zakura). Honshu—Musashi.

On *Prunus Cerasus* L. (Mizakura). Hokkaido—Iburi. Honshu—Rikuchu.

On *Prunus Grayana* MAXIM. (Uwamizu-zakura). Honshu—Rikuchu, Hitachi.

On *Prunus Mume* SIEB. & ZUCC. (Mume). Hokkaido—Ishikari. Honshu—Musashi, Hitachi, Etchu, Yamashiro.

On *Prunus Padus* L. (Yezo-no-uwamizu-zakura). Saghalien—Izutsukawara.

On *Prunus Persica* SIEB. & ZUCC. var. *vulgaris* MAXIM. (Momo). Honshu—Musashi.

On *Prunus serrulata* LINDL. var. *albida* MAKINO subvar. *speciosa* MAKINO (Ohshima-zakura). Honshu—Musashi.

On *Prunus triflora* ROXB. (Sumomo). Hokkaido—Shiribeshi, Ishikari. Honshu—Musashi, Echigo.

On *Prunus yedoensis* MATSUM. (Someiyoshino). Honshu—Musashi, Echigo.

Distrib. Japan (Saghalien, Hokkaido, Honshu and Formosa), Manchuria, Europe and North America.

Remarks. The present species is widely found on different species of the genus Prunus. In the character of the appendages which are produced from the upper part of the perithecium, it is easily distinguished from *Podosphaera Oxyacanthae* in which the appendages are basal.

Podosphaera spiralis MIYABE

(Pl. VII, fig. 21)

In IDETA, Jap. Phytopath. p. 199, 1911. (SYD. Ann. Myc. XI, p. 113, 1913; SHIRAI & MIYAKE, List, p. 471, 1917; SHIRAI & HARA, List, p. 287, 1927).

Hypophyllous, mycelium evanescent; perithecia gregarious or subgregarious, 84.0–105.6 μ in diameter; cells 12.0–16.8 × 9.6–12.0 μ in size; appendages 2–8 in number, produced from the basal part of the perithecium, forming sinistrorse spirals, 3–4 times in the lower half of their length, 77.0–126 μ long, dark brown colored throughout or hyaline from middle upward, usually 2–3 septate, rarely aseptate, dichotomously branched 2–3 times, (rarely 4 times), tips of the ultimate branches broad, recurved or not; ascus 1, subglobose or ovate, short stalked, 72.0–98.4 × 57.2–81.6 μ; spores 8, rarely 7, oblong or ovate, 21.2–26.4 × 14.4–16.8 μ.

Hab. On leaves of *Ulmus propinqua* KOIDZ. (Harunire). Hokkaido—Ishikari.

Distrib. Japan (Hokkaido).

Remarks. This species is endemic to Japan. It can readily be distinguished from other species of Podosphaera, by the spiral appendages of the perithecium and by the larger ascus.

Podosphaera spiralis is found on the leaves of Ulmus bush, frequently associated with *Uncinula clandestina*, which occurs on the upper surface of the leaves, while the present fungus is always found on the under surface. The mycelium of the latter entirely disappears when the perithecia are formed so that it is very difficult to find it. This very interesting species was first collected and named by Prof. MIYABE.

Podosphaera Oxyacanthae (DC.) DE BARY

(Pl. VII, fig. 22)

Beitr. Morph. Phys. Pilz. I, xiii, p. 48, 1870; SACC. Syll. Fung. I, p. 2, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 29, 1884; EARLE, Bot. Gaz. IX, p. 26, 1884; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 412 (p.p.), 1887; ELL. & EVERH. N. Amer. Pyren. p. 21, 1892; SHRÖT. in COHN's Krypt. Fl. Schles. II, p. 234, 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 743, 1896; MAGNUS, Erysiph. Tirol. p. 10, 1898; SALM. Monogr. Erysiph. p. 29, 1900, and Bull. Torr. Bot. Club, XXIX, p. 83, 1902; NEGER, Krypt. Fl. d. Mark Brand. VII, p. 112, 1905; KLIKA, Erysiph. Czechosl. p. 44, 1924; JØRST. Erysiph. Norway, p. 47, 1925; ŠKORIĆ, Erysiph. Croat. p. 40, 1926; TAI & WEI, Sinensia, III, p. 121, 1932. (GALLOW. Journ. Myc. IV, p. 34, 1888; PAMM. Journ. Myc. IV, p. 38, 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 143, 1899; SALM. Bull. Torr. Bot. Club, XXVII, p. 455, 1900, Ann. Myc. III, p. 251, 1905, and VI, p. 11, 1908; MATSUM. Ind. Plant. Jap. I, p. 162, 1904; LAWR. Journ. Myc. XI, p. 107, 1905; SHIRAI, List, p. 71, 1905; IDETA, Jap. Phytopath. p. 198, 1911;

JAAP, Ann. Myc. IX, p. 333, 1911; SAWADA, Agric. Exp. Stat. Formosa, Bull. IX, p. 48, 1914; I. MIYAKE, Bot. Mag. Tokyo, XXVIII, p. 39, 1914; SHIRAI & MIYAKE, List, p. 469, 1917; HARA, Dendropath. p. 8, 1923; SHIRAI & HARA, List, p. 287, 1927).

Syn. *Erysiphe Oxyacanthae* DC. Fl. Fr. VI, p. 106, 1815; TULASNE, Selecta Fung. Carpolog. I, p. 202, 1861.

Erysibe clandestina LK. in WILLD. Sp. Pl. VI, p. 103, 1824; RABENH. Deutschl. Krypt. Fl. I, p. 237, 1844.

Erysiphe clandestina (*Oxyacanthae*) FR. Syst. Myc. III, p. 238, 1829.

Podosphaera clandestina LÉV. Ann. Sci. Nat. III, 15, p. 136, 1851; KICKX, Fl. Crypt. Fland. I, p. 376, 1867; COOKE, Handb. Brit. Fung. II, p. 648, 1871; QUÉL. Champ. Jur. Vosg. p. 534, 1875; LIND, Danish Fung. p. 161, 1913. (FUCK. Symb. Myc. p. 77, 1869–70).

Podosphaera Kunzei LÉV. Ann. Sci. Nat. III, 15, p. 135 (p.p.), 1851; COOKE & PECK, Journ. Bot. I, p. 170, 1872.

Podosphaera minor E. C. HOWE, Bull. Torr. Bot. Club, V, p. 3, 1874; SACC. Syll. Fung. IX, p. 364, 1891.

Microsphaera fulvofulcra COOKE, Grevillea, V, p. 110, 1877; SACC. Syll. Fung. I, p. 14, 1882.

Oidium Crataegi GROG. in ROUMEG. Fung. Gall. No. 881, 1888; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 82, 1907; SACC. Syll. Fung. XXII, p. 1249, 1913.

Amphigenous, mycelium evanescent or subpersistent, forming thin and effused film; perithecia scattered or subgregarious, globose, 70.0–88.0 μ in diameter; cells 11.8–19.0 × 10.0–13.6 μ in width; appendages produced from the basal part of the perithecium, 8–16 in number, straight or more or less curved throughout, thin walled, dark brown colored from middle downward, 84–126 μ, aseptate, 4–5 times dichotomously branched at the apex, ultimate branches broad and recurved or not; ascus 1, subglobose or broadly ovate, 58.6–60.0 × 45.6–48.0 μ, without stalk; spores 7–8, rarely 5, including remarkably well developed fibrosin bodies, oblong or ellipsoidal, 24.0–28.8 × 12.0–14.4 μ.

Hab. On leaves of *Crataegus chlorosarca* MAXIM. (Kuromi-sanzashi). Saghalien—Otani, Konuma.

On *Crataegus jozana* C. K. SCHN. (Yezo-sanzashi). Hokkaido—Ishikari.

On *Crataegus Maximowiczii* SCHNEID. (Arage-akasanzashi). Saghalien—Otatomari, Ruikofu.

On *Spiraea betulifolia* PALL. (Maruba-shimotsuke). Saghalien—Tonnai. Hokkaido—Ishikari.

On *Spiraea salicifolia* L. var. *lanceolata* TORR. & GRAY. (Hozaki-shimotsuke). Saghalien—Kamiarumudan. Hokkaido—Iburi.

Distrib. Japan (Saghalien, Hokkaido, Honshu and Formosa), China, Europe and North America.

Remarks. *Podosphaera Oxyacanthae* which is known as the cherry powdery mildew or apple mildew is injurious especially to the young stock of nurseries.

Podosphaera myrtillina is included in this species as a synonym by SALMON, but the examination of the form on *Vaccinium uliginosum* has shown that the diameter of the perithecia is larger, being 112 μ and the appendages are very long, reaching about 840 μ in length. These characters are sufficient to distingish it from *Podosphaera Oxyacanthae*.

Erysiphe HEDW. f.

Mycelium is superficial, sending haustoria into the epidermal cells of the host plants; haustoria are subglobose or finger-like in shape (graminis); matured conidia are produced in a chain or solitary and fibrosin bodies are wanting; perithecia are globose; appendages of the perithecium are simple; asci and ascospores are several.

This genus can be divided into three sections, Polygoni (*Erysiphe Polygoni, E. Heraclei, E. Pisi, E. Aquilegiae*), Cichoracearum (*Erysiphe Cichoracearum, E. Galeopsidis*), and Graminis (*Erysiphe graminis*). These sections can be identified by the characters of their conidia. In the Polygoni section, the matured conidia are solitary; in the Cichoracearum section, they are always produced in a chain; and in the Graminis section, they are in a long chain and there is a bulbous swelling at the base of the conidiophore.

Key to the species of the genus Erysiphe

I. Polygoni section.
  Matured conidia solitary, ascospores 3–8 in an ascus.
  A. Appendages hyaline or pale brown colored at the base.
    1. Appendages simple .... ***E. Pisi*** (321)
    2. Appendages vaguely branched and flexuous ..... ***E. Heraclei*** (324)
  B. Appendages colored.
    1. Appendages simple, brown colored from middle downward .... ***E. Polygoni*** (326)

2. Appendages deep brown colored throughout at maturity, flexuous and vaguely branched .... *E. Aquilegiae* (330)

II. Graminis section.

Matured conidia produced in a chain, having a bulbous swelling at the base of the conidiophore, ascospores 3–8 .... *E. graminis* (333)

III. Cichoracearum section.

Matured conidia borne in a chain, ascospores 2, rarely 3.

1. Ascospores are matured on the living host plants .... *E. Cichoracearum* (335)
2. Ascospores remain immatured on the living host plants .... *E. Galeopsidis* (340)

Erysiphe Pisi DC.

(Pl. VII, figs. 23, 24, and Pl. VIII, figs. 1, 2)

Fl. Fr. II, p. 274, 1805. (RANOJ. Ann. Myc. VIII, p. 356, 1910).

Syn. *Alphitomorpha communis* WALLR. Berl. Ges. Nat. Freund. Verh. I, p. 31 (p.p.), 1819; PRILL. Malad. Pl. Agr. III, p. 14, 1897.

Erysibe Pisi DC. in GRAY. Nat. Arr. Brit. Pl. I, p. 589, 1821; SCHRÖT. in COHN's Krypt. Fl. Schles. II, p. 236, 1893. (JAAP, Ann. Myc. IX, p. 333, 1911).

Erysiphe communis FR. Syst. Myc. III, p. 239 (p.p.), 1829; KICKX, Fl. Crypt. Fland. I, p. 380 (p.p.), 1867; SACC. Syll. Fung. I, p. 18 (p.p.), 1882; BURR. & EARLE, Ill. Stat. Lab. Nat. Hist. II, p. 402 (p.p.), 1887; ELL. & EVERH. N. Amer. Pyren. p. 10 (p.p.), 1892; OUDEM. Rév.Champ. Pays-Bas, II, p. 97 (p.p.), 1897; LIND, Danish Fung. p. 162 (p.p.), 1913. (TRACY & GALL. Journ. Myc. IV, p. 34 (p.p.), 1888; PAMM. Journ. Myc. IV, p. 37 (p.p.), 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 141 (p.p), 1899; SHIRAI, List, p. 32 (p.p), 1905; SHIRAI & MIYAKE, List, p. 223 (p.p.), 1917).

Erysibe communis LK. in RABENH. Deutschl. Krypt. Fl. I, p. 223 (p.p.), 1844.

Erysiphe communis MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837, and Syn. Nouv. Fl. Paris, p. 84 (p.p.), 1837.

Erysiphe communis (not FR.) DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 50 (p.p.), 1870.

Erysiphe communis (not FR.) COOKE, Handb. Brit. Fung. II, p. 652 (p.p.), 1871.

Erysiphe Martii LÉV. Ann. Sci. Nat. III, 15, p. 166 (p.p.), 1851; COOKE, Handb. Brit. Fung. II, p. 651 (p.p.), 1871; SACC. Syll. Fung. I, p. 19 (p.p.), 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2,

p. 31 (p.p.), 1884; JACZEW. Bull. l'Herb. Boiss. IV, p. 729 (p.p.), 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 97 (p.p.), 1897; MAGNUS, Erysiph. Tirol. p. 13 (p.p.), 1898. (FUCK. Symb. Myc. p. 83 (p.p.), 1869–70).

Erysiphe communis (not FR.) QUÉL. Champ. Jur. Vosg. p. 532 (p.p.), 1875.

Erysiphe Polygoni (not DC.) SALM. Monogr. Erysiph. p. 174 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 181 (p.p.), 1902; NEGER, Krypt. Fl. d. Mark Brand. VII, p. 118 (p.p.), 1905; KLIKA, Erysiph. Czechosl. p. 66 (p.p.), 1924; TAI & WEI, Sinensia, III, p. 96 (p.p.), 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 443 (p.p.), 1900, Ann. Myc. III, p. 249 (p.p.), 1905, and VI, p. 8 (p.p.), 1908; MATSUM. Ind. Plant. Jap. I, p. 141 (p.p.), 1904; LAWR. Journ. Myc. XI, p. 106 (p.p.), 1905; YOSHINO, Bot. Mag. Tokyo, XIX, p. 205 (p.p.), 1905; IDETA, Jap. Phytopath. p. 204 (p.p.), 1911; I. MIYAKE, Bot. Mag. Tokyo, XXVI, p. 53, 1912; DOIDGE, Roy. Soc. South Afr. V, p. 241 (p.p.), 1915; SHIRAI & MIYAKE, List, p. 225 (p.p.), 1917).

Erysibe Pisi DC. var. *Desmodii* P. HENN. in ENGR. Bot. Jahrb. XXIX, p. 148, 1901. (SHIRAI, List, p. 32, 1905; SHIRAI & MIYAKE, List, p. 227, 1917).

Erysiphe communis (not FR.) RANOJ. Hedw. XLI, p. 102, 1902.

Microsphaera Polygoni SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 53 (p.p.), 1914, and XIX, p. 168 (p.p.), 1919. (SHIRAI & MIYAKE, List, p. 367 (p.p.), 1917; IDETA, Jap. Phytopath. (Suppl. I), p. 210 (p.p.), 1923; SHIRAI & HARA, List, p. 217 (p.p.), 1927; MIURA, Pub. South. Manch. Rwy. Co. XXVII, p. 135 (p.p.), 1928).

Amphigenous, mostly hypophyllous, also on petioles and stems; mycelium persistent or subpersistent, white powdery at first, turning to greyish color when mature; matured conidia solitary, vacuolate, elongate oblong or ellipsoidal, 36.0–50.4 × 12.0–19.2 μ in size; perithecia scattered, globose or depressed-globose, 93.6–140 μ in diameter (on *Diervilla japonica* 116–168 μ) ; cells 8.4–16.8 × 9.6–21.6 μ in size; appendages simple, mostly hyaline, rarely pale brown to the first septum, 8–22 in number, flaccid or flexuous, 266–462 μ in length, aseptate or 1–5 septate; asci hyaline or rarely light yellow, 4–9 in number, oblong or ovate, with a short stalk, thick walled, 51.6–74.4 × 31.2–57.6 μ; spores hyaline, 3–8 in number, ellipsoidal or ovate, 15.6–25.2 × 9.6–16.8 μ.

Hab. On leaves and stems of *Alnus pendula* MATSUM. (Hime-yashabushi). Honshu—Rikuchu.

On *Aeschynomene indica* L. (Kusa-nemu). Honshu—Inaba.

On *Astragalus reflexistipulus* MIQ. (Momenzuru). Hokkaido—Ishikari.

On *Astragalus secundus* DC. (Rishiri-wogi). Hokkaido—Ishikari.

On *Desmodium caudatum* DC. var. *japonicum* NAKAI (Nusubito-hagi). Hokkaido—Oshima. Honshu—Musashi, Sagami. Shikoku—Tosa. Kyushu—Higo.

On *Falcata japonica* KOM. (Yabumame). Hokkaido—Oshima, Shiribeshi, Iburi, Ishikari. Honshu—Rikuchu, Musashi, Echigo, Etchu, Kaga, Mino. Kyushu—Buzen, Higo.

On *Indigofera pseudo-tinctoria* MATSUM. (Komatsunagi). Honshu—Musashi.

On *Indigofera tinctoria* L. (Kiai). Kyushu—Higo.

On *Lathyrus maritimus* BIGEL. (Hama-endo). Hokkaido—Ishikari.

On *Lespedeza bicolor* TURCZ. var. *japonica* NAKAI (Hagi). Honshu—Etchu.

On *Lespedeza cuneata* G. DON. (Medo-hagi). Honshu—Kazusa. Kyushu—Higo.

On *Lespedeza pilosa* SIEB. & ZUCC. (Neko-hagi). Honshu—Musashi, Yamashiro. Kyushu—Higo.

On *Lespedeza virgata* DC. (Makie-hagi). Honshu—Musashi, Hitachi.

On *Lotus corniculatus* L. var. *japonicus* REGEL (Miyakogusa). Hokkaido—Iburi.

On *Lupinus perennis* L. (Hauchiwa-mame). Hokkaido—Ishikari.

On *Medicago lupulina* L. (Kibana-no-kometsubu-umagoyashi). Hokkaido—Ishikari.

On *Microlespedeza stipulacea* MAKINO (Yahazuso). Honshu—Etchu.

On *Phaseolus Mungo* L. (Ke-tsuru-azuki). Honshu—Musashi.

On *Phaseolus radiatus* L. var. *aurea* PRAIN. (Azuki). Kyushu—Higo.

On *Pisum sativum* L. (Endo). Hokkaido—Oshima, Ishikari, Kitami. Honshu—Rikuzen, Musashi, Tamba. Kyushu—Higo.

On *Sophora angustifolia* SIEB. & ZUCC. (Kurara). Honshu—Bizen, Hoki.

On *Thermopsis fabacea* DC. (Sendaihagi). Honshu—Musashi.

On *Trifolium incarnatum* L. (Kurimuson-kuroba). Hokkaido—Ishikari.

On *Trifolium repens* L. (Kuroba). Hokkaido—Ishikari.

On *Vigna sinensis* SAVI (Sasage). Kyushu—Higo. Formosa—Shinchiku.

On *Diervilla decora* NAKAI (Nishiki-utsugi). Honshu—Kaga.

On *Diervilla japonica* DC. (Tani-utsugi). Hokkaido—Ishikari. Honshu—Ugo, Sagami, Echigo.

Distrib. All over the world.

Remarks. In this species the appendages are hyaline, simple, more or less straight and scarcely distinguishable from the mycelium. The great number of Leguminosae and a small part of Betulaceae and Caprifoliaceae are included as host plants of the species in this country.

Erysiphe Pisi was first recorded by DE CANDOLLE as a species causing the powdery mildew on Leguminosae. Since then, it was considered as the synonym of *Erysiphe communis* or *E. Martii*, and in 1900, SALMON included it under *Erysiphe Polygoni* together with the above mentioned two species.

As the result of careful examination, the author has found that it differs from *E. Polygoni* in that the appendages are almost hyaline and simple.

In 1901, P. HENNINGS (78) treated the fungus on *Desmodium podocarpum* var. *latifolium*, as a new variety of *E. Pisi* DC. (*E. Pisi* DC. var. *Desmodii* P. HENN.—Prov. Musashi: Mt. Takao, Oct. 18, 1899, S. KUSANO). The co-type specimen was kindly given to the author by Prof. S. KUSANO, who kindly informed her that the host plant was not *Desmodium* but *Falcata japonica*. As the result of studies on this specimen as well as on the numerous specimens of the same fungus on *Falcata japonica* which had been collected in different parts of this country, we have found that there is no need of keeping the var. *Desmodii*, as it is essentially the same in characters as *E. Pisi*.

The forms on *Vicia Cracca* and *Robinia pseudacacia* have hitherto been included in this species, but they had better be included in Microsphaera, as the appendages are regularly dichotomously branched once or twice.

In the form on *Medicago lupulina*, the cells of the perithecial walls are large, being 18.0–21.6 × 12.0–16.8 μ in size.

In the form on *Astragalus reflexistipulus*, the asci and ascospores are small, the asci being 40.8–52.8 × 30.0–39.6 μ and the ascospores 18.0–20.4 × 10.4–12.0 μ in size.

In the form on *Diervilla japonica*, the perithecium attains a large size, being 110–168 μ in diameter.

The form on the fruit of *Alnus pendula* is very interesting in that the fungus could not be distinguished from *E. Pisi*, as the appendages of the perithecium are hyaline or pale brown toward the base and always simple. As the result of the comparison with *Erysiphe aggregata* on Alnus, the present fungus is found to have smaller perithecia and asci.

Erysiphe Heraclei DC.

(Pl. VIII, figs. 3, 4, 5)

Fl. Fr. VI, p. 107, 1815. (RANOJ. Ann. Myc. VIII, p. 356, 1910).
Syn. *Erysiphe Scandicis* DC. Fl. Fr. VI, p. 107, 1815.

Erysiphe communis FR. Syst. Myc. III, p. 239 (p.p.), 1829; LIND, Danish Fung. p. 162 (p.p.), 1913. (SHIRAI, List, p. 32 (p.p.), 1905; SHIRAI & MIYAKE, List, p. 223, 1917).

Erysibe communis LK. in RABENH. Deutschl. Krypt. Fl. I, p. 233 (p.p.), 1844.

Erysiphe communis MÉRAT. Nouv. Fl. Paris, p. 75 (p.p.), 1837, and Syn. Nouv. Fl. Paris, p. 84 (p.p.), 1837.

Erysiphe Martii LÉV. Ann. Sci. Nat. III, 15, p. 166 (p.p.), 1851; KICKX, Fl. Crypt. Fland. I. p. 382, 1867; COOKE, Handb. Brit. Fung. II, p. 651 (p.p.), 1871; SACC. Syll. Fung. I, p. 19 (p.p.), 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 31 (p.p.), 1884; JACZEW. Bull. l'Herb. Boiss. IV, p. 729 (p.p.), 1896. (FUCK. Symb. Myc. p. 83 (p.p.), 1869–70).

Erysiphe Umbelliferarum DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 50, 1870; SACC. Syll. Fung. I, p. 17, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 31, 1884; MAGNUS, Erysiph. Tirol. p. 13, 1898.

Erysiphe Martii LK. in QUÉL. Champ. Jur. Vosg. p. 532 (p.p.), 1875.

Erysibe Heraclei DC. in SCHRÖT. COHN'S Krypt. Fl. Schles. III, p. 239, 1893. (JAAP, Ann. Myc. IX, p. 333, 1911).

Erysiphe communis Fr. var. *Umbelliferarum* JACZEW. Bull. l'Herb. Boiss. IV, p. 733, 1896.

Erysiphe Polygoni (not DC.) SALM. Monogr. Erysiph. p. 174 (p.p.), 1900, Bull. Torr. Bot. Club, XXVII, p. 443 (p.p.), 1900, and XXIX, p. 181 (p.p.), 1902; NEGER, Krypt. d. Mark Brand. VII, p. 118 (p.p.), 1905; KLIKA, Erysiph. Czechosl. p. 66 (p.p.), 1924. (MATSUM. Ind. Plant. Jap. I, p. 141 (p.p.), 1904; SALM. Ann. Myc. III, p. 249 (p.p.), 1905, and VI, p. 8 (p.p.), 1908; P. HENN. in ENGL. Bot. Jahrb. XXXII, p. 41, 1903, and XXXIV, p. 600, 1905; YOSHINO, Bot. Mag. Tokyo, XIX, p. 205 (p.p.), 1905; SYD. Ann. Myc. VII, p. 170, 1909, and XI, p. 113, 1913; IDETA, Jap. Phytopath. p. 204 (p.p.), 1911; SHIRAI & MIYAKE, List, p. 225 (p.p.), 1917).

Microsphaera Polygoni SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 53 (p.p.), 1914, and XIX, p. 168 (p.p.), 1919. (SHIRAI & MIYAKE, List, p. 367 (p.p.), 1917; HARA, Dendropath. p. 13, 1923; IDETA, Jap. Phytopath. (Suppl. I), p. 210 (p.p.), 1923; SHIRAI & HARA, List, p. 217 (p.p.), 1927).

Amphigenous, also on stems, petioles and inflorescences; mycelium evanescent; matured conidia solitary, vacuolate, granulate, ellipsoidal or elongate-ellipsoidal, 33.6–45.6 ×16.8–18.0 μ; perithecia globose or depressed-globose, 84–136 μ in diameter; cells 12.0–21.6 × 8.4–13.2 μ in size; appendages irregular in form and length, 14–17 in number, aseptate or 1–2 septate, about 188–210 μ long, hyaline, light brown colored toward the base, sometimes irregularly branched at the apex; asci 4–6, subglobose or ellipsoidal, evidently stalked, 40.8–62.4 × 30.0–43.2 μ; spores 3–6, ellipsoidal, oblong or ovate, 19.2–39.6 × 9.6–14.4 μ. (The size of three spores in an ascus is larger than that of the others).

Hab. On leaves and stems of *Quercus glauca* THUNB. (Ara-gashi). Honshu—Kii, Yamashiro, Kawachi, Inaba. Shikoku—Tosa. Kyushu—Hizen, Higo.

On *Quercus myrsinaefolia* BLUME (Shira-kashi). Honshu—Bitchu.

On *Quercus stenophylla* MAKINO (Urajiro-gashi). Honshu—Aki.

On *Fagopyrum esculentum* MOENCH. (Soba). Hokkaido—Ishikari. Honshu—Hitachi, Etchu. Kyushu—Hizen, Higo.

On *Angelica Miqueliana* MAXIM. (Yama-zeri). Honshu—Musashi.

On *Peucedanum terebinthaceum* FISCH. (Kawara-bofu). Hokkaido—Ishikari.

On *Seseli Libanotis* KOCH. (Hama-ibuki-bofu). Hokkaido—Iburi. Honshu—Ugo.

On *Torilis Anthriscus* BERNK. (Yabu-jirami). Hokkaido—Shiribeshi, Iburi, Ishikari, Kushiro.

Distrib. All over the world.

Remarks. The present species can be distinguished from *Erysiphe Pisi* by the fact that the appendages of the perithecium are very irregularly branched and numerous in number.

Erysiphe Polygoni DC.

(Pl. VIII, figs. 6, 7, 8)

Fl. Fr. II, p. 273, 1805; SALM. Monogr. Erysiph. p. 174 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 181 (p.p.), 1902; NEGER, Krypt. d. Mark Brand. VII, p. 118 (p.p.), 1905; KLIKA, Erysiph. Czechosl. p. 66 (p.p.), 1924; TAI & WEI, Sinensia, III, p. 96 (p.p.), 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 443 (p.p.), 1900, Ann. Myc. III, p. 249 (p.p.), 1905, and VI, p. 8 (p.p.), 1908; MATSUM. Ind. Plant. Jap. I, p. 141 (p.p.), 1904; LAWR. Journ. Myc. XI, p. 106

(p.p.), 1905; IDETA, Jap. Phytopath. p. 204 (p.p.), 1911; I. MIYAKE, Bot. Mag. Tokyo, XXVIII, p. 39, 1914; SHIRAI & MIYAKE, List, p. 225 (p.p.), 1917; TOGASHI, Jap. Journ. Bot. II, p. 79, 1924).

Syn. *Erysiphe Convolvuli* DC. Fl. Fr. II, p. 274, 1805.

Alphitomorpha communis WALLR. Berl. Ges. Nat. Freuend. Verh. I, p. 31 (p.p.), 1819.

Erysibe Polygoni DC. in GRAY, Nat. Arr. Brit. I, p. 589, 1821; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 234, 1893; P. HENN. in ENGL. Bot. Jahrb. XXIX, p. 148, 1901.

Erysiphe communis FR. Syst. Myc. III, p. 239 (p.p.), 1829; KICKX, Fl. Crypt. Fland. I, p. 380 (p.p.), 1867; SACC. Syll. Fung. I, p. 18 (p.p.), 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 32 (p.p.), 1884; BURR. & EARLE, Ill. Stat. Lab. Nat. Hist. II, p. 402 (p.p.), 1887; ELL. & EVERH. N. Amer. Pyren. p. 10 (p.p.), 1892; MAGNUS, Erysiph. Tirol. p. 15 (p.p.), 1895; JACZEW. Bull. l'Herb. Boiss. IV, p. 732 (p.p.), 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 97 (p.p.), 1897; LIND, Danish Fung. p. 162 (p.p.), 1913. (FUCK. Symb. Myc. p. 85 (p.p.), 1869–70; TRACY et GALLOW. Journ. Myc. IV, p. 34 (p.p.), 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 141 (p.p.), 1899; P. HENN. in ENGL. Bot. Jahrb. XXVIII, p. 272, 1901; MATSUM. Ind. Plant. Jap. I, p. 141, 1904; SHIRAI, List, p. 32 (p.p.), 1905; SHIRAI & MIYAKE, List, p. 223, 1917).

Erysibe communis LK. in RABENH. Deutschl. Krypt. Fl. I, p. 233 (p.p.), 1844.

Erysiphe communis MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837.

Erysiphe Martii LÉV. Ann. Sci. Nat. III, 15, p. 166 (p.p.), 1851; JACZEW. Bull. l'Herb. Boiss. IV, p. 729 (p.p.), 1896.

Erysiphe communis DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 50 (p.p.), 1870.

Erysiphe Martii LK. in QUÉL. Champ. Jur. Vosg. p. 532 (p.p.), 1875.

Erysiphe Polygoni SCHRÖT. in RANOJ. Ann. Myc. VIII, p. 356, 1910.

Microsphaera Polygoni SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 53 (p.p.), 1914. (SAWADA, Agr. Exp. Stat. Formosa, Bull. XIX, p. 168 (p.p.), 1919; IDETA, Jap. Phytopath. (Suppl. I), p. 210 (p.p.), 1923; SHIRAI & HARA, List, p. 217 (p.p.), 1927; MIURA, Pub. South Manch. Rwy. Co. XXVII, p. 135 (p.p.), 1928).

Ovularia Clematidis CHITT. Gard. Chron. p. 299, 1903.

Oidium Clematidis SACC. & TRAV. in SACC. Syll. Fung. XXII, p. 1249, 1913.

Amphigenous, also on stems and petioles; mycelium persistent, at first forming white mycelial patches and finally spreading over the surface of the leaves and stems; matured conidia solitary, vacuolate, granulate, elongate-ellipsoidal or oblong, 31.2–42.0 × 12.0–16.8 μ (except the form on *Elsholtzia Patrini*); perithecia scattered or gregarious, 84–140 μ in diameter, globose or depressed-globose; cells 9.6–25.2 × 8.4–16.8 μ in size; appendages variable in number, 1–5 times the diameter of the perithecia, several septate or rarely aseptate, brown colored from middle downward, always simple; asci hyaline or light yellow, 4–10, oblong or ovate, evidently stalked, 38.4–70.4 × 26.4–48.0 μ; spores 3–6 in number, elongate-ellipsoidal, 14.4–28.8 × 8.0–16.8 μ.

Hab. On leaves, stems and inflorescence of *Pilea viridissima* MAKINO (Aomizu). Hokkaido—Ishikari, Kushiro.

On *Polygonum aviculare* L. (Michiyanagi). Saghalien—Baguntan. Hokkaido—Oshima, Shiribeshi, Ishikari, Teshio, Kushiro. Honshu—Rikuchu, Musashi, Echigo. Shikoku—Tosa.

On *Aconitum kamtschaticum* WILLD. (Chishima-torikabuto). Hokkaido—Kurile Isls. Etorofu Isl.

On *Clematis alpina* MILL. (Miyama-hanshozuru). Hokkaido—Ishikari.

On *Clematis fusca* TURCZ. var. *mandshurica* TAKEDA (Kurobana-hanshozuru). Hokkaido—Ishikari.

On *Clematis paniculata* THUNB. (Senninso). Honshu—Aki. Shikoku—Tosa.

On *Macleya cordata* R. BR. (Takeni-gusa). Honshu—Musashi.

On *Sedum Aizoon* L. (Hosobano-kirinso). Saghalien—Akashiki. Hokkaido—Iburi.

On *Sedum alboroseum* BAK. (Benkei-so). Hokkaido—Ishikari, Kushiro. Honshu—Musashi, Etchu.

On *Sedum Telephium* L. var. *purpureum* L. (Murasaki-benkeiso). Saghalien—Akashiki. Hokkaido—Ishikari.

On *Saxifraga cortusaefolia* SIEB. & ZUCC. var. *typica* MAKINO (Daimonjiso). Hokkaido—Ishikari.

On *Linum usitatissimum* L. (Ama). Hokkaido—Ishikari.

On *Abelmoschus esculentus* MOENCH. (Tororo-aoi). Honshu—Etchu.

On *Lythrum Salicaria* L. (Yezo-misohagi). Hokkaido—Ishikari, Kushiro.

On *Clinopodium chinense* KUNTZE (Kurumabana). Hokkaido—Ishikari.

On *Clinopodium sachalinense* KOIDZ. (Miyama-kurumabana). Hokkaido—Tokachi. Honshu—Etchu.

On *Elsholtzia Patrini* GARCKE (Naginata-koju). Hokkaido—Iburi, Ishikari, Kitami, Tokachi, Kushiro. Honshu—Mutsu, Rikuchu.

On *Scutellaria dependens* MAXIM. (Hime-namiki). Saghalien—Alexandrowsk. Hokkaido—Shiribeshi, Ishikari. Honshu—Echigo.

On *Scutellaria galericulata* L. var. *pubescens* REGEL (Oh-namiki). Saghalien—Odomari.

On *Scutellaria scordifolia* FISCH. f. *puberula* KOM. (Yezo-namiki). Hokkaido—Ishikari.

On *Scutellaria strigillosa* HEMSL. (Namikiso). Hokkaido—Shiribeshi.

On *Scutellaria ussuriensis* KUDO (Yezo-tatsunamiso). Hokkaido—Iburi, Ishikari, Kushiro.

On *Mimulus inflatus* NAKAI (Mizo-hoozuki). Hokkaido—Shiribeshi, Ishikari, Kitami, Kushiro.

On *Actinostemma lobatum* MAXIM. var. *racemosum* MAK. (Gokizuru). Honshu—Musashi, Kazusa. Shikoku—Tosa. Kyushu—Higo.

On *Schizopepon bryoniaefolius* MAXIM. (Miyama-nigauri). Hokkaido—Kushiro.

On *Trichosanthes cucumeroides* MAXIM. (Karasu-uri). Honshu—Echigo.

On *Cacalia delphinifolia* SIEB. & ZUCC. (Momijigasa). Hokkaido—Ishikari.

Distrib. All over the world.

Remarks. The powdery mildew parasitic on *Polygonaceae* was named *Erysiphe Polygoni* by DE CANDOLLE. Afterward, a large number of host plants have been gradually added to the fungus by many authors. In 1900, SALMON (32) considered *Erysiphe Polygoni* as a very large collective species, the number of its host plants amounting to about 350 species and synonyms to about 50 in number having been attributed to the species. The writer has carefully examined every specimen on the host plants belonging to 84 species collected in the different parts of this country. As the result of the examination, the writer has come to the conclusion that SALMON's *Erysiphe Polygoni* could be divided into four types by the characters of the appendages (*Erysiphe Pisi, E. Heraclei, E. Polygoni* and *E. Aquilegiae*), although all of them have 3–8 spores in an ascus.

In the present species, the appendages are simple and brown colored from the middle downward.

In 1914, *Erysiphe Polygoni* was transferred to *Microsphaera Polygoni* by SAWADA (149) because of the following points; the conidia are solitary and the apex of the appendages is frequently divided once or twice. From what the present writer has examined, she does not hesitate to transfer the form on *Vicia Cracca* and *Vicia unijuga* to Microsphaera, but in the forms on other host plants she considers it better to retain them in the genus Erysiphe.

In the form on *Elsholtzia Patrini,* the conidia differ from others in respect to their subglobose form, and smaller size, 28.8–30.0 × 19.2–

22.8 μ, also the appendages include many granules and they are very evidently 4–7 septate.

In the form on *Aconitum kamtschaticum,* although the forms on other species of Aconitum belong to *Erysiphe Aquilegiae,* the appendages are light brown colored at the base, and always simple, the asci and ascospores are larger, the asci being 45.6–70.4 × 30.0–48.0 μ and the ascospores 22.4–26.4 × 12.0–16.8 μ.

In the form on *Sedum Telephium,* the ascospores are subglobose and the appendages are difficult to distinguish from the mycelium, as they are both brown colored.

Erysiphe Aquilegiae DC.

(Pl. VIII, figs. 9, 10, 11)

Fl. Fr. VI, p. 105, 1815.

Syn. *Alphitomorpha communis* WALLR. Berl. Ges. Nat. Freund. Verh. I, p. 31 (p.p.), 1819.

Erysiphe communis FR. Syst. Myc. III, p. 239 (p.p.), 1829; KICKX, Fl. Crypt. Fland. I, p. 380 (p.p.), 1867; DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 50 (p.p.), 1870; SACC. Syll. Fung. I, p. 18 (p.p.), 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 32 (p.p.), 1884; BURR. & EARLE, Ill. Stat. Lab. Nat. Hist. II, p. 402 (p.p.), 1887; ELL. & EVERH. N. Amer. Pyren. p. 10 (p.p.), 1892; JACZEW. Bull. l'Herb. Boiss. IV, p. 732 (p.p.), 1896; OUDEM. Rév. Champ. Pays-Bass, II, p. 97 (p.p.), 1897; MAGNUS, Erysiph. Tirol. p. 15 (p.p.), 1898; LIND, Danish Fung. p. 162 (p.p.), 1913. (FUCK. Symb. Myc. p. 85 (p.p.), 1869–70; TRAÇY & GALLOW. Journ. Myc. IV, p. 34 (p.p.), 1888; PAMM. Journ. Myc. IV, p. 37 (p.p.), 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 141 (p.p.), 1899; SHIRAI, List, p. 32 (p.p.), 1905; SHIRAI & MIYAKE, List, p. 223 (p.p.), 1917).

Erysibe communis LK. in RABENH. Deutschl. Krypt. Fl. I, p. 233 (p.p.), 1844.

Erysiphe communis MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837.

Erysibe nitida (*delphinii*) RABENH. Deutschl. Krypt. Fl. I, p. 231, 1844.

Erysiphe communis SCHL. ex. COOKE, Handb. Brit. Fung. II, p. 652 (p.p.), 1871; COOKE & PECK, Journ. Bot. I, p. 13, 1872, and I, p. 171, 1872.

Erysiphe vernalis KARST. Myc. Fenn. II, p. 193, 1874; SACC. Syll. Fung. I, p. 19, 1882.

Erysiphe communis QUÉL. (not FR.) Champ. Jur. Vosg. p. 532 (p.p.), 1875.

Erysiphe communis FR. f. *Paeoniae* RAHM, Hedw. XXIV, p. 70, 1885.

Erysiphe Polygoni (not DC.), SALM. Monogr. Erysiph. p. 174 (p.p.), 1900, Bull. Torr. Bot. Club, XXVII, p. 443 (p.p.), 1900, and XXIX, p. 181 (p.p.), 1902; NEGER, Krypt. d. Mark. Brand. VII, p. 118 (p.p.), 1905; KLIKA, Erysiph. Czechosl. p. 66 (p.p.), 1924. (MATSUM. Ind. Plant. Jap. I, p. 141 (p.p.), 1904; LAWR. Journ. Myc. XI, p. 106 (p.p.), 1905; SALM. Ann. Myc. III, p. 249 (p.p.), 1905, and VI, p. 8 (p.p.), 1908; IDETA, Jap. Phytopath. p. 204 (p.p.), 1911; SHIRAI & MIYAKE, List, p. 225 (p.p.), 1917).

Erysibe Polygoni DC. in JAAP, Ann. Myc. IX, p. 333, 1911.

Microsphaera Polygoni SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 53 (p.p.), 1914. (IDETA, Jap. Phytopath. (Suppl. I), p. 210 (p.p.), 1923; SHIRAI & HARA, List, p. 217 (p.p.), 1927).

Amphigenous, also on petioles, stems and calyxes; mycelium persistent or evanescent, grayish colored; matured conidia solitary, vacuolate, granulate, ellipsoidal or elongate-ellipsoidal, 28.8–40.0 × 15.8–16.8 μ; perithecia gregarious, imbedded in the mycelial mass, globose or depressed-globose, 70–144 μ in diameter; cells 13.2–27.5 × 8.4–16.8 μ in size; appendages 11–49 in number, dark brown colored from the base to the apex or light brown colored toward the apex, aseptate or 1–4 septate, of the same width throughout, 98–490 μ long; asci 3–6, subglobose or ovate, with a short stalk, thick-walled, 43.2–62.4 × 28.8–42.8 μ; spores 2–7 in number, usually 3, ellipsoidal or oblong, 16.8–26.4 × 8.4–14.4 μ.

Hab. On leaves and stems of *Alnus pendula* MATSUM. (Hime-yashabushi). Honshu—Rikuchu.

On *Aconitum Fischeri* REICHB. (Hiroha-no-karafuto-bushi). Saghalien—Toyohara.

On *Aconitum gigas* LEV. & VNT. (Oh-reijinso). Saghalien—Tsumanai.

On *Aconitum japonica* THUNB. (Torikabuto). Honshu—Rikuchu.

On *Aconitum yezoense* NAKAI (Yezo-torikabuto). Saghalien—Otani. Hokkaido—Shiribeshi, Ishikari, Teshio, Kitami, Hidaka.

On *Actaea acuminata* WALL. (Ruiyo-shoma). Honshu—Echigo.

On *Aquilegia flabellata* SIEB. & ZUCC. (Odamaki). Hokkaido—Ishikari.

On *Aquilegia flabellata* SIEB. & ZUCC. f. *pumila* KUDO (Okumiyama-odamaki). Saghalien—Mt. Tosso. Hokkaido—Ishikari.

On *Caltha palustris* L. f. *gigas* LÉV. (Yezo-no-ryukinkwa). Saghalien—Shisuka, Konuma. Hokkaido—Iburi, Tokachi, Hidaka.

On *Caltha palustris* L. var. *procumbens* BECK. (Hai-ryukinkwa). Hokkaido—Kurile Isls. Kunashiri Isl.

On *Caltha palustris* L. var. *sibirica* REGEL f. *decumbens* MAKINO (Yenkoso). Saghalien—Nueuo.

On *Paeonia albiflora* PALL. var. *hortensis* MAKINO (Shakuyaku). Hokkaido—Ishikari.

On *Paeonia japonica* MIYABE & TAKEDA (Shirobana-yamashakuyaku). Hokkaido—Ishikari.

On *Ranunculus acris* L. var. *Steveni* REGEL (Miyama-kimpoge). Hokkaido—Kurile Isls. Etorofu Isl.

On *Ranunculus japonicus* LANGSD. (Kitsune-no-botan). Hokkaido—Shiribeshi, Ishikari. Honshu-Rikuzen.

On *Ranunculus repens* L. (Hai-kimpoge). Saghalien—Makunkotan, Kitanayoshi.

On *Thalictrum akanense* HUTH. (Miyama-akikaramatsu). Hokkaido—Ishikari, Kitami, Kushiro.

On *Thalictrum Thunbergii* NAKAI (Aki-karamatsu). Saghalien—Toyohara, Ambetsu, Mt. Suzuya. Hokkaido—Shiribeshi, Ishikari, Tokachi, Kushiro. Honshu—Rikuchu.

On *Cirsium Grayanum* NAKAI (Maruba-hire-azami). Hokkaido—Ishikari.

On *Cirsium schantarense* TRAUTV. & MEY. (Okuyezo-azami). Saghalien—Kita-nayoshi.

On *Cirsium Weyrichii* MAXIM. (Yezo-azami). Saghalien—Oioro, Kushunnai, Mt. Kashippo.

Distrib. All over the world.

Remarks. In this fungus, the appendages are deep brown colored throughout. In comparison with *Erysiphe Polygoni,* the appendages in the present species are more numerous, nearly blackish brown colored when mature, and moreover, are flexuous and irregularly branched.

The forms on *Aconitum yezoense* and *A. japonicum* resemble *E. Polygoni* in that the appendages are light brown colored in the young stages, but turn deep brown when mature.

In the form on *Caltha palustris,* the appendages are numerous and very deep brown colored from the base to the apex.

Erysiphe graminis DC.

(Pl. VIII, fig. 12)

Fl. Fr. VI, p. 106, 1815; LÉV. Ann. Sci. Nat. III, 15, p. 165, 1851; KICKX, Fl. Crypt. Fland. I, p. 383, 1867; COOKE, Handb. Brit. Fung. II, p. 651, 1871; COOKE & PECK, Journ. Bot. I, p. 13, 1872; QUÉL. Champ. Jur. Vosg. p. 531, 1875; SACC. Syll. Fung. I, p. 19, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I. 2, p. 30, 1884; ELL. & EVERH. N. Amer. Pyren. p. 15, 1892; JACZEW. Bull. l'Herb. Boiss. IV, p. 728, 1896; OUDEM. RÉV. Champ. Pays-Bas, II, p. 98, 1897; PRILL. Malad. Pl. Agr. II, p. 9, 1897; MAGNUS, Erysiph. Tirol. p. 12, 1898; SALM. Monogr. Erysiph. p. 209, 1900, and Bull. Torr. Bot. Club, XXIX, p. 195, 1902; NEGER, Krypt. Fl. d. Mark Brand. VII, p. 114, 1905; LIND, Danish Fung. p. 161, 1913; KLIKA, Erysiph. Czechosl. p. 62, 1924; ŠKORIĆ, Erysiph. Croat. p. 95, 1926; TAI & WEI, Sinensia, III, p. 95, 1932. (FUCK. Symb. Myc. p. 83, 1869–70; TRACY & GALLOW. Journ. Myc. IV, p. 35, 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 142, 1899; SALM. Bull. Torr. Bot. Club, XXVII, p. 443, 1900, Ann. Myc. III, p. 249, 1905, and VI, p. 8, 1908; P. HENN. in ENGL. Bot. Jahrb. XXXII, p. 42, 1903; MATSUM. Ind. Plant. Jap. I, p. 141, 1904; LAWR. Journ. Myc. XI, p. 106, 1905; SHIRAI, List, p. 32, 1905; YOSHINO, Bot. Mag. Tokyo, XIX, p. 205, 1905; RANOJ. Ann. Myc. VIII, p. 357, 1910; IDETA, Jap. Phytopath. p. 203, 1911, and Jap. Phytopath. (Suppl. I), p. 200, 1923; DOIDGE, Roy. Soc. South Afr. p. 242, 1915; SAWADA, Agric. Exp. Stat. Formosa, Bull. IX, p. 35, 1914, and XIX, p. 145, 1919; SHIRAI & MIYAKE, List, p. 223, 1917; SHIRAI & HARA, List, p. 132, 1927; MIURA, Pub. South Manch. Rwy. Co. XXVII, p. 124, 1928).

Syn. *Alphitomorpha communis* var. *graminearum* WALLR. Berl. Ges. Nat. Freund. Verh. I, p. 31, 1819.

Erysiphe communis FR. Syst. Myc. III, p. 239 (p.p.), 1829.

Erysiphe communis MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837.

Erysibe communis LK. in RABENH. Deutschl. Krypt. Fl. I, p. 232 (p.p.), 1844.

Erysibe graminis DC. in SCHRÖT. in COHN'S Krypt. Fl. Schles. III, p. 240, 1893. (JAAP, Ann. Myc. IX, p. 333, 1911).

Acrosporium monilioides NEES, Syst. Pilz. u. Schwam. p. 53, 1817; UNGER, Exantheme d. Pflanz. p. 389, 1833.

Oidium monilioides LINK, Sp. Pl. I, p. 122, 1824; FR. Syst. Myc. III, p. 431, 1829; SACC. Syll. Fung. IV, p. 46, 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 78, 1907, and IX, p. 724, 1910.

Torula tritici CORD. Icon. Fung. V, p. 51, 1842.

Torula bulbigera BON. Bot. Zeitung, XIX, p. 195, 1861.

Oidium monilioides LINK, var. *ochraceum* THÜM. Fung. Austr. n. 1804, 1874; SACC. Syll. Fung. IV, p. 46, 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 79, 1907.

Oidium Tritici SACC. et VOGL. Syll. Fung. IV, p. 46, 1886.

Oidium bulbigerum SACC. et VOGL. Syll. Fung. IV, p. 47, 1886.

Amphigenous, mostly epiphyllous, also on glumes and sheaths; mycelium persistent, at first white mycelial hyphae appear along the vein, but finally turn to a grayish colored, thick cushion, hyphal cells comparatively broad, smooth and shining; matured conidia produced in a chain, having a bulbous swelling at the base of the conidiophore, vacuolate, granulate, ellipsoidal or elongate-ellipsoidal, 22.8–46.8 × 10.8–20.4 μ; perithecia gregarious or scattered, imbedded in the mycelial masses, depressed-globose or concave, 174–224 μ in diameter, blackish brown colored when mature; cells obscure, 13.2–14.4 × 8.4–9.6 μ in size; appendages about 11 in number, shorter than the diameter of the perithecium, light brown colored at the base, simple, aseptate; asci about 11 in number, elongate-ovate, 73.2–93.6 × 24.0–38.4 μ, with a stalk; spores always 8, subglobose or broad-ellipsoidal, 14.4–19.2 × 9.6–14.4 μ in size.

Hab. On leaves, glumes and sheaths of *Agropyrum ciliare* FRANCH. (Kamoji-gusa). Honshu—Musashi, Echigo, Bizen.

On *Agropyrum repens* BEAUV. (Shibamugi). Saghalien—Shisuka.

On *Brachypodium miserum* KOIDZ. (Yama-kamoji-gusa). Shikoku—Iyo. Kyushu—Hizen, Higo.

On *Bromus japonicus* THUNB. (Suzumeno-chahiki). Honshu—Rikuchu.

On *Elymus mollis* TRIN. (Tenki-gusa). Hokkaido—Kushiro.

On *Hordeum sativum* JESS. var. *hexastichon* L. (Hadaka-mugi). Hokkaido—Shiribeshi, Ishikari. Honshu—Shinano. Shikoku—Awa.

On *Hordeum sativum* JESS. var. *vulgare* HACK. (Oh-mugi). Hokkaido—Iburi, Ishikari. Honshu—Musashi, Echigo, Owari, Yamashiro, Harima, Bizen, Bitchu. Shikoku—Iyo. Kyushu—Hizen, Higo.

On *Poa annua* L. (Suzumeno-katabira). Honshu—Etchu.

On *Poa pratensis* L. (Nagaha-gusa). Saghalien—Kita-nayoshi. Hokkaido—Ishikari.

On *Poa sphondylodes* TRIN. var. *strictula* KOIDZ. (Ichigo-tsunagi). Saghalien—Shisuka.

On *Stipa sibirica* LAM. var. *japonica* HACK. (Hirohano-hanegaya). Hokkaido—Shiribeshi, Ishikari.

On *Trisetum flavescens* BEAUV. var. *genuinum* HACK. (Chishima-kanitsuri). Saghalien—Shisuka.

On *Triticum sativum* LAM. var. *vulgare* HACK. (Komugi). Hokkaido—Ishikari. Honshu—Musashi, Shinano, Bitchu.

Distrib. Japan (Saghalien, Hokkaido, Honshu, Shikoku, Kyushu and Formosa), China, Manchuria, India, Europe, South Africa and North America.

Remarks. This species is a very common powdery mildew on Gramineae. On wheat and barley, it appears especially more luxuriously on the pot culture materials in the green house than in the field. In the forms on wheat, barley and *Agropyrum ciliare,* the mycelial patches are at first white, but finally they turn to a gray color and form thick velvety masses. In the form on *Poa pratensis,* however, the mycelium retains its white color throughout all stages.

Erysiphe graminis differs distinctly from other species of Erysiphe in respect to its conidiophore having a bulbous swelling at the base, and besides, in respect to its haustoria which have several finger-like branches on one or both sides, and are larger in size than those of other species. These characters have not been found in other species of Erysiphaceae.

Many specialized forms have been recorded in this species; namely, *E. graminis* f. sp. *Tritici* MARCHAL, f. sp. *Hordei* MARCHAL, f. sp. *Secalis* MARCHAL, f. sp. *Avenae* MARCHAL, f. sp. *Poae* MARCHAL, f. sp. *Agropyri* MARCHAL, f. sp. *Bromi* MARCHAL and f. sp. *Elymi* HOMMA. In these forms, the mean values which the writer has measured on the conidia, 500 in number, for the length and the width are as follows:

f. sp. *Tritici*	37.35 ± 0.037	14.5 ± 0.035
f. sp. *Hordei*	35.45 ± 0.078	14.64 ± 0.04
f. sp. *Poae*	31.00 ± 0.045	16.31 ± 0.043
f. sp. *Agropyri*	33.26 ± 0.088	15.74 ± 0.047
f. sp. *Elymi*	26.67 ± 0.144	13.84 ± 0.068

Erysiphe Cichoracearum DC. (Emend Wint.)

(Pl. VIII, figs. 13, 14)

Fl. Fr. II, p. 274, 1805; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 33, 1884; BURR. & EARLE, Ill. Stat. Lab. Nat. Hist. II, p. 404, 1887; ELL. & EVERH. N. Amer. Pyren. p. 12, 1892; MAGNUS, Erysiph. Tirol. p. 17, 1897; SALM. Monogr. Erysiph. p. 193, 1900, and Bull. Torr. Bot. Club, XXIX, p. 191, 1902; NEGER, Krypt. Fl. d. Mark Brand. VII, p. 116, 1905; LIND, Danish Fung. p. 162, 1913; KLIKA, Erysiph. Czechosl. p. 64, 1924; ŠKORIĆ, Erysiph. Croat. p. 46, 1926; TAI & WEI, Sinensia, III, p. 93, 1932. (TRACY & GALLOW. Journ. Myc. IV, p. 34, 1888; PAMM. Journ. Myc. IV, p. 37, 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 141, 1899; SALM. Bull. Torr. Bot. Club, XXVII, p. 443, 1900, Ann. Myc. III, p. 249, 1905, and VI, p. 8, 1908; MATSUM. Ind. Plant. Jap. I, p. 140, 1904; P. HENN. in ENGL. Bot. Jahrb. XXXIV, p. 600, 1905; YOSHINO, Bot. Mag. Tokyo, XIX, p. 205, 1905; SHIRAI, List, p. 31, 1905; LAWR. Journ. Myc. XI, p. 106, 1905; NAMBU, Bot. Mag. Tokyo, XX, p. 250, 1906; RANOJ. Ann. Myc. VIII, p. 356, 1910; IDETA, Jap. Phytopath. p. 205, 1911, and Jap. Phytopath. (Suppl. I), p. 199, 1923; I. MIYAKE, Bot. Mag. Tokyo, XXVI, p. 53, 1912; SAWADA, Agric. Exp. Stat. Formosa, Bull. IX, p. 31, 1914, and XIX, p. 139, 1919; DOIDGE, Roy. Soc. South Afr. V, p. 241, 1915; SHIRAI & MIYAKE, List, p. 221, 1917; TOGASHI, Jap. Journ. Bot. II, p. 78, 1924; SHIRAI & HARA, List, p. 131, 1927; MIURA, Pub. South Manch. Rwy. Co. XXVII, p. 122, 1928; HARA, Agr. Rep. Shizuoka, CCCLXIV, p. 6, 1928).

Syn. *Alphitomorpha communis*, var. *Cichoracearum* WALLR. Berl. Ges. Nat. Freund. Verh. I. p. 31, 1819.

Erysibe lamprocarpa var. *Plantaginis* LINK, in WILLD. Sp. Pl. VI, p. 109, 1824.

Erysiphe communis FR. Syst. Myc. III, p. 239 (p.p.), 1829; LIND, Danish Fung. p. 162 (p.p.), 1913.

Erysiphe communis MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837.

Erysiphe compositarum DUBY, Bot. Gall. II, p. 870, 1830; MÉRAT, Nouv. Fl. Paris, p. 75, 1837, and Syn. Nouv. Fl. Paris, p. 84, 1837.

Erysiphe lamprocarpa MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837, and Syn. Nouv. Fl. Paris, p. 84 (p.p.), 1837.

Erysibe communis LK. in RABENH. Deutschl. Krypt. Fl. I, p. 232 (p.p.), 1844.

Erysibe circumfusa LK. in RABENH. Deutschl. Krypt. Fl. I, p. 232 (p.p.), 1844.

Erysibe depressa LK. in RABENH. Deutschl. Krypt. Fl. I, p. 232, 1844.

Erysibe lamprocarpa RABENH. Deutschl. Krypt. Fl. I, p. 232 (p.p.), 1844.

Erysibe horridula RABENH. Deutschl. Krypt. Fl. I, p. 235, 1844.

Erysiphe lamprocarpa LÉV. Ann. Sci. Nat. III, 15, p. 163 (p.p.), 1851; DE BARY, Beitr. Morphor. Phys. Pilz. I, xiii, p. 49, 1870; COOKE, Handb. Brit. Fung. II, p. 650, 1871; COOKE & PECK, Journ. Bot. I, p. 13, 1872, and I, p. 171, 1872; QUÉL. Champ. Jur. Vosg. p. 532, 1875; JACZEW. Bull. l'Herb. Boiss. IV, p. 730, 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 94, 1897. (FUCK. Symb. Myc. p. 82, 1869–70).

Erysiphe Linkii LÉV. Ann. Sci. Nat. III, 15, p. 161, 1851; COOKE, Handb. Brit. Fung. II, p. 650, 1871; QUÉL. Champ. Jur. Vosg. p. 532, 1875; SACC. Syll. Fung. I, p. 16, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I. p. 30, 1884; JACZEW. Bull. l'Herb. Boiss. IV, p. 727, 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 93, 1897; MAGNUS, Erysiph. Tirol. p. 12, 1898. (FUCK. Symb. Myc. p. 82, 1869–70).

Erysiphe Montagnei LÉV. Ann. Sci. Nat. III, 15, p. 169, 1851; COOKE, Handb. Brit. Fung. II, p. 651, 1871; QUÉL. Champ. Jur. Vosg. p. 532, 1875; SACC. Syll. Fung. I, p. 17, 1882.

Erysiphe Martii LÉV. Ann. Sci. Nat. III, 15, p. 166 (p.p.), 1851; MAGNUS, Erysiph. Tirol. p. 13 (p.p.), 1898.

Erysiphe horridula LÉV. Ann. Sci. Nat. III, 15, p. 170, 1851; KICKX, Fl. Crypt. Fland. I, p. 381, 1867; COOKE, Handb. Brit. Fung. II, p. 652, 1871; SACC. Syll. Fung. I, p. 17, 1882; OUDEM. Rév. Champ. Pays-Bas, II, p. 96, 1897.

Erysiphe spadicea BERK. & CURT. Grevillea, IV, p. 159, 1876; SACC. Syll. Fung. I, p. 18, 1882.

Erysibe Cichoracearum DC. in SCHRÖT. COHN's Krypt. Fl. Schles. III, p. 238, 1893.

Erysiphe lamprocarpa KICKX, Fl. Crypt. Fland. p. 382, 1897.

Erysiphe Plantaginis SAWADA, Agric. Exp. Stat. Formosa, Bull. XXIV, p. 47, 1927; MIURA, Pub. South Manch. Rwy. Co. XXVII, p. 125, 1928. (SHIRAI & HARA, List, p. 132, 1927).

Oidium erysiphoides FR. Syst. Myc. III, p. 432 (p.p.), 1829; SACC. Syll. Fung. IV, p. 41 (p.p.), 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 79 (p.p.), 1907.

Oidium Chrysanthemi RABENH. Hedw. I, p. 19, 1862; SACC. Syll. Fung. IV, p. 43, 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 87, 1907.

Amphigenous, also on petioles, stems and fruits, mycelium persistent or subevanescent; matured conidia produced in a chain, subglobose or ellipsoidal, vacuolate, granulate, 24.0–43.2 × 14.4–26.4 μ; perithecia gregarious or rarely sub-scattered, 84–168 μ in diameter, globose or depressed-globose; cells 12.0–33.6 × 8.4–20.4 μ; appendages 13–35 in number, very irregular in length and forms, 1–6 times the diameter of the perithecia, brown colored from the base to the apex or gradually becoming a light color or hyaline in the upper part, 1–6 septate, simple, rarely irregularly or dichotomously branched; asci 5–15 in number, ellipsoidal, evidently stalked, 43.2–74.4 × 25.2–45.6 μ; spores always 2, sometimes 3, very rarely 1, subglobose or ovate, 16.8–31.2 × 12.0–19.2 μ.

Hab. On leaves, petioles, stems and fruits of *Laportea bulbifera* WEDD. (Mukago-irakusa). Hokkaido—Shiribeshi, Ishikari.

On *Arabis pendula* L. (Yezo-hatazao). Saghalien—Arakai, Tomioka, Tei.

On *Brassica campestris* L. var *rapifera* METZG. (Aburana). Hokkaido—Ishikari.

On *Cardamine flexiosa* WITH. (Tanetsuke-bana). Hokkaido—Ishikari.

On *Raphanus sativus* L. (Daikon). Hokkaido—Ishikari.

On *Polemonium coeruleum* L. var. *laxiflorum* MIYABE & MIYAKE (Karafuto-hanashinobu). Saghalien—Kami-arumudan, Kita-nayoshi.

On *Polemonium coeruleum* L. var. *racemosum* MIYABE & KUDO (Kushiro-hanashinobu). Saghalien—Shisuka.

On *Polemonium coeruleum* L. var. *yezoense* MIYABE & KUDO (Yezo-hanashinobu). Hokkaido—Ishikari.

On *Serratula coronata* L. (Tamuraso). Honshu—Rikuzen, Musashi. Shikoku—Tosa. Kyushu—Higo.

On *Nicotiana alata* LINK. & OTTO (Shikukon-tabako). Honshu—Musashi.

On *Nicotiana Tabacum* L. (Tabako). Kyushu—Higo. Formosa—Daihoku.

On *Physalis Francheti* MAST. var. *Bunyardii* MAKINO (Hoozuki). Hokkaido—Ishikari. Honshu—Hitachi, Musashi, Echigo, Etchu, Kaga. Shikoku—Tosa. Kyushu—Satsuma.

On *Physaliastrum echinatum* MAK. (Iga-hoozuki). Honshu—Ugo. Shikoku—Tosa.

On *Scopolia japonica* MAXIM. (Hashiri-dokoro). Honshu—Etchu.

On *Solanum Melongena* L. (Nasu). Honshu—Etchu.

On *Solanum nigrum* L. (Inu-hoozuki). Hokkaido—Ishikari.

On *Plantago kamtschatica* LINK (Yezo-ohbako). Hokkaido—Shiribeshi, Tokachi. Honshu—Mutsu.

On *Plantago lanceolata* L. (Hera-ohbako). Hokkaido—Shiribeshi.

On *Plantago major* L. var. *asiatica* DECNE (Ohbako). Saghalien—Sakaehama, Ochiai, Alexandrowsk, Kita-nayoshi, Tsumanai, Maoka, Minami-nayoshi, Konuma. Hokkaido—Kurile Isls. Shikotan Isl., Oshima, Shiribeshi, Iburi, Ishikari, Teshio, Kitami, Tokachi, Hidaka, Kushiro. Honshu—Rikuchu, Rikuzen, Uzen, Musashi, Shimozuke, Echigo, Etchu, Echizen, Kaga, Shima. Shikoku—Iyo. Kyushu—Bungo, Higo, Hiuga.

On *Galium Aparine* L. (Yaemugura). Hokkaido—Ishikari.

On *Galium verum* L. var. *lacteum* MAXIM. (Kawara-matsuba). Hokkaido—Ishikari.

On *Galium verum* L. var. *typicum* MAXIM. (Kibana-no-kawara-matsuba). Saghalien—Makunkotan.

On *Adenophora Thunbergiana* KUDO (Tsurigane-ninjin). Honshu—Musashi.

On *Achillea millefolium* L. (Seiyo-nokogiriso). Hokkaido—Shiribeshi. Honshu—Etchu.

On *Achillea Ptarmicoides* MAXIM. (Yama-nokogiri). Kyushu—Higo.

On *Achillea sibirica* LEDEB. (Nokogiriso). Hokkaido—Ishikari. Kyushu—Higo.

On *Artemisia japonica* THUNB. (Otoko-yomogi). Hokkaido—Oshima, Shiribeshi, Iburi, Ishikari, Tokachi, Kushiro. Kyushu—Higo.

On *Artemisia japonica* THUNB. var. *desertorum* MAXIM. (Hosoba-otoko-yomogi). Saghalien—Maoka. Hokkaido—Ishikari.

On *Artemisia vulgaris* L. var. *indica* MAXIM. (Yomogi). Honshu—Musashi, Echigo, Etchu, Echizen. Kyushu—Higo.

On *Artemisia vulgaris* L. var. *kamtschatica* BESS. (Yezo-yomogi). Saghalien—Nayoshi, Pilewo, Akashiki, Manue, Maoka, Konuma. Hokkaido—Shiribeshi, Iburi, Ishikari, Kitami, Tokachi, Kushiro.

On *Artemisia vulgaris* L. var. *latiloba* LEDEB. (Hiroha-urajiro-yomogi). Saghalien—Mt. Tosso.

On *Aster Laulureanus* FRANCH. (Yomena). Honshu—Musashi, Etchu.

On *Chrysanthemum Marschalii* ASCHERS. (Aka-mushiyoke-giku). Hokkaido—Ishikari. Honshu—Shimozuke. Kyushu—Higo.

On *Chrysanthemum sinense* SABIN. var. *hortense* MAKINO (Kiku). Hokkaido—Ishikari.

On *Cirsium Weyrichii* MAXIM. (Yezo-azami). Saghalien—Makunkotan, Mt. Tosso.

On *Inula salicina* L. (Kasenso). Hokkaido—Iburi, Ishikari.

On *Matricaria Chamomilla* L. (Kamitsure). Hokkaido—Ishikari.

On *Picris hieracioides* L. var. *japonica* REGEL (Kozorina). Saghalien—Kushunnai, Ochiai, Kita-nayoshi, Kami-kiminai, Konuma. Hokkaido—Ishikari, Kitami, Tokachi, Kushiro. Honshu—Shinano.

On *Scorzonera radiata* FISCH. (Futanamiso). Saghalien—Nueuo.

On *Solidago Virgaurea* L. (Akino-kirinso). Hokkaido—Ishikari. Honshu—Rikuchu.

On *Sonchus arvensis* L. var. *uliginosus* TRAUTV. (Hachijona). Saghalien—Konuma. Hokkaido—Ishikari, Tokachi.

On *Sonchus asper* VILL. (Oni-nogeshi). Honshu—Echigo.

On *Sonchus oleraceus* L. (Nogeshi). Honshu—Musashi, Oki. Kyushu—Higo, Hiuga.

On *Tanacetum vulgare* L. (Yomogigiku). Hokkaido—Ishikari.

Distrib. Japan (Saghalien, Hokkaido, Honshu, Shikoku, Kyushu and Formosa), Manchuria, India, Europe, Africa, Australia and North America.

Remarks. The present species is a very common powdery mildew spread all over the world. The Japanese name of *Udonkokin* is originated from this species.

The writer has examined every specimen on the numerous host plants and has found that the appendages of the perithecia are not entirely hyaline when mature in all the specimens. In the form on Artemisia, the appendages are recorded as colorless by many authors, but as the result of the studies on about sixty specimens collected at different parts of this country, the writer has found the interesting fact that the perithecia which are embedded in the abundant hairs of the under-surface of the leaves usually have colorless appendages, while those produced on the upper smooth surface have appendages light or deep brown colored toward the base or throughout.

In the forms on *Galium Aparine* and *Serratula coronata*, the appendages remain hyaline for a long time, but finally turn to a brown color.

K. SAWADA regarded the form on Plantago as a new species and described it under the name *Erysiphe Plantaginis* n. sp. He distinguished it from *E. Cichoracearum* by the size of conidia, asci and ascospores and besides by the result of the infection experiments. But the present writer is inclined to recognize it simply as a biological form.

In *Erysiphe Cichoracearum* there are two forms. In one of them the appendages are brown colored from the young stages, and in others they are colorless at first, but finally turn to a brown color when mature.

This species occurs not only on Compositae, but also on many other families, but the writer could not recognize in them any important difference in the morphological characters.

Erysiphe Galeopsidis DC.

(Pl. VIII, fig. 15)

Fl. Fr. VI, p. 108, 1815; DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 49, 1870; SACC. Syll. Fung. I, p. 16, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 33, 1884; BURR. & EARLE, Ill. Stat. Lab. Nat. Hist. II, p. 404, 1887; ELL. & EVERH. N. Amer. Pyren. p. 13, 1892; JACZEW. Bull. l'Herb. Boiss. IV, p. 731, 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 95, 1897; MAGNUS, Erysiph. Tirol. p. 17, 1898; SALM. Monogr. Erysiph. p. 204, 1900, Bull. Torr. Bot. Club, XXVII, p. 443, 1900, and XXIX, p. 193, 1902; NEGER, Krypt. Fl. d. Mark Brand. VII, p. 115, 1905; KLIKA, Erysiph. Czechosl. p. 63, 1924; ŠKORIĆ, Erysiph. Croat. p. 45, 1926. (TRACY & GALLOW. Journ. Myc. IV, p. 34, 1888; PAMM. Journ. Myc. IV, p. 37, 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 142, 1899; SALM. Bull. Torr. Bot. Club, XXVII, p. 443, 1900, Ann. Myc. III, p. 249, 1905, and VI, p. 8, 1908; MATSUM. Ind. Plant. Jap. I, p. 141, 1904; SHIRAI, List, p. 32, 1905; RANOJ. Ann. Myc. VIII, p. 356, 1910; IDETA, Jap. Phytopath. p. 205, 1911, and Jap. Phytopath. (Suppl. I), p. 201, 1923; SAWADA, Agric. Exp. Stat. Formosa, Bull. IX, p. 33, 1914; SHIRAI & MIYAKE, List, p. 223, 1917; TOGASHI, Jap. Journ. Bot. II, p. 78, 1924; SHIRAI & HARA, List, p. 132, 1927).

Syn. *Alphitomorpha communis* var. *Labiatarum* WALLR. Berl. Ges. Nat. Freund. Verh. I, p. 31, 1819.

Erysiphe communis FR. Syst. Myc. III, p. 239 (p.p.), 1829.

Erysiphe Chelones SCHWEIN. Syn. Fung. Am. Bor. p. 270, 1834; SACC. Syll. Fung. I, p. 21, 1882.

Erysiphe lamprocarpa MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837, and Syn. Nouv. Fl. Paris, p. 84 (p.p.), 1837.

Erysibe lamprocarpa LK. in RABENH. Deutschl. Krypt. Fl. I, p. 232 (p.p.), 1844.

Erysiphe Labiatarum LIND, Danish Fung. p. 162, 1913.

Erysibe Galeopsidis DC. in SCHRÖT. COHN'S Krypt. Fl. Schles. III, p. 237, 1893. (JAAP, Ann. Myc. IX, p. 333, 1911).

Oidium erysiphoides FR. Syst. Myc. III, p. 432 (p.p.), 1829; SACC. Syll. Fung. IV, p. 41 (p.p.), 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 79 (p.p.), 1907.

Oidium Hormini FARN. Svil. e Polim. Nuovo, Microm. Par. VII, p. 5, 1902; SACC. Syll. Fung. XVIII, p. 505, 1906.

Oidium Lamii RABENH. Krypt. Fl. Deutschl. VIII, p. 81, 1907.

Amphigenous, on stems and petioles; mycelium persistent or evanescent, at first forming white thin effused film, and finally turning to a deep brown color; matured conidia in a chain, vacuolate, granulate, subglobose or ellipsoidal, 26.4–37.2 × 12.8–20.4 μ; perithecia gregarious or scattered, 112–161 μ in diameter, globose or depressed-globose; cells 10.8–19.2 × 8.4–12.0 μ; appendages about 17–31 in number, irregular in length, about 2–4 times the diameter of the perithecia, brown colored throughout, evidently 1–5 septate, almost always simple, sometimes vaguely branched; asci 5–11 in number, ovate or pyriform, pedicellate, 45.6–72.0 × 21.6–34.8 μ; spores remain immature on the living host.

Hab. On leaves, petioles and stems of *Geranium erianthum* DC. (Chishima-furo). Hokkaido—Kitami.

On *Geranium nepalense* SWEET. (Furoso). Hokkaido—Ishikari.

On *Geranium sibiricum* L. (Ichige-furo). Hokkaido—Kitami, Kushiro.

On *Geranium yezoense* FRANCH. & SAV. (Yezo-furo). Hokkaido—Ishikari.

On *Chelonopsis longipes* MAKINO (Tani-jakoso). Shikoku—Tosa.

On *Chelonopsis moschatus* MIQ. (Jakoso). Hokkaido—Oshima, Shiribeshi.

On *Galeopsis Tetrahit* L. (Chishima-odorikoso). Saghalien—Maoka, Futarayapachi, Ochiai, Alexandrowsk, Nayoshi, Ambetsu, Konuma, Shimizu, Baguntan, Horo, Sakaehama. Hokkaido—Kitami, Kushiro.

On *Lamium album* L. var. *barbatum* FR. & SAV. (Odorikoso). Saghalien—Odomari. Hokkaido—Oshima, Shiribeshi, Ishikari, Kushiro. Honshu—Rikuchu, Musashi, Kozuke, Yamashiro. Kyushu—Higo.

On *Lycopus lucidus* TURCZ. var. *genuinus* HERD. (Shirone). Hokkaido—Ishikari.

On *Plectranthus glaucocalyx* MAXIM. var. *japonicus* MAKINO (Hikiokoshi). Honshu—Rikuchu.

On *Stachys baicalensis* FISCH. var. *hispida* NAKAI (Yezo-inugoma). Hokkaido—Ishikari, Kitami, Tokachi.

On *Stachys baicalensis* FISCH. var. *hispidula* NAKAI (Inugoma). Hokkaido—Ishikari. Honshu—Musashi.

On *Ligularia stenocephala* MATSUM. (Metakarako). Honshu—Mutsu, Shimozuke.

Distrib. All over the world.

Remarks. The ascospores of the present fungus remain immatured on the living host plants. SALMON said that *Erysiphe Galeopsidis* differs from *Erysiphe Cichoracearum* by "the lobed haustoria and the non-development of spores on the living host plant". On the other hand, several authors have recorded that two spores are developed in an ascus in the next year and that such a character is restricted to the Labiatae.

Erysiphe Galeopsidis resembles *Erysiphe Cichoracearum* in number of spores, although they are produced in the following year, and also in the fact that conidia are produced in a perfect chain.

Oidium belonging to Erysiphe

Polygoni section.

On *Beta vulgaris* L. var. *Rapacea* C. KOCH. (Sato-daikon). Hokkaido—Ishikari.

On *Chrysosplenium flagelliferum* FR. SCHM. (Tsuru-nekonome). Hokkaido—Ishikari.

On *Agastache rugosa* KUNTZE (Kawamidori). Honshu—Echigo.

On *Agastache rugosa* KUNTZE var. *hypoleuca* KUDO (Kita-kawamidori). Hokkaido—Kushiro.

Cichoracearum section.

On *Elodes japonica* BL. (Mizu-otogiri). Honshu—Echigo.

On *Brunella vulgaris* L. (Utsubo-gusa). Honshu—Kaga.

On *Sesamum indicum* L. (Goma). Honshu—Etchu, Izumo.

Uncinula LÉV.

Mycelium is superficial, thinly effused as a cobweb; haustoria are sent into epidermal cells or sometimes into subepidermal tissues of the host plants, they are globose or subglobose in shape and thin-walled, including granules; matured conidia are produced either solitary or very rarely in a chain, and are smaller than in the Microsphaera, including vacuoles and granules; perithecia are globose or depressed-globose, including several asci; appendages are simple and usually hyaline, frequently colored, and with or without several septa, and the apex is uncinate. This genus includes 23 species in this country. Among them 4 species are new to science.

Key to the species of the genus Uncinula

- A. Appendages enlarged at the circinate part.
  - 1. Ascospores 3–7.
    - Appendages straight .... *U. Clintonii* (344)
    - Appendages narrower and rarely bent .... *U. Zelkowae* (346)
  - 2. Ascospores 2 .... *U. clandestina* (347)
- B. Appendages not enlarged at the circinate part.
  - I. Appendages broad in diameter.
    - 1. Appendages straight and smooth.
      - Appendages enlarged upward .... *U. Delavayi* (349)
      - Appendages sometimes divided .... *U. bifurcata* (349)
      - Appendages narrowed at the apical part .... *U. australiana* (350)
      - Appendages stout, frequently narrowed in the basal part .... *U. Sengokui* (351)
    - 2. Appendages frequently twisted.
      - * Appendages colorless.
        - Appendages frequently enlarged upward ... *U. Salmoni* (352)
        - Appendages not enlarged upward .... *U. Picrasmae* (353)

* Appendages colored.
Appendages, 126–210 μ in length .... *U. necator* (367)
Appendages longer, 140–238 μ in length .... *U. Actinidiae* (353)
II. Appendages narrow.
1. Appendages straight.
a. Appendages aseptate or uni-septate.
* Appendages colorless or light brown colored at the base.
Appendages 112–126 μ in length .... *U. verniciferae* (355)
Appendages very numerous, 41–117 μ in length .... *U. Salicis* (356)
* Appendages colored throughout .... *U. simulans* (359)
b. Appendages multi-septate.
Circinate part of appendages narrowed and not septate .... *U. curvispora* (360)
Circinate part of appendages rather broad and several septate .... *U. septata* (361)
2. Appendages geniculate or flexuous.
a. Appendages geniculate.
Appendages 112–182 μ (aver. 158.6 μ) in length .... *U. geniculata* (361)
Appendages 119–210 μ (aver. 148.8 μ) in length .... *U. Betulae* (362)
Appendages 154–231 μ (aver. 184 μ) in length .... *U. carpinicola* (363)
b. Appendages flexuous.
Appendages 154–238 μ in length .... *U. Fraxini* (364)
Appendages 112–238 μ in length and uncinate part not narrowed, sometimes angulary bent ...... *U. Miyabei* (365)
Appendages 126–168 μ in length and uncinate part abruptly narrowed .... *U. Mori* (366)
Appendages 84–120 μ in length and usually 10 in number .... *U. Nishidana* (367)

Uncinula Clintonii PECK

(Pl. VIII, figs. 16, 17, 18)

Trans. Albany Inst. VII, p. 216, 1872; SACC. Syll. Fung. I, p. 17, 1882; ELL. & EVERH. N. Amer. Pyren. p. 15, 1892; SALM. Monogr. Erysiph. p. 109, 1900, and Bull. Torr. Bot. Club, XXIX, p. 100, 1902; TAI & WEI, Sinensia, III, p. 103, 1932. (SALM. Bull. Torr. Bot. Club, XXVIII, p. 446, 1900, Ann. Myc. III, p. 252, 1905, and VI, p. 12, 1908; MATSUM. Ind. Pl. Jap. I, p. 178, 1904; P. HENN. in ENGL. Bot. Jahrb. XXXIV, p. 600, 1905; SHIRAI, List, p. 102, 1905; YOSHINAGA, Bot. Mag. Tokyo, XIX, p. 35, 1905; YOSHINO, Bot. Mag. Tokyo, XIX,

p. 206, 1905; IDETA, Jap. Phytopath. p. 214, 1911; SYDOW, Ann. Myc. XI, p. 114, 1913; SHIRAI & MIYAKE, List, p. 675, 1917; SAWADA, Agr. Exp. Stat. Formosa, Bull. XIX, p. 175, 1919; HARA, Dendropath. p. 23, 1923; SHIRAI & HARA, List, p. 402, 1927).

Syn. *Uncinula Kusanoi* SYD. Mem. l'Herb. Boiss. IV, p. 4, 1900; SACC. Syll. Fung. XVI, p. 401, 1902. (NAMBU, Bot. Mag. Tokyo, XVIII, p. 2, 1904; SHIRAI, List, p. 103, 1905; SHIRAI & MIYAKE, List, p. 675, 1917).

Amphigenous, usually hypophyllous; mycelium subpersistent or evanescent, at first forming circumscribed white mycelial patches; perithecia 98–133 μ in diameter, gregarious or scattered, globose; cells 16.8–27.6 × 9.6–19.2 μ in size; appendages 6–23 in number, straight aseptate or uni-septate near the base, colorless, apex uncinate or circinate and generally wider than the other part, 77–196 μ long; asci 4–6, ovate or oval, with a short stalk, 43.2–63.6 × 36.0–50.4 μ; spores 4–6, usually 6, elongate-ellipsoidal, granulate, 18.0–31.2 × 9.6–16.8 μ.

Hab. On leaves of *Aphananthe aspera* PLANCH. (Muku-enoki). Honshu—Rikuchu, Rikuzen, Ugo, Musashi, Echigo, Etchu, Suruga.

On *Celtis sinensis* PERS. (Enoki). Honshu—Rikuchu, Musashi, Kazusa, Hitachi, Echigo, Yamashiro, Bizen, Bitchu. Shikoku—Awa, Iyo, Tosa. Kyushu—Buzen, Higo. Formosa—Daihoku.

On *Tilia japonica* SIMK. (Shinanoki). Hokkaido—Ishikari.

Distrib. Japan (Hokkaido, Honshu, Shikoku, Kyushu and Formosa), China and North America.

Remarks. The species of Uncinula parasitic on Celtis have been very much confused. The species, which have hitherto been published, are *Uncinula Clintonii, U. polychaeta, U. Shiraiana, U. Kusanoi, U. parvula* and *U. confusa*. The co-type specimens of *U. Shiraiana* and *U. Kusanoi,* and those of *U. Clintonii* and *U. polychaeta,* are fortunately preserved in our herbarium. *U. Clintonii* is originally the form occurring on Tilia in America, but SALMON has included in this species the fungus on Celtis and Aphananthe which were sent to him from Japan.

Uncinula polychaeta was recorded on Celtis as an American endemic species, but in 1900, SALMON determined as the same species the form on Celtis from China and also that on *Aphananthe aspera* from Japan (coll. Y. SENGOKU, Oct. 29, 1895, in Tokyo).

Uncinula Shiraiana was the name given by P. HENNINGS to the fungus on *Celtis sinensis* which was sent to him from Japan (coll. S. KUSANO, Oct. 26, 1899, in Bot. Gard. Tokyo).

Uncinula polychaeta and *U. Shiraiana* parasitic on Celtis, as the result of our careful studies, seem to belong to the genus Uncinulopsis (see genus Uncinulopsis), judging from the characters of mycelium and the form of conidia. As to *Uncinula Kusanoi,* in 1900, P. HENNINGS first described it from the specimen on *Celtis sinensis* from Japan (coll. S. KUSANO Oct. 26, 1899, in Meguro, Tokyo). He compared it with *Uncinula confusa, U. parvula* and *U. polychaeta,* but said nothing about *U. Clintonii.* A minute examination of the co-type specimens of *Uncinula Kusanoi,* discloses that it entirely coincides with *U. Clintonii. Uncinula parvula* is also a fungus from North America, and the number of appendages of a perithecium is 50–160. Up to the present time, this species has not been collected in this country.

As to *Uncinula confusa,* according to the original description of MASSEE, the size of the perithecia is 150–200 μ in diameter. *U. Clintonii* whose perithecia reach to 130 μ in diameter, can easily be distinguished from *U. confusa* in this respect.

Uncinula parasitic on *Zelkowa serrata* (coll. K. MIYABE, Aug. 24, 1889, in Kobe) was included under *Uncinula Clintonii* by SALMON, but the writer is inclined to consider it rather as *Uncinula Zelkowae.*

In the form on *Tilia japonica,* the appendages of the perithecium are longer than those of the form parasitic on Celtis, and they are longer than those of the American type too, but in other characters these forms could not be distinguished from each other.

In the form on *Aphananthe aspera,* the appendages are 6–16 in number, but in other points it coincides with the present species.

Uncinula Zelkowae P. HENN.

(Pl. VIII, fig. 19)

in ENGL. Bot. Jahrb. XXIX, p. 149, 1901; SACC. Syll. Fung. XVI, p. 400, 1902. (SHIRAI, List, p. 104, 1905; SHIRAI & MIYAKE, List, p. 679, 1917; HARA, Dendropath. p. 18, 1923; SHIRAI & HARA, List, p. 403, 1927).

Amphigenous, mycelium evanescent; matured conidia solitary, oblong or cylindrical, granulate, vacuolate, 26.4–37.2 × 10.8–16.8 μ; perithecia scattered, 79.2–124.8 μ in diameter, globose or depressed-globose; cells 16.0–19.2 × 12.0–15.6 μ in size; appendages 14–25 in number, aseptate or very rarely uni-septate at the base, flexuous, 2 or 3 times at the upper half, hyaline or a slightly light brown color at the base, very irregular in length, 69.6–176.0 μ, simple, width at the base 5.6 μ, middle 4.0 μ, apex 8.4 μ, abruptly enlarged at the circinate part; asci 2–5, subglobose or ovate, 51.6–55.2 × 33.6–48.0 μ; spores 3–6, elongate-ellipsoidal or ovate, 19.2–28.8 × 12.0–15.6 μ.

Hab. On leaves of *Zelkowa serrata* MAK. (Keyaki). Honshu—Rikushu, Rikuzen, Hitachi, Echigo, Etchu, Settsu, Inaba.

Distrib. Japan (Honshu).

Remarks. *Uncinula Zelkowae* is an endemic species in this country. It is related to *Uncinula Clintonii* and *U. clandestina*. *U. clandestina* has always two spores in an ascus. Compared with *U. Clintonii*, the appendages of the perithecium of the present species are more or less narrow, straight and irregular in length, especially in the specimen collected in Kobe in which the size of perithecia is very small, 79.2–96 μ and the appendages are narrower and shorter.

Uncinula clandestina (BIV. BERN.) SCHRÖT.

(Pl. VIII, fig. 20)

in COHN's Krypt. Fl. Schles. III, p. 245, 1893; SALM. Monogr. Erysiph. p. 97, 1900, and Bull. Torr. Bot. Club, XXIX, p. 99, 1902; LINDAU, Krypt. d. Mark Brand. p. 133, 1905; ŠKORIĆ, Erysiph Croat. p. 42, 1926; TAI & WAI, Sinensia, III, p. 102, 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 446, 1900, and Ann. Myc. III, p. 252, 1905; MATSUM. Ind. Plant. Jap. I, p. 178, 1904; SHIRAI, List, p. 102, 1905; RANOJ. Ann. Myc. VIII, p. 357, 1910; IDETA, Jap. Phytopath. p. 214, 1911, and Jap. Phytopath. (Suppl. I) p. 215, 1923; SAWADA, Agric. Exp. Stat. Formosa, Bull. IX, p. 68, 1914; SHIRAI & MIYAKE, List, p. 675, 1917; HARA, Dendropath. p. 23, 1923; SHIRAI & HARA, List, p. 402, 1927).

Syn. *Erysiphe clandestina* BIV. BERN. Stirp. Rar. Sic. Man. III, p. 20, 1815.

Erysibe adunca LK. var. *ulmorum* LK. in WILLD. Sp. Pl. VI, p. 112, 1824; RABENH. Deutschl. Krypt. Fl. I, p. 236, 1844.

Erysiphe adunca FR. Syst. Myc. III, p. 245, 1829.

Uncinula Bivonae LÉV. Ann. Sci. Nat. III, 15, p. 151, 1851; KICKX, Fl. Crypt. Fland. I, p. 377, 1867; COOKE & PECK, Journ. Bot. I, p. 11, 1872; SACC. Syll. Fung. I, p. 6, 1882; RABENH. Krypt. Fl. Deutschl. I, 2, p. 40, 1884; JACZ. Bull. l'Herb. Boiss. IV, p. 741, 1896; MAGNUS, Erysiph. Tirol. p. 21, 1898. (FUCK. Symb. Myc. p. 80, 1869–1870).

Erysiphe Bivonae TULASNE, Select. Fung. Carp. I, p. 200, 1861.

Uncinula clandestina (BIV. BERN.) SCHRÖT. f. *japonica* P. HENN. in ENGL. Bot. Jahrb. XXIX, p. 149, 1901. (Shirai, List. p. 102, 1905).

Amphigenous, mostly epiphyllous; mycelium persistent, at first forming thin white patches and finally covering the entire upper surface of the leaves; perithecia gregarious or scattered, 77–112 μ in diameter, globose, blackish brown colored; cells 14.4–16.8 × 12.0–14.4 μ in size; appendages 8–30 in number, aseptate, hyaline, becoming broad towards the apex, 69.6–114 μ long, simple, straight, the apex circinate or uncinate; asci 3–4, usually 4, globose or subglobose, rarely short stalked, 40.8–50.4 × 36.0–57.2 μ; spores 2, large, granulate, 21.6–32.4 × 15.6–17.4 μ.

Hab. On leaves of *Ulmus laciniata* MAYR. (Ohyo). Hokkaido—Ishikari, Kushiro.

On *Ulmus parvifolia* JACZ. (Aki-nire). Honshu—Mutsu, Musashi. Kyushu—Higo.

On *Ulmus propinqua* KOIDZ. (Haru-nire). Hokkaido—Ishikari. Honshu—Musashi.

Distrib. Japan (Hokkaido, Honshu and Kyushu), Manchuria, China, Europe and Africa.

Remarks. In the present species, the uncinate parts of the appendages are abruptly enlarged and the asci are bi-spored. By these characters it can be distinguished from other related species.

In 1901, the fungus on *Ulmus parvifolia* (coll. S. KUSANO) was recorded as a form of this species by P. HENNINGS. As results of our studies on the co-type specimen of this fungus, the perithecia are found to be 77–97 μ in diameter, appendages of the perithecium to be 8–29 in number and 69.6–91.0 μ long, asci and ascospores to be of a similar size to those of *U. clandestina*. According to this observation, the size of perithecia and length of appendages are more or less smaller and shorter, but in the other important characters, the form on *U. parvifolia* could not be distinguished from the present species.

Uncinula Delavayi PAT.

(Pl. VIII, fig. 21)

Journ. Bot. II, p. 217, 1888; SACC. Syll. Fung. IX, p. 367, 1891; SALM. Monogr. Erysiph. p. 118, 1900. (SALM. Ann. Myc. III, p. 252, 1905, and VI, p. 12, 1908; IDETA, Jap. Phytopath. p. 215, 1911; SYD. Ann. Myc. XII, p. 161, 1914; SHIRAI & MIYAKE, List, p. 675, 1917; HARA, Dendropath. p. 24, 1923; SHIRAI & HARA, List, p. 402, 1927).

Amphigenous, mycelium persistent on the upper surface of the leaves and evanescent on the under; perithecia gregarious or subgregarious, 112–161 μ in diameter, depressed-globose; cells 13.2–19.2 μ wide; appendages 9–15, more or less enlarged towards the apex, 1- or 2-septate, hyaline, straight, granulate in the tip, 126–157 μ long, usually about 150 μ, apex circinate; asci 6–9 in number, ovate, with short stalk, 43.2–60.0 × 33.6–43.2 μ; spores 6–8, ellipsoidal or elongate-ellipsoidal, 17.6–18.0 × 10.8–12.0 μ.

Hab. On leaves of *Cedrela sinensis* JUSS. (Chanchin). Honshu—Mutsu, Rikuchu, Musashi, Echigo.

Distrib. Japan (Honshu) and China.

Remarks. In this country, the first record of the present species on *Cedrela sinensis* was by SALMON. The appendages of the perithecium are enlarged toward the tip, they are much wider than in the case of the other species of Uncinula and they are perfectly smooth and stout. This species is related to *Uncinula australiana* and *U. Sengokui*, but in the former, the circinate parts of the appendages are narrow, and in the latter, the appendages are frequently flexuous.

Uncinula bifurcata HOMMA sp. nov.

(Pl. VIII, fig. 22)

Amphigena, plerumque epiphylla; mycelio persistente, albo, demum griseo; peritheciis sparsis, globosis v. globoso-depressis, 88–126 μ. diam., cellulis 15.6–19.2 × 14.4–16.8; appendicibus 9–14, simplicibus v. bifurcatis, 102–154 μ. longis, rectis v. curvatis, continuis v. 1-septatis, deorsum brunneis, apice uncinatis, tenue tunicatis; ascis 5–8 in quoque perithecio, ellipsoideis v. ovatis, brevissime pedicellatis, 48.0–70.8 × 28.8–40.8, 3–4-sporis; sporidiis ellipsoideis v. oblongo-ovatis, 12.8–18.0 × 8.4–12.0.

Hab. On leaves of *Quercus serrata* THUNB. (Konara) Honshu—Prov. Echigo; Mt. Ninoji (Oct. 10, 1924, Y. HOMMA, type).
Distrib. Japan (Honshu).

Remarks. Up to the present time, Uncinula known to be parasitic on Quercus has been restricted to *U. septata*. *Uncinula septata* can easily be distinguished from the present species by its many septate appendages. The present species appears on both surfaces of the leaves and at first the mycelium is white, gradually becoming a gray color just as in the case *Cystotheca lanestris*. The characteristic point of the appendages is in their dichotomous branching at the base, while in the other characters, they are nearly similar to *Uncinula Delavayi* and *U. Sengokui*. Compared with *U. Delavayi*, the perithecia in the present species are smaller, and the septa of the appendages are less, besides being brown-colored at the base. Compared with *Uncinula Sengokui*, the appendages of the perithecium in the species under consideration are less in number.

Uncinula australiana MCALPINE

(Pl. VIII, fig. 23)

Journ. Linn. Soc. N. S. Wales, XXIV, p. 302, 1899; SALM. Monogr. Erysiph. p. 118, 1900; SACC. Syll. Fung. XXII, p. 21, 1910; TAI & WEI, Sinensia, III, p. 101, 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 446, 1900; MATSUM. Ind. Pl. Jap. I, p. 178, 1904; SHIRAI, List, p. 102, 1905; IDETA, Jap. Phytopath. p. 215, 1911; SHIRAI & MIYAKE, List, p. 675, 1917; HARA, Dendropath. p. 22, 1923; SHIRAI & HARA, List, p. 402, 1927).

Amphigenous, mycelium persistent, at first forming white circular patches on the leaves; matured conidia solitary, ellipsoidal, vacuolate, 24.0–34.5 × 15.0–19.0 μ; perithecia 112–140 μ in diameter, globose or depressed-globose; cells 12.0–14.4 μ in width; appendages 13–17 in number, usually uni-septate, amber brown-colored at the base, gradually becoming narrower toward the apex, especially narrow at the circinate part; asci 4 or 5 in number, ovate or subglobose, with or without short stalk, 50.4–57.6 × 40.8–50.4 μ; spores 7 or 8, usually 8, ellipsoidal, 13.2–20.4 × 9.6–15.6 μ.

Hab. On leaves of *Lagerstroemia indica* L. (Sarusuberi). Honshu—Rikuzen, Musashi, Kozuke, Suruga, Yamashiro. Shikoku—Iyo. Kyushu—Higo. Formosa—Daihoku.

Distrib. Japan (Honshu, Shikoku, Kyushu and Formosa), China and Australia.

Remarks. In the present species, the appendages of the perithecium are smooth, deep brown-colored under the septum and narrowed in the circinate part.

Uncinula Sengokui SALM.

(Pl. VIII, fig. 24)

Monogr. Erysiph. p. 120, 1900, and Bull. Torr. Bot. Club, XXIX, p. 647, 1902; SACC. Syll. Fung. XVI, p. 399, 1902. (SALM. Bull. Torr. Bot. Club, XXVII, p. 447, 1900, Ann. Myc. III, p. 253, 1905, and VI, p. 12, 1908; MATSUM. Ind. Plant. Jap. I, p. 179, 1904; SHIRAI, List, p. 103, 1905; IDETA, Jap. Phytopath. p. 215, 1911; SHIRAI & MIYAKE, List, p. 679, 1917; HARA, Dendropath. p. 23, 1923; SHIRAI & HARA, List, p. 403, 1927).

Amphigenous, mycelium persistent on the upper surface of the leaf, evanescent on the under surface, at first forming white roundish mycelial patches; matured conidia produced in a chain, ellipsoidal, granulate, including well developed fibrosin bodies, 24.0–27.6 × 13.6–17.6 μ; perithecia scattered, 105–133 μ in diameter, globose or depressed-globose; cells various in form and size, 12.0–18.0 × 10.8–16.8 μ in size; appendages 11–23 in number, straight, broad, stout, more or less light colored at the base, sometimes hyaline, aseptate, rarely 1-septate, 112–154 μ in length, apex uncinate, frequently a little expanded at the first part of the coil; asci broadly ovate or oval, with a stalk, hyaline, thin-walled, granulate, 4–7 in number, 48.0–64.8 × 31.2–43.2 μ; spores 4–6 in number, usually 5, oval, ellipsoidal or oblong, granulate, 18.0–21.6 × 9.6–13.2 μ.

Hab. On leaves of *Celastrus articulata* THUNB. (Tsuru-umemotogi). Hokkaido—Iburi, Ishikari. Honshu—Musashi.

Distrib. Japan (Hokkaido and Honshu) and Manchuria.

Remarks. The present fungus was sent to SALMON (in 1900) from MIYABE, together with many other Japanese specimens. SALMON described it as a new species after the name of the collector. This species is distinguished from others by the form of the appendages, which are stout, straight, broad, hyaline or slightly pale brown colored at the base and perfectly uncinate at the apex. At the base of the uncinate apex, a swollen part is frequently observed.

Uncinula Salmoni Sydow

(Pl. IX, fig. 1)

Ann. Myc. XI, p. 114, 1913; Sacc. Syll. Fung. XXIV, p. 225, 1928. (Shirai & Miyake, List, p. 679, 1917; Hara, Dendropath. p. 23, 1923; Ideta, Jap. Phytopath. (Suppl. I), p. 215, 1923; Shirai & Hara, List, p. 403, 1927).

Syn. *Uncinula Sengokui* Salm. forma Salm. Ann. Myc. III, p. 253, 1905.

Amphigenous, mycelium subpersistent or evanescent; perithecia gregarious or scattered, globose, 90–126 μ in diameter; cells 13.2–16.8 × 9.6–14.4 μ in size; appendages 13–22 in number, yellowish brown colored at the base, aseptate or 1-septate, 91–140 μ in length, generally enlarged upward, very irregular in width, apex uncinate or helicoid; asci 4–6 in number, usually 5, globose, short stalked, 43.2–49.2 × 30.0–42.0 μ; spores ellipsoidal or oblong, 6–7 in number, 16.8–20.4 × 10.8–13.2 μ.

Hab. On leaves of *Fraxinus japonica* Bl. (Toneriko). Hokkaido—Ishikari. Honshu—Musashi, Echigo. Kyushu—Bungo.

On *Fraxinus longicuspis* Sieb. & Zucc. (Koba-no-toneriko). Honshu—Rikuchu.

On *Fraxinus mandschurica* Rupr. (Yachidamo). Hokkaido—Hidaka.

On *Fraxinus ornus* L. Honshu—Musashi.

On *Fraxinus Sieboldiana* Bl. (Aodamo). Honshu—Etchu.

On *Fraxinus Sieboldiana* Bl. var. *pubescens* Koidz. (Arage-aodamo). Honshu—Musashi.

Distrib. Japan (Hokkaido, Honshu and Kyushu) and Manchuria.

Remarks. In 1905, Salmon considered the present species as a form of *Uncinula Sengokui,* based on the fungus collected in Tokyo, Nov. 6, 1901, by K. Yoshino. In 1913, Sydow separated it from *Uncinula Sengokui,* and recognized it as a new species. It has a close affinity to *U. Sengokui,* but is distinguished from the latter by the perithecia being smaller, the appendages being irregular in width or frequently enlarged upward, and the asci being fewer in number as well as larger in size.

On the other hand, in *U. Fraxini,* the perithecia are smaller in diameter, and the appendages are delicate, narrowed throughout and longer than in *U. Salmoni.*

In the form on *Fraxinus Sieboldiana* var. *pubescens*, the appendages are longer than in the case on other host plants, being 98–140 μ, usually 112–126 μ in length.

Uncinula Picrasmae HOMMA, sp. nov.

(Pl. IX, fig. 2)

Amphigena; mycelio persistente; peritheciis sparsis v. subgregariis, globosis v. globoso-depressis, 96–120 μ. diam., cellulis 12.0–14.4 × 8.4–10.8; appendicibus 14–25, continuis v. 1- 2- septatis, deorsum fulvis, 147–182 μ. longis, rectis v. lenissime curvulis, superne abrupte flexis, apice uncinatis v. helicoideis; ascis 4–6 in quoque perithecio, subglobosis, brevissime pedicellatis 45.6–62.4 × 38.4–50.4, 6–8-sporis; sporidiis ellipsoideis, 15.4–21.6 × 8.4–12.0.

Hab. On leaves of *Picrasma quassioides* BENN. (Nigaki). Hokkaido—Prov. Iburi: Tomakomai (Oct. 17, 1904, K. MIYABE & J. HANZAWA). Prov. Ishikari: Nopporo (Oct. 2, 1921, K. TOGASHI; Sept. 14, 1922, Y. HOMMA, type; Oct. 12, 1923, H. TAKASUGI).

Honshu—Prov. Musashi: Himonya, Tokyo (Apr. 18, 1923, K. KITAJIMA).

Distrib. Japan (Hokkaido and Honshu).

Remarks. The present species seems to take an intermediate place between *Uncinula Salmoni* and *U. Actinidiae*. The appendages of this species are not enlarged upward and are longer than in *U. Salmoni*, while from *U. Actinidiae* it can easily be distinguished by the lighter colored appendages. It is considered from the above characters, that the present fungus should be treated as a new species.

Uncinula Actinidiae MIYABE

(Pl. IX, fig. 3)

in SALMON, Monogr. Erysiph. p. 101, (nomen nudum) 1900.

Syn. *Uncinula necator* (SCHWEIN.) BURR. in SALM. Monogr. Erysiph. p. 99 (p.p.), 1900. (SALM. Bull. Torr. Bot. Club, XXVII, p. 447, 1900, and Ann. Myc. VI, p. 12, 1908; SHIRAI, List, p. 103 (p.p.), 1905; SHIRAI & MIYAKE, List, p. 677, 1917).

Uncinula necator (SCHWEIN.) BURR. var. *Actinidiae* HARA, Journ. Forest. Assoc. Jap. No. 392, p. 63, 1915; TANAKA, Mycolog. XI, p. 81, 1919; SACC. Syll. Fung. XXIV, p. 224, 1928. (HARA, Dendropath. p. 23, 1923; SHIRAI & HARA, List, p. 403, 1927).

Amphigenous, mycelium persistent or evanescent, usually forming thin effused film, and causing an atrophy of young leaves; matured conidia produced in a chain or solitary, ellipsoidal, vacuolate, granulate, including well-developed fibrosin bodies, 19.2–42.0 × 14.4–18.0 μ; perithecia gregarious or scattered, 91–112 μ in diameter, globose or depressed-globose; cells 16.8–19.2 × 14.4–16.8 μ in size; appendages 7–13 in number, usually 9, 1-septate, brown colored for more than half their length, 140–238 μ long, simple, sometimes dichotomously branched at the upper half, apex irregular in form, broad or narrowed, loosely helicoid or uncinate, more or less widened toward the base; asci 4, very rarely 3, globose or subglobose, with short stalk, 50.4–57.6 × 32.4–43.2 μ; spores 7 or 8 in number, elongate-ellipsoidal, 13.4–16.8 × 9.6–10.4 μ.

Hab. On leaves and stems of *Actinidia arguta* PLANCH. (Kokuwa). Hokkaido—Ishikari. Honshu—Musashi.

On *Actinidia Kolomicta* MAXIM. (Miyama-matatabi). Hokkaido—Iburi, Ishikari. Honshu—Musashi.

On *Actinidia polygama* MAXIM. (Matatabi). Hokkaido—Shiribeshi, Ishikari, Hidaka. Honshu—Rikuchu, Rikuzen, Inaba.

Distrib. Japan (Hokkaido and Honshu).

Remarks. In 1900, SALMON made the following remarks in regard to this species; "the occurrence of *Uncinula necator* on species of Actinidia—a genus of plants belonging to Ternstroemiaceae, an order in no way related to Vitaceae—is very interesting, not only because the vine mildew has hitherto been supposed to be confined to vines, but also for the evidence it gives on the question, mentioned below, of the native country of *U. necator.* Professor MIYABE sent me numerous specimens of this form from Japan as *Uncinula Actinidiae* MIYABE mss., but on examination the specimens proved to agree well with certain forms of *U. necator* from America". The present writer made a careful study on the specimens of *U. necator* parasitic on cultivated Vitis from the U. S. A. which had been sent to Prof. MIYABE by Prof. SALMON. These two fungi coincide in the character that their appendages are dark brown colored in the lower half, but in *U. necator,* the appendages are longer and have several septa, the outer wall-cells of the perithecium are very evident, and the spores are rather larger. The appendages of the perithecium of *U. Actinidiae* are frequently dichotomously divided in the upper half. From these characters, the present writer has considered the present fungus as a new species.

In the form which was collected by the author, in the Bot. Gard. Sapporo, Oct. 17, 1923, the appendages are exceedingly irregular in form, here and there producing short or long branches while the apices are almost not uncinate and very rarely falcate. But among them was found a small number having the normal form of *U. Actinidiae* on the same leaves. This material seems to be the result of abnormal formation caused by environmental factors.

Uncinula verniciferae P. HENN.

(Pl. IX, fig. 4)

in ENGL. Bot. Jahrb. XXIX, p. 149, 1901; SACC. Syll. Fung. XVI, p. 399, 1902; SALM. Bull. Torr. Bot. Club, XXIX, p. 101, and p. 648, 1902, and Ann. Myc. III, p. 243, 1905; TAI & WEI, Sinensia, III, p. 114, 1932. (MATSUM. Ind. Plant. Jap. I, p. 179, 1904; SHIRAI, List, p. 104, 1905; YOSHINO, Bot. Mag. Tokyo, XIX, p. 207, 1905; SALM. Ann. Myc. III, p. 253, 1905, and VI, p. 13, 1908; IDETA, Jap. Phytopath. p. 210, 1911; SHIRAI & MIYAKE, List, p. 697, 1917; HARA, Dendropath. p. 17, 1923; SHIRAI & HARA, List, p. 403, 1927; SAWADA, Depart. Agr. Govern. Res. Inst. Formosa, LXI, p. 28, 1933).

Amphigenous, also on fruits, mycelium subpersistent on the leaves, persistent on the fruits, forming thin effused film; perithecia gregarious, globose-depressed, brownish black colored, 112–126 μ in diameter; cells obscure, 12.0–15.6 μ wide; appendages 11–23 in number, commonly aseptate or rarely 1-septate, hyaline or more or less pale brown colored toward the base, 84–112 μ in length, apex simple, narrowed, uncinate or helicoid; asci usually 4, broadly ovate, 45.6–48.0 × 38.4–45.6 μ; spores elongate-ellipsoidal or ovate, 18.4–20.4 × 12.0–14.4 μ.

Hab. On leaves and fruits of *Rhus japonica* L. (Nurude). Honshu—Musashi.

On *Rhus succedanea* L. (Hazenoki). Honshu—Musashi, Izumo. Shikoku—Iyo, Tosa. Kyushu—Higo.

On *Rhus sylvestris* SIEB. & ZUCC. (Yamahaze). Honshu—Musashi.

On *Rhus Toxicodendron* L. var. *vulgaris* PURSH. f. *radicans* ENGL. (Tsuta-urushi). Hokkaido—Ishikari.

On *Rhus trichocarpa* MIQ. (Yama-urushi). Honshu—Rikuchu.

On *Rhus vernicifera* DC. (Urushi). Honshu—Rikuchu, Musashi, Hitachi, Echigo, Ise, Izumo.

Distrib. Japan (Hokkaido, Honshu, Shikoku, Kyushu and Formosa) and China.

Remarks. In 1901, P. HENNINGS described the present species from a specimen on *Rhus vernicifera* which was collected in Tokyo, Bot. Gard. by KUSANO. The writer fortunately could examine the co-type specimen which was sent to Prof. Miyabe from Prof. Kusano. Compared with *U. geniculata*, the appendages in this species are gradually narrowed upwards, straight and not geniculate.

Uncinula Salicis (DC.) WINT.

(Pl. IX, figs. 5, 6, 7)

in RABENH. Krypt. Fl. Deutschl. I, 2, p. 40, 1884; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 410, 1887; ELL. & EVERH. N. Amer. Pyren. p. 19, 1892; SCHRÖT, in COHN's Krypt. Fl. Schles. III, p. 245, 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 742, 1896; OUDEM. Rév. Champ. Pays-Bas, p. 87, 1897; MAGNUS, Erysiph. Tirol. p. 20, 1898; SALM. Monogr. Erysiph. p. 81, 1900, and Bull. Torr. Bot. Club, XXIX, p. 96, 1902; NEGER, Krypt. d. Mark Brand. VII, p. 130, 1905; KLIKA, Erysiph. Czechosl. p. 48, 1924; JØRST. Erysiph. Norway, p. 99, 1925; ŠKORIĆ, Erysiph. Croat. p. 43, 1926; TAI & WEI, Sinensia, III, p. 110, 1932. (TRACY & GALLOW. Journ. Myc. IV, p. 35, 1888; PAMM. Journ. Myc. IV, p. 38, 1888; GRIFF., Bull. Torr. Bot. Club, XXVI, p. 144, 1899; SALM. Bull. Torr. Bot. Club, XXVII, p. 447, 1900, Ann. Myc. III, p. 253, 1905, and VI, p. 12, 1908; P. HENN. in ENGL. Bot. Jahrb. XXIX, p. 149, 1901; MATSUM. Ind. Plant. Jap. I, p. 178, 1904; SHIRAI, List, p. 103, 1905; LAWR. Journ. Myc. XI, p. 108, 1905; SYD. Ann. Myc. XI, p. 114, 1913; RANOJ. Ann. Myc. VIII, p. 357, 1910; JAAP, Ann. Myc. IX, p. 333, 1911; IDETA, Jap. Phytopath. p. 214, 1911; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 66, 1914; SHIRAI & MIYAKE, List, p. 677, 1917; HARA, Dendropath. p. 15, 1923; TOGASHI, Jap. Journ. Bot. II, p. 78, 1924; SHIRAI & HARA, List, p. 403, 1927).

Syn. *Erysiphe salicis* DC. Fl. Fr. II, p. 273, 1805; MÈRAT, Nouv. Fl. Paris, p. 74, 1837, and Syn. Nouv. Fl. Paris, p. 83, 1837; TULASNE, Selecta Fung. Carpolog. I, p. 198, 1861.

Erysiphe adunca (not LK.) MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837, and Syn. Nouv. Fl. Paris, p. 84 (p.p.), 1837.

Erysiphe populi DC. in DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 52, 1870.

Erysiphe adunca vars. *Populi* et *salicis* FR. Syst. Myc. III, p. 245, 1892.

Uncinula adunca LÉV. Ann. Sci. Nat. III, 15, p. 151, 1851; KICKX, Fl. Crypt. Fland. I, p. 377, 1867; COOKE, Handb. Brit. Fung. II, p. 646, 1871; COOKE & PECK, Journ. Bot. I, p. 12, 1872, and I, p. 170, 1872; QUÉL. Champ. Jur. Vosg. p. 533, 1875; SACC. Syll. Fung. I, p. 7, 1882; LIND, Danish Fung. p. 164, 1913. (FUCK. Symb. Myc. p. 80, 1869–70).

Uncinula heliciformis E. G. HOWE, Bull. Torr. Bot. Club, V, p. 4, 1874; SACC. Syll. Fung. IX, p. 367, 1891.

Erysiphe Populi PAT. Journ. d. Bot. II, p. 217, 1888; SACC. Syll. Fung. IX, p. 370, 1891.

Amphigenous, mostly hypophyllous, mycelium persistent or evanescent, usually thinly effused or forming circular patches; matured conidia solitary, ellipsoidal, granulate, vacuolate, 27.6–30.0 × 16.8–18.0 μ; perithecia globose or depressed-globose, densely gregarious or scattered, 126–210 μ in diameter; cells 10.8–16.2 μ in width; appendages 41–117 in number, aseptate, simple, more or less curved throughout, hyaline, apex uncinate, 64.8–308 μ in length; asci 5–12 in number, subglobose or elongate-ellipsoidal, with a stalk, hyaline, 43.2–86.4 × 31.2–60.0 μ; spores 4–7 in number, ovoid or ellipsoidal, 19.2–28.8 × 9.0–16.8 μ.

Hab. On leaves of *Populus Maximowiczii* A. HENRY (Doro-yanagi). Hokkaido—Ishikari.

On *Populus Sieboldii* MIQ. (Yamanarashi). Hokkaido—Kitami, Kushiro. Honshu—Rikuchu.

On *Salix Bakko* KIMURA (Bakko-yanagi). Hokkaido—Ishikari. Honshu—Echigo.

On *Salix Gilgiana* SEEMEN (Kawa-yanagi). Honshu—Musashi.

On *Salix gracilistyla* MIQ. (Neko-yanagi). Honshu—Rikuchu, Musashi, Echigo, Echizen. Shikoku—Tosa.

On *Salix Hultenii* FLODERS var. *angustifolia* KIMURA (Yezo-no-bakko-yanagi). Hokkaido—Shiribeshi, Iburi, Ishikari.

On *Salix integra* THUNB. (Inu-koriyanagi). Honshu—Rikuchu, Musashi.

On *Salix Lackschewitziana* TOEPFFER (Yezo-yanagi). Hokkaido—Ishikari.

On *Salix purpurea* L. (Koriyanagi). Honshu—Musashi, Hitachi.

On *Salix sachalinensis* FR. SCHM. (Nagaba-yanagi). Hokkaido—Iburi, Ishikari.

On *Salix Sieboldiana* BLUME (Yama-yanagi). Kyushu—Higo.

On *Toisusu Urbaniana* KIMURA (Ohba-yanagi). Honshu—Rikuchu, Etchu.

Distrib. Widely distributed throughout the world.

Remarks. Up to the present time, Salix, Populus and Betula have been known as the host plants of *Uncinula Salicis*. After a careful examination of the materials at hand, the writer found two groups in the forms of *U. Salicis* on Salix. In one of them which is found on *Salix Hultenii* and *Toisusu Urbaniana*, the perithecia are larger, 140–210 μ in diameter, and the appendages are more numerous and shorter, about 73–117 in number and 113 μ in length. In the other form which is produced on *Salix purpurea, S. integra, S. Gilgiana, S. gracilistyla, S. sachalinensis* and *S. Lackschewitziana*, the perithecia are smaller, 126–154 μ in diameter, and the appendages are fewer and rather longer, about 41–67 in number and 126–154 μ in length. The characters of the leaves of the host plants are nearly alike in each group; in the former group, the leaves are larger and broader, and in the latter, they are narrowed and elongated. At first, it appeared that *U. Salicis* might be divided into two species, but in other characters they entirely coincide, namely the appendages are hyaline, smooth, more or less curved throughout, and with an uncinate apex, and the asci and ascospores are similar in size. These two forms are too difficult to be divided.

Uncinula Salicis is a very common powdery mildew on willows and is widely spread in this country. In the form on *Salix Hultenii* and *Toisusu Urbaniana*, the mycelium is amphigenous, on *S. gracilistyla* and *S. Lackschewitziana* it is epiphyllous, while on other hosts it is hypophyllous. In the amphigenous group, the mycelium is densely persistent on the upper surface of the leaves and on the lower surface evanescent, even at the time when the perithecia are produced. The perithecia turn upside down when matured, especially on the under surface of the leaf, while on the upper side this phenomenon very rarely occurs.

In 1900, SALMON remarked, "LÉVEILLE, WINTER, JACZEWSKI, SACCARDO and other authors have recorded *U. Salicis* as growing on Betula, but I have not been able to find specimens on this host plant in any herbarium. It may be that perithecia (without appendages) of *Phyllactinia corylea*—species which occurs commonly on Betula—have been mistaken for immature examples of the present species". *Phyllactinia corylea* parasitic on Betula is a very common powdery mildew in this country too, but among the specimens which have been gathered for the present work, we found a fine Uncinula.

This form seems at first sight to be near to *U. Salicis*, but it could not be included in it because the appendages are frequently geniculate.

In the form on *Populus Maximowiczii*, the appendages are 98–154 μ in length. In the form on *Populus Sieboldii* (Prov. Rikuchu: Samurai-hara, Oct. 17, 1910, G. YAMADA), the appendages are longer, 182–210 μ. These two forms could not be distinguished from *U. Salicis* although the appendages are longer and more or less flexuous. The form on the latter host plant which was collected in Abashiri, Prov. Kitami, Nov. 1894, by J. Tanaka, has the longest appendages, 210–308 μ in length becoming narrowed upwards, the apices are slightly circinate, and very rarely irregularly branched at the upper half while the asci are more or less larger in size. The writer takes this material to be of an abnormal form.

Uncinula simulans SALM.

(Pl. IX, fig. 8)

Ann. Myc. VI, p. 2, 1908; SACC. Syll. Fung. XXII, p. 21, 1910; TAI & WEI, Sinensia, III, p. 112, 1932. (SALM. Ann. Myc. VI, p. 12, 1908; SHIRAI & MIYAKE, List, p. 679, 1917; SHIRAI & HARA, List, p. 403, 1927).

Amphigenous, mycelium evanescent; perithecia scattered, depressed-globose or lenticular, 96–126 μ in diameter; cells nearly black colored, 9.0–12.0 μ wide; appendages 13–25 in number, usually 16, aseptate or 1-septate, conspicuously dark brown colored from the base to the apex, thick-walled throughout, 105–175 μ long, narrowed upward, simple or very rarely branched (1 or 2 in a perithecium), straight or bent at $\frac{1}{3}$ of the length, apex more or less light-colored, uncinate or helicoid; asci 5–7, usually 7, subglobose or broadly ovate, with a short stalk, 50.0–60.0 × 33.6–45.6 μ; spores ellipsoidal, elongate-ellipsoidal or oblong, 16.0–32.4 × 9.6–11.4 μ.

Hab. On leaves of *Rosa multiflora* THUNB. (Nobara). Honshu—Rikuchu, Shimozuke.

Distrib. Japan (Honshu) and China.

Remarks. In 1908, SALMON described the present fungus as a new species of Uncinula which was found parasitic on *Rosa multiflora* collected in Morioka, Sept. 5, 1906, and Oct. 20, 1907, by

OKUMURA. The dark brown colored appendages of the perithecium are the characteristic of the species.

Uncinula septata and *U. curvispora* resemble this species in respect to the colored appendages, but the appendages of those two species have many septa. In *Uncinula simulans* the appendages are usually aseptate or rarely uniseptate and few in number and the perithecia are smaller in size.

Uncinula curvispora HARA

(Pl. IX, fig. 9)

in TANAKA, Mycolog. XI, p. 80, 1919; HARA, Dendropath. p. 21, 1923; SACC. Syll. Fung. XXIV, p. 224, 1928. (SHIRAI & HARA, List, p. 402, 1927).

Syn. *Uncinula septata* SALM. var. *curvispora* HARA, Journ. Forest. Assoc. Jap. No. 392, p. 62, 1915.

Amphigenous, mostly hypophyllous; mycelium evanescent, forming thin effused film; perithecia depressed-globose or lenticular, large, 168–203 μ in diameter; cells 7.2–11.4 × 6.0–6.4 μ; appendages very numerous (about 247), arising from the upper part of the perithecium, 40.8–146.4 μ long, simple, 5–8 septate, brown-colored below the 1st or 3rd septum, gradually narrowed upwards, more or less curved, apex simple, narrow, delicate, circinate or helicoid; asci 10–13, ellipsoidal or oblong, with a short stalk, hyaline, 46.8–55.2 × 26.4–40.8 μ; spores usually immature on the living host plant, "spores ovate or ellipsoidal, yellowish colored, granulate, 28–35 × 12–15 μ, rarely 45–18 μ". (acc. to K. Hara).

Hab. On leaves of *Fagus japonica* MAXIM. (Inubuna). Honshu—Mino.
Distrib. Japan (Honshu).

Remarks. In the genus Uncinula, up to this time the only species has been *U. septata,* which has numerous septa. In 1915, HARA first described a new variety (var. *curvispora*) of *Uncinula septata,* which was afterward in 1919, raised to specific rank.

The appendages of the present fungus are gradually narrowed upward, even to the circinate part. In *Uncinula septata,* the appendages are enlarged upward and have septa from the circinate apex to the base, but in *U. curvispora,* the septa are never produced in the circinate part.

Uncinula septata SALMON

(Pl. IX, fig. 10)

Journ. Bot. XXXVII, p. 427, 1900, and Bull. Torr. Bot. Club, XXIX, p. 102, 1902; SACC. Syll. Fung. XVI, p. 400 and p. 1123, 1902, and XVII, p. 524, 1905; TAI & WEI, Sinensia, III, p. 111, 1932. (MATSUM. Ind. Plant. Jap. I, p. 179, 1904; SALM. Ann. Myc. III, p. 253, 1905, and VI, p. 12, 1908; SHIRAI, List, p. 103, 1905; NAMBU, Bot. Mag. Tokyo, XX, p. 252, 1906; IDETA, Jap. Phytopath. p. 215, 1911; SHIRAI & MIYAKE, List, p. 679, 1917; HARA, Dendropath. p. 19, 1923; SHIRAI & HARA, List, p. 403, 1927).

Hypophyllous, mycelium subpersistent or evanescent; perithecia depressed-globose or lenticular, large, 140–231 μ in diameter; cells 7.8–12.0 × 7.2–9.2 μ in size; appendages numerous, about 168, arising from the upper part of the perithecium, 84.0–105.6 μ in length, colorless, 6–11-septate, narrowed upward, but at uncinate part becoming thickened and septate, thin-walled from the apex to the base, apex simple, uncinate; asci 13–14, ellipsoidal or elongate-ellipsoidal, with a short stalk, hyaline, 43.2–55.2 × 26.4–31.2 μ; spores mostly immature on the living host leaves.

Hab. On leaves of *Quercus serrata* THUNB. (Konara). Honshu—Musashi, Hitachi, Kozuke.

Distrib. Japan (Honshu).

Remarks. The most important characters of the present species are the large size of the perithecium and the septate appendages, whose septa are formed even in the thick uncinate part.

Uncinula geniculata GERARD

(Pl. IX, fig. 11)

Bull. Torr. Bot. Club, IV, p. 48, 1873; ELL. & EVERH. N. Amer. Pyren. p. 19, 1892; SACC. Syll. Fung. I, p. 8, 1882; PAMM. Journ. Myc. IV, p. 37, 1888; SALM. Monogr. Erysiph. p. 111, 1900. (SALM. Ann. Myc. III, p. 252, 1905; Ideta, Jap. Phytopath. p. 215, 1911; SHIRAI & MIYAKE, List, p. 675, 1917; HARA, Dendropath. p. 24, 1923; SHIRAI & HARA, List, p. 402, 1927).

Amphigenous, mostly epiphyllous, mycelium evanescent; perithecia scattered, 102–126 μ in diameter, globose or depressed-globose;

cells 14.4–15.6 × 9.6–12.0 μ in size; appendages 23–36 in number, hyaline, aseptate, smooth, simple, delicate, narrowed upwards, especially so in circinate part, curved or bent at about half their length; asci 5–9, ellipsoidal or broadly ovate, with a short stalk, 48.0–55.2 × 34.4–46.4 μ; spores 5 or 6, ellipsoidal, oblong or ovate, 15.6–21.6 × 9.6–14.4 μ.

Hab. On leaves of *Styrax Obassia* SIEB. & ZUCC. (Hakuumboku). Honshu—Rikuchu, Musashi.

Distrib. Japan (Honshu) and North America.

Remarks. *Uncinula geniculata* has not yet been found on Morus in this country. In 1905, the form on *Styrax Obassia* was included under this species by SALMON.

The appendages of this species are abruptly geniculate at about half their length, which character is found in 2 or 3 appendages in a perithecium. They are delicate, narrow, gradually narrowed upward, straight or more or less curved; and the ascospores are 6 in number in an ascus.

Uncinula Betulae HOMMA, sp. nov.

(Pl. IX, fig. 12)

Syn. *Uncinula Salicis* (DC.) SYD. Ann. Myc. VII, p. 170, 1909.

Amphigena; mycelio epiphyllo tenui, effuso subpersistente; mycelio hypophyllo evanido; peritheciis sparsis, globosis v. globoso-depressis, 84–126 μ. diam., cellulis parvis, 12.0–14.4 × 9.6–10.8; appendicibus 22–38, tenuibus, interdum flexuosis, geniculatis, hyalinis, simplicibus, 119–210 μ. longis, continuis, apice circinatis; ascis 6–12 in quoque perithecio, pedicellatis, 40.8–55.2 × 25.2–38.4, 6–8-sporis; sporidiis oblongis v. oblongo-ellipsoideis, 16.8–18.0 × 9.6–10.8.

Hab. On leaves of *Betula Ermanii* CHAM. var. *subcordata* KOIDZ (Akakamba)

Honshu—Prov. Shinano: Mt. Akaishi (Aug. 17, 1930, K. HARA).

On *Betula Tauschii* KOIDZ. (Shirakamba)

Hokkaido—Prov. Iburi: Tomakomai (Oct. 17, 1904, K MIYABE & J. HANZAWA. Prov. Ishikari: Mt. Sapporo-dake (Sept. 5, 1921, K. TOGASHI); Mt. Maruyama (Aug. 29, 1924, Oid. Y. HOMMA; Oct. 14, 1925, Y. HOMMA, type); Mt. Moiwa (Sept. 7, 1925, Y. HOMMA); Mt. Soranuma (Sept. 18, 1930, Y. TOKUNAGA). Prov. Kitami: Oniwaki, Rishiri-Isl. (Oct. 11, 1923, K. TOGASHI).

Distrib. Japan (Hokkaido and Honshu).

Remarks. The powdery mildew on Betula has hitherto been treated as *Uncinula Salicis,* but in our form it seems to differ from it by the following characters. In the present species, the perithecia and ascospores are smaller in size, and the appendages are fewer in number and sometimes geniculate or flexuous at the upper half. On the other hand, the present fungus resembles rather *U. carpinicola* and *U. geniculata.* The appendages of the former are mostly more delicate and narrowed, while those of the latter are similar to our species in being geniculate, but *U. geniculata* is comparatively smaller in all points and the circinate part of the appendages more narrowed. The present fungus not being referable to any other species of *Uncinula,* the writer has considered it as a new species.

Uncinula carpinicola HARA

(Pl. IX, fig. 13)

Dendropath. p. 16, 1923. (in Japanese). (Shirai & Hara, List, p. 402, 1927).

Syn. *Uncinula geniculata* GER. var. *carpinicola* HARA, Journ. Forest. Assoc. Jap. No. 382, p. 62, 1915; TANAKA, Mycolog. XI, p. 80, 1919; SACC. Syll. Fung. XXIV, p. 223, 1928.

Amphigenous, mycelium subevanescent, thinly effused on the upper surface of the leaf; perithecia 77–112 μ in diameter, globose or depressed-globose; cells 9.6–14.4 × 8.4–13.2 μ in size; appendages 20–23 in number, aseptate or uniseptate, the former hyaline and the latter light brown colored under the septum, straight, thin-walled, 154–231 μ long, enlarged upwards, 4.8–5.6 μ in width, apex simple, circinate; asci 5–10, hyaline, globose or ovate, thin-walled, without stalk, rarely short stalked, 43.2–57.6 × 32.4–45.6 μ; spores 8, ellipsoidal, oblong or elongate-ovate, 17.4–21.6 × 9.6–10.8 μ.

Hab. On leaves of *Carpinus laxiflora* BL. (Akashide). Honshu—Suruga.
Distrib. Japan (Honshu).

Remarks. In 1915, HARA treated the present fungus as a new variety of *Uncinula geniculata,* but in 1923, he elevated it to a new species in his Dendropathology (in Japanese). According to his note, the characteristic points of this fungus are the small size of perithecia and long appendages, 1.5 to 4 times the diameter of the perithecium, additional to which the writer has found the following characters: the appendages are enlarged from the basal part of the circination and the number of spores is always 8.

Uncinula Fraxini MIYABE

(Pl. IX, fig. 14)

in SALM. Monogr. Erysiph. p. 119, 1900; SACC. Syll. Fung. XVI, p. 400, 1902; TAI & WEI, Sinensia, III, p. 105, 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 447, 1900, and Ann. Myc. VI, p. 12, 1908; MATSUM. Ind. Plant. Jap. I, p. 178, 1904; SHIRAI, List, p. 102, 1905; IDETA, Jap. Phytopath. p. 214, 1911; I. MIYAKE, Bot. Mag. Tokyo, XXVIII, p. 39, 1914; SHIRAI & MIYAKE, List, p. 675, 1917; HARA, Dendropath. p. 22, 1923; SHIRAI & HARA, List, p. 402, 1927).

Amphigenous, mycelium evanescent; perithecia depressed-globose or lenticular, 84–102.7 μ in diameter, gregarious or scattered; cells 12–18 μ wide; appendages 17–25 in number, usually aseptate or sometimes 1-septate at the base, hyaline or brown colored toward the base, simple, refractive in the upper half and sometimes flexuous, apex circinate, 154–238 μ in length; asci 5–6 in number, subglobose or ovate, granulate, stalked, 43.2–52.8 × 38.4–43.2 μ; spores 7–8, ellipsoidal or elongate-ellipsoidal, 16.8–19.2 × 9.6 μ.

Hab. On leaves of *Fraxinus japonica* BLUME (Toneriko). Hokkaido—Iburi. Honshu—Rikuchu, Musashi, Echigo, Aki.

On *Fraxinus longicuspis* SIEB. & ZUCC. (Kobano-toneriko). Hokkaido—Iburi, Ishikari.

On *Fraxinus mandschurica* RUPR. (Yachidamo). Hokkaido—Ishikari, Kushiro. Honshu—Rikuchu, Echigo.

On *Fraxinus Sieboldiana* BL. (Aodamo). Hokkaido—Ishikari. Honshu—Rikuchu.

Distrib. Japan (Hokkaido and Honshu) and China.

Remarks. In 1900, the note and specimens of this fungus were sent from Prof. MIYABE to Prof. SALMON, who published it under the present name. In this group, this form has the longest appendages which are somewhat undulately curved but never abruptly bent.

In the form on *Fraxinus japonica* (Mt. Hayachine, Prov. Rikuchu, Sept. 7, 1920, K. TOGASHI), the fungus is very small in all points, the perithecia being 84 μ in diameter, and the appendages only 4 in number. This form may better be treated as var. *minor* HOMMA.

Uncinula Miyabei (SALM.) SACC. & SYD.

(Pl. IX, figs. 15, 16)

SACC. Syll. Fung. XVI, p. 401, 1902. (SHIRAI, List, p. 102, 1905; SALM. Ann. Myc. III, p. 253, 1905, and Ann. Myc. VI, p. 12, 1908; SYD. Ann. Myc. VII, p. 170, 1909, and Ann. Myc. XI. p. 114, 1913; IDETA, Jap. Phytopath. p. 214, 1911, and Jap. Phytopath. (Suppl. I) p. 214, 1923; SAWADA, Agric. Exp. Stat. Formosa, Bull. IX, p. 69, 1914; SHIRAI & MIYAKE, List, p. 677, 1917; HARA, Dendropath. p. 23, 1923; SHIRAI & HARA, List, p. 402, 1927).

Syn. *Uncinula Salicis* (DC.) WINT. var. *Miyabei* SALM. Monogr. Erysiph. p. 88, 1900. (SALM. Bull. Torr. Bot. Club, XXVII, p. 447, 1900; SHIRAI, List, p. 103, 1905; SHIRAI & MIYAKE, List, p. 679, 1917).

Uncinula Miyabei SALM. Bull. Torr. Bot. Club, XXIX, p. 97, 1902. (MATSUM. Ind. Plant. Jap. I, p. 178, 1904).

Amphigenous, mycelium evanescent or subpersistent, forming thin effused film; conidia solitary, cylindrical, vacuolate, 26.4–31.2 × 10.8–12.4 μ; perithecia gregarious or scattered, depressed-globose, 98.4–127.2 μ in diameter; cells 10.8–14.4 × 9.5–12.0 μ in size; appendages 13–31 in number, 112–168 μ long, simple, usually aseptate or occasionally uniseptate at the base, straight or frequently 1–3 times flexuous or abruptly bent in the upper half, rarely dichotomous, hyaline or pale brown colored toward the base, thin-walled, enlarged upwards, apex uncinate; asci 4–11, globose or broadly ovate, with or without stalk, 43.2–66.0 × 36.0–51.6 μ; spores 5–6 in number, subglobose or ellipsoidal, including the well-developed fibrosin bodies, 18.0–26.4 × 10.8–15.6 μ.

Hab. On leaves of *Alnus cylindrostachys* MAKINO (Miyama-kawara-hannoki). Honshu—Musashi.

On *Alnus pendula* MATSUM. (Hime-yashabushi). Honshu—Inaba.

On *Alnus hirsuta* TURCZ. (Ke-yama-hannoki). Hokkaido—Ishikari. Honshu—Rikuchu, Echigo.

On *Alnus hirsuta* TURCZ. var. *sibirica* SCHNEID. (Yama-hannoki). Hokkaido—Iburi. Honshu—Musashi, Echigo, Kaga.

On *Alnus japonica* SIEB. & ZUCC. (Hannoki). Hokkaido—Shiribeshi, Ishikari. Honshu—Rikuchu, Ugo, Musashi, Echigo, Etchu, Kaga.

On *Alnus japonica* SIEB. & ZUCC. var. *arguta* CALL. (Yezo-hannoki). Hokkaido—Ishikari.

On *Tilia japonica* SIMK. (Shinanoki). Hokkaido—Ishikari.

On *Tilia Maximowicziana* SHIRASAWA (Ohba-bodaiju). Hokkaido—Ishikari.

Distrib. Japan (Hokkaido and Honshu) and Manchuria.

Remarks. The present species was first regarded by SALMON as a variety of *Uncinula Salicis* under the name of var. *Miyabei* SALM. Afterward SACCARDO and SYDOW elevated it to specific rank. In this species compared with *U. Salicis*, the appendages of the perithecium are flexuous and frequently abruptly bent, and rarely dichotomous, also the number of the appendages is generally less. In form the appendages are rather related to *U. Mori* and *U. geniculata*. In *U. Mori*, the appendages are regularly flexuous and their apices more narrowed and smaller. From *U. geniculata*, *U. Miyabei* differs by the less geniculate appendages.

Uncinula Mori I. MIYAKE

(Pl. IX, fig. 17)

Bot. Mag. Tokyo, XXI, p. 1, 1907; SACC. Syll. Fung. XXII, p. 23, 1910. (IDETA, Jap. Phytopath. p. 213, 1911; I. MIYAKE, Bot. Mag. Tokyo, XXVI, p. 53, 1912, and Rep. Sericult. Exp. Stat. I, p. 307, 1916; SHIRAI & MIYAKE, List, p. 677, 1917; SHIRAI & HARA, List, p. 402, 1927).

Epiphyllous, rarely hypophyllous, mycelium subpersistent or evanescent, thinly effused forming roundish patches on the upper surface of the leaves; perithecia scattered or gregarious, 100–112 μ in diameter, globose or depressed-globose; cells 15.6–19.2 × 12.0–14.4 μ in size; appendages 16–22 in number, simple, hyaline, 126–168 μ long, flexuous and abruptly bent at the upper portion, thick-walled toward the base, apex narrowed, circinate or uncinate; asci 2–6 in number, globose or subglobose, granulate, without stalk, 50.4–55.2 × 38.4–45.6 μ; spores 3–5, usually 5, ellipsoidal or elongate-ellipsoidal, granulate, 24.0–27.6 × 13.2–14.4 μ.

Hab. On leaves of *Morus bombycis* KOIDZ. (Yama-guwa). Hokkaido—Ishikari, Kushiro. Honshu—Musashi, Echigo, Kaga, Inaba. Shikoku—Tosa.

Distrib. Japan (Hokkaido, Honshu and Shikoku).

Remarks. This species is parasitic usually on the upper surface of the leaves of Morus, but sometimes on the edges of the under-surface too. The mycelial hyphae are thinly effused in a cobweb manner. This species is nearly related to *U. Miyabei*, but differs from it by the appendages being regularly flexuous and fewer in number, and the circinate part being narrower and smaller.

Uncinula Nishidana HOMMA, sp. nov.

(Pl. IX, fig. 18)

Amphigena, plerumque epiphylla; mycelio epiphyllo persistente; peritheciis gregariis, 98–126 μ. diam., globosis v. globoso-depressis, nigris, cellulis obscuris, 16.0–24.0 × 12.0–16.8; appendicibus paucis, 9–13, hyalinis, continuis, 84–120 μ. longis, superne flexuosis, granulatis, apice summo plerumqua uncinatis, raro circinatis; ascis 3–4 in quoque perithecio, late ellipsoideis, brevissime pedicellatis, 51.6–62.4 × 36.0–45.6, 4–5-sporis; sporidiis ellipsoideis v. ovatis, 19.2–25.2 × 12.0–14.4.

Hab. On leaves of *Sterculia platanifolia* L. (Aogiri)

Kyushu—Prov. Higo: Kumamoto (Nov. 3, 1924, S. MIYAMOTO, type); Prov. Osumi: Kanoya (Oct. 1, 1907, Oid. K. YOSHINO).

Distrib. Japan (Kyushu).

Remarks. This species is closely related to *Uncinula Mori* and *U. Miyabei* in respect to the appendages being flexuous and frequently abruptly bent in the upper half. But, in this species the appendages are less in number and shorter, the asci and ascospores are smaller, the appendages are the same in width throughout, and the outer wall cells of the perithecium are comparatively larger. The present species was named after the late Dr. T. NISHIDA, who had made a great contribution to the Mycological Flora of Kyushu.

Uncinula necator (SCHWEIN.) BURR.

in ELL. & EVERH. N. Amer. Pyren. p. 15, 1892; MAGNUS, Erysiph. Tirol. p. 22, 1898; SALM. Monogr. Erysiph. p. 99, 1900, and Bull. Torr. Bot. Club, XXIX, p. 99, 1902; LIND, Danish Fung. p. 164, 1913; KLIKA, Erysiph. Czechosl. p. 50, 1924; ŠKORIĆ, Erysiph. Croat. p. 41, 1926. (RANOJ. Hedw. XLI, p. 102, 1902; MATSUM. Ind. Plant. Jap. I, p. 178, 1904; SHIRAI, List, p. 103 (p.p.), 1905; SALM. Ann. Myc. III, p. 253, 1905; LAWR. Journ. Myc. XI, p. 108, 1905; YOSHINO, Bot. Mag. Tokyo, XIX, p. 206, 1905; IDETA, Jap. Phytopath. p. 206, 1911; SAWADA, Agric. Exp. Stat. Formosa, Bull. IX, p. 67, 1914, and XIX p. 177, 1919; DOIDGE, Roy. Soc. South Afr. V, p. 240, 1915; SHIRAI & MIYAKE, List, p. 677, 1917; SHIRAI & HARA, List, p. 403, 1927).

Syn. *Erysiphe necator* SCHWEIN. Syn. Fung. Am. Bor. p. 270, 1834; SACC Syll. Fung. I. p. 22, 1882.

Erysiphe Tuckeri BERK. Journ. Hort. Soc. London, IX, p. 66, 1855; KICKX, Crypt. Fl. Fland. I, p. 382, 1867; DE BARY, Beitr. Morph. Phys. Pilz, I, xiii, p. 50, 1870; SACC. Syll. Fung. I, p. 20, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 34, 1884. (SHIRAI, List, p. 32, 1905; SHIRAI & MIYAKE, List, p. 227, 1917).

Sphaerotheca Castagnei v. *Vitis* FUCK. Symb. Myc. p. 79, 1869–70.

Uncinula ampelopsidis PECK, Trans. Albany Inst. VII, p. 216, 1872; SACC. Syll. Fung. I, p. 7, 1882; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 406, 1887. (TRACY & GALLOW. Journ. Myc. IV, p. 35, 1888; PAMM. Journ. Myc. IV, p. 37, 1888).

Uncinula americana E. C. HOWE, Journ. Bot. II, p. 170, 1872; SACC. Syll. Fung. I, p. 8, 1882; PRILL. Malad. Pl. Agr. II, p. 17, 1897. (SHIRAI, List, p. 102, 1905; SHIRAI & MIYAKE, List, p. 673, 1917).

Erysibe Tuckeri (BERK.) SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 241, 1893.

Uncinula spiralis BERK. & CURT. Grev. IV, p. 159, 1876; JACZEW. Bull. l'Herb. Boiss. IV, p. 739, 1896. (COOKE & PECK, Journ. Bot. I, p. 170, 1872; SHIRAI, List, p. 103, 1905; SHIRAI & MIYAKE, List, p. 679, 1917).

Oidium Tuckeri BERK. Garden. Chron. p. 779, 1847; SACC. Syll. Fung. IV, p. 41, 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 84, 1907.

Amphigenous, usually epiphyllous, mycelium persistent on the upper leaves sometimes on the inflorescences or young fruits; "perithecia usually epiphyllous, sometimes hypophyllous, occasionally occurring on the inflorescence, globose-depressed, more or less scattered, 70–128 μ in diameter, averaging 98 μ, cells distinct, rather irregular in shape, 10–20 μ wide, appendages very variable in number and length, 7–32, rarely irregularly crowded and as many as 40, 1–4 times the diameter of the perithecium, smooth, simple, septate, thin-walled, light or dark amber-brown in the lower half, flexuous and flaccid when long, subrigid and straight when shorter, apex more or less helicoid when mature, often strongly so; asci 4–6, rarely 6–9, broadly ovate or ovate-oblong to subglobose, with or without a short stalk, 50–60 × 30–40 μ; spores 4–7, 18–25 × 10–12 μ." (acc. to SALMON, Monogr. Erysiph. p. 99).

Hab. On leaves of *Vitis vinifera* L. (Seiyo-budo). Honshu—Kai, Settsu. Kyushu—Higo.

On *Ampelopsis heterophylla* SIEB. & ZUCC. (Nobudo). Hokkaido—Ishikari.

Distrib. Japan (Hokkaido, Honshu, Kyushu and Formosa), Manchuria, North America, Europe and South Africa.

Remarks. The writer unfortunately could not find the perithecial stage of *U. necator* in Japan, although the conidial stage has been collected in different parts of this country.

Oidium belonging to Uncinula

On *Rosa indica* L. var. *formosana* HAY. (Koshin-bara). *Oidium Rosae-indicae* SAW. (According to SAWADA, Depart. Agr. Govern. Research Inst. Formosa, Japan, No. 61, p. 82, 1933).

On *Alangium platanifolium* BAILL. var. *macrophyllum* WAG. (Urinoki). Honshu—Musashi.

On *Cephalanthus occidentalis* L. (Tamagasanoki). *Oidium Cephalanthi* SAW. (According to SAWADA, Depart. Agr. Govern. Research Inst. Formosa, Japan, No. 61, p. 81, 1933).

Typhulochaeta S. ITO & HARA

Mycelium is superficial, haustoria are epidermal and subglobose in shape; perithecia are globose or depressed-globose, including several asci in a perithecium; appendages are simple and clavate in shape. The genus is represented by only one species.

Typhulochaeta *japonica* S. ITO & HARA

(Pl. IX, fig. 19)

Bot. Mag. Tokyo, XXIX, p. 20, 1915, and Trans. Sapporo Nat. Hist. Soc. V, p. 198, 1915; HARA, Journ. Forest. Assoc. Japan, No. 392, p. 61, 1915; SACC. Syll. Fung. XXIV, p. 226, 1926. (HARA, Dendropath. p. 24, 1923; IDETA, Jap. Phytopath. (Suppl. I), p. 216, 1923; SHIRAI & HARA, List, p. 401, 1927).

Amphigenous, usually hypophyllous, mycelium persistent or subevanescent, forming thin effused film; perithecia scattered or subgregarious, globose or depressed-globose, 154–182 μ in diameter; cells 9.6–12.0 μ in width; appendages springing from the upper part of the perithecium from a broad coronate ring composed of two or three rows, 96–142 in number, about 50–63 μ in length, 12–15 μ in width, hyaline, clavate, simple, rounded at apex, thick-walled; asci 5–13, ovate or ellipsoidal, stalked, 70.0–97.0 × 33.6–55.0 μ; spores 8, rarely 6, oblong or ellipsoidal, 19.2–36.0 × 12.0–18.0 μ.

Hab. On leaves of *Quercus aliena* BLUME (Nara-gashiwa). Kyushu—Higo.

On *Quercus crispula* BLUME (Mizu-nara). Honshu—Rikuchu, Echigo.

On *Quercus serrata* THUNB. (Ko-nara). Honshu—Suruga, Mino, Totomi, Yamashiro. Kyushu—Higo.

On *Fraxinus japonica* BLUME (Toneriko). Honshu—Totomi.

Distrib. Japan (Honshu and Kyushu).

Remarks. The present genus was first described in 1915 by Prof. S. ITO. By the clavate appendages of the perithecium it can be distinguished from all other genera of Erysiphaceae, moreover these appendages spring from the upper part of the perithecium in the form of a broad coronate band composed of 2–3 rows. According to Prof. ITO, the appendages "are simple and clavate in shape, with a close resemblance to the fructification of a species belonging to the genus Typhula of Basidiomycetes in their outlines, and also to the immature stage of the penicillate cells of Phyllactinia". The penicillate cells of Phyllactinia are also produced on the upper part of the perithecium forming a coronate ring composed of one to three rows, but always accompanied by the appendages. In the present genus, the appendages are constant in shape, being clavate and simple, never producing the penicillate bodies.

Quercus crispula, Q. aliena and *Fraxinus japonica* were added as new hosts to this species.

In order to collect the conidia of this species, in the early part of August in 1930, the writer made a collecting trip to Shizuoka Prefecture, where this fungus was collected in the previous year by Mr. HARA. But no conidial formation could be found except a white thin effused mycelial film on the leaves of *Quercus serrata*. In September of the same year Mr. HARA kindly sent a specimen which was found to be also in the mycelial stage. Thus, the conidial stage of this species is still lacking.

Sawadaea MIYABE

Mycelium is superficial, forming haustoria in the epidermal cells of the host plants; matured conidia are produced in a chain, including well-developed fibrosin bodies; perithecia are depressed-globose or concave, including several asci; appendages spring from the upper part of the perithecium and are simple or dichotomously branched, sometimes trichotomously, and are colorless and thick-walled.

In 1914, this genus was separated from Uncinula by MIYABE under a new generic name of Sawadaea. It was first published by SAWADA, in Agric. Exp. Stat. Formosa, Spec. Bull. IX, p. 49. (in Japanese). The original description is as follows:

Amphigenous, mycelium superficial, more or less persistent, white powdery at first and finally turning to a grayish color, sending haustoria into epidermal cells, globose in shape; conidia have both stages of micro- and macro- forms, conidiophores straight, branching from the creeping mycelium, at the branching point swelling a little, conidia produced in a chain, including fibrosin bodies, elongate-octahedron in shape; perithecia depressed-globose, numerous appeandages arise from the upper part of the perithecium, hyaline, straight, dichotomously or trichotomously branched or simple, apex helicoid, asci numerous, spores 8, elongate-ellipsoidal.

In the conidial stages the present genus comes closer to Podosphaera than to Uncinula. In the perithecial stages it nearly resembles Uncinula, from which it differs by the appendages arising from the upper part of the perithecium and being dichotomously or trichotomously branched.

In the present genus, the most important point of distinction from genus Uncinula is in the character of the appendages of the perithecium which are regularly dichotomously branched while the appendages of the species of Uncinula are rarely irregularly branched.

This genus includes 3 species in this country.

Key to the species of the genus Sawadaea

I. Appendages always dichotomously or trichotomously branched and simple appendages very few .... *S. bicornis* (371)
II. Appendages dichotomously or trichotomously branched to $\frac{2}{3}$ of all numbers in a perithecium and others simple.
    1. Mycelium persistent, densely thickened .... *S. Tulasnei* (374)
    2. Mycelium evanescent, thinly effused .... *S. Negundinis* (375)

Sawadaea bicornis (WALLR.) MIYABE nom. nov.

(Pl. IX, fig. 20)

Syn. *Erysiphe aceris* DC. Syn. Pl. Fl. Gall. p. 57, 1806, and Fl. Fr. VI. p. 104, 1815; MÉRAT, Nouv. Fl. Paris, p. 75, 1837, and Syn. Nouv. Fl. Paris p. 84, 1837; TULASNE, Selecta Fung. Carpolog. I, p. 197, 1861; DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 52, 1870.

Erysiphe varium FR. Obs. Myc. I, p. 206 (p.p.), 1815.

Alphitomorpha bicornis WALLR. Berl. Ges. Nat. Freund. Verh. I, p. 38, 1819.

Erysibe bicornis LK. in WILLD. Sp. Pl. VI, p. 112, 1824; RABENH. Deutschl. Krypt. Fl. I, p. 235, 1844.

Erysiphe bicornis FR. Syst. Myc. III, p. 244 (p.p.), 1829; CORDA, Icon. Fung. II, p. 28, 1838.

Uncinula Aceris SACC. Syll. Fung. I, p. 8, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 41, 1884; ELL. & EVERH. N. Amer. Pyren. p. 17, 1892; SCHRÖT. in COHN's Crypt. Fl. Schles. III, p. 246, 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 738, 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 88, 1897; MAGNUS, Erysiph. Tirol. p. 21, 1898; SALM. Monogr. Erysiph. p. 90 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 97, 1902; NEGER, Krypt. Fl. d. Mark Brand. VII, p. 131, 1905; KLIKA, Erysiph. Czechosl. p. 49, 1924; JØRST. Erysiph. Norway, p. 101, 1925; ŠKORIĆ, Erysiph. Croat. p. 41, 1926. (SALM. Ann. Myc. VI, p. 12, 1908; RANOJ. Hedw. XLI, p. 102, 1902; SHIRAI & MIYAKE, List, p. 673 (p.p.), 1917).

Uncinula bicornis LÉV. Ann. Sci. Nat. III, 15, p. 153 (p.p.), 1851; KICKX, Fl. Crypt. Fland. I, p. 377, 1867; COOKE, Handb. Brit. Fung. II, p. 647, 1871; QUÉL. Champ. Jur. Vosg. p. 533, 1875; LIND, Danish Fung. p. 164, 1913. (FUCK. Symb. Myc. p. 80, 1869–70).

Oidium Aceris RABENH. Flora, XXXVII, p. 207, 1854; SACC. Syll. Fung. IV, p. 44, 1886; LIND. in RABENH. Krypt. Fl. Deutschl. VIII, p. 81, 1907.

Amphigenous, mycelium evanescent; perithecia scattered, 175–196 μ in diameter, depressed-globose; cells 10.8–12.0 × 7.2–8.4 μ; appendages numerous, about 126–140 μ in length, hyaline, aseptate, thick walled throughout, bifurcate at the upper half or rarely trifid, very few simple (2 or 3 in a perithecium), apex uncinate or helicoid; asci about 14 in number, ellipsoidal or elongate-ellipsoidal, with or without stalk, 66.4–81.6 × 38.4–44.4 μ; spores 8, elongate-ellipsoidal or elongate-ovate, 16.8–26.4 × 12.0–14.4 μ.

Hab. On leaves of *Acer cissifolium* C. KOCH. (Mitsuba-kaede). Honshu—Rikuchu.

Distrib. Japan (Honshu), Transcaucasia and Europe.

Remarks. This species can be distinguished from others at once by the appendages which are almost all dichotomous or trichotomous, and also by the mycelium which becomes evanescent when the perithecia are produced on the leaves. According to SALMON's description in *Uncinula Aceris* "mycelium evanescent or persistent as a thin effused film; appendages usually a very few simple, the rest bifid" and in *Uncinula Aceris* var. *Tulasnei* "mycelium usually epiphyllous, very rarely amphigenous, persistent, densely compacted, forming either roundish circumscribed spots or irregular blotches following the veins of the leaf; appendages simple or bifid (usually mostly simple, inter-mixed with a few bifid ones)".

In the fungus which has been known as *Sawadaea Aceris* MIYABE the mycelium is very densely compacted and persistent, and the simple appendages exist to more than $\frac{1}{3}$ of the total number in a perithecium; therefore, these specimens must be transferred to *Sawadaea Tulasnei* HOMMA. In 1908, the form on *Acer cissifolium* was described as *Uncinula Aceris* by SALMON. (Ann. Myc. VI, p. 12). This specimen evidently belongs to *Sawadaea Aceris,* as the mycelium is evanescent when the perithecia are formed, the simple appendages are only 2 or 3 in a perithecium and the size of the asci is larger than in *Sawadaea Tulasnei.*

The writer paid special attention to the presence of the micro- and macro-conidia in Sawadaea and Uncinula parasitic on Acer. On *U. circinata* and *S. Aceris,* the micro-conidia have not been observed up to the present time. *Oidium Aceris* RABENH. is a macro-form from its shape and size, and it belongs to the conidial stage of *U. Aceris* judging by its host plant and symptom. On the other hand, as the result of the examination of many exotic herbarium specimens of *U. circinata* from America and *U. Aceris* from Europe, it was found that they all have macro-conidia in concatenate chain, while the micro-conidia could not be found in spite of careful observation. In *S. Tulasnei* both forms of conidia have hitherto been reported by many authors, and have also been observed in many Japanese specimens.

The form on *Acer cissifolium* is the typical *Sawadaea Aceris,* but this specific name was proved to be a synonym of *Sawadaea Tulasnei.* Therefore, the next older name was used for this species.

Sawadaea Tulasnei (FUCK.) HOMMA, comb. nov.

(Pl. IX, fig. 21)

Syn. *Erysiphe bicornis* FR. Syst. Myc. III, p. 244 (p.p.), 1829.

Uncinula bicornis LÉV. Ann. Sci. Nat. III, 15, p. 135 (p.p.), 1851.

Uncinula Tulasnei FUCK. Fung. Rhenani exsiccati, No. 1746, 1866, and Symb. Myc. p. 81, 1869–70; SACC. Syl. Fung. I, p. 9, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 41, 1884; JØRST. Erysiph. Norway, p. 102, 1925.

Uncinula Aceris (not SACC.) SALM. Monogr. Erysiph. p. 90 (p.p.), 1900. (SALM. Bull. Torr. Bot. Club, XXVII, p. 446, 1900, and Ann. Myc. III, p. 252, 1905; P. HENN. in ENGL. Bot. Jahrb. XXXII, p. 42, 1903; NAMBU, Bot. Mag. Tokyo, XVIII, p. 2, 1904; MATSUM. Ind. Plant. Jap. I, p. 178, 1904; SHIRAI, List, p. 102, 1905; IDETA, Jap. Phytopath. p. 214, 1911; SYDOW, Ann. Myc. XI, p. 114, 1913; SHIRAI & MIYAKE, List, p. 673 (p.p.), 1917).

Sawadaea Aceris MIYABE, in SAWADA, Agric. Exp. Stat. Formosa, Bull. IX, p. 50, 1914. (HARA, Dendropath. p. 9, 1923; IDETA, Jap. Phytopath. (Suppl. I), p. 209, 1923; SHIRAI & HARA, List, p. 350, 1927).

Uncinula Aceris SACC. var. *Tulasnei* SALM. Monogr. Erysiph. p. 93, 1900; KLIKA, Erysiph. Czechosl. p. 50, 1924. (I. MIYAKE, Bot. Mag. Tokyo, XXVIII, p. 39, 1914).

Amphigenous, mostly epiphyllous, mycelium persistent, in densely compacted patches having a white or grayish color with a silky lustre, especially growing in a net-work manner on the veinlets of the leaf; matured conidia produced in a chain, including well-developed fibrosin bodies, macro-conidia ellipsoidal, 21.6–30.0 × 13.2–18.0 μ, micro-conidia globose or subglobose, 7.2–9.6 × 7.2–8.4 μ; perithecia depressed-globose or lenticular, 154–189 μ in diameter; cells 12.6–16.8 ×9.6–12.0 μ in size; appendages numerous (about 70), 69.6–91.2 μ in length, aseptate, colorless, simple or dichotomous, rarely trichotomous, apex uncinate or helicoid, thick-walled; asci 8–15 in number, subtriangular or ovate, with a short stalk, 64.8–76.8 × 34.8–39.6 μ; spores 7–8 in number, usually 8, oblong or ellipsoidal, 12.0–19.2 × 10.8–13.2 μ.

Hab. On leaves of *Acer crataegifolium* SIEB. & ZUCC. (Urikaede). Honshu—Echizen.

On *Acer Miyabei* MAXIM. (Kurobi-itaya). Hokkaido—Ishikari.

On *Acer Mayrii* GRAF. v. SCHW. (Beni-itaya). Hokkaido—Ishikari, Kushiro.

On *Acer palmatum* THUNB. (Yama-momiji). Hokkaido—Ishikari. Honshu—Rikuchu, Musashi, Echigo. Kyushu—Satsuma.

On *Acer pictum* THUNB. (Itaya-kaede). Hokkaido—Shiribeshi, Iburi, Ishikari, Hidaka, Kushiro. Honshu—Rikuchu, Rikuzen, Shimozuke, Musashi, Yamashiro.

On *Acer ukurunduense* TRAUTV. & MEY. (Ogarabana). Hokkaido—Ishikari.

Distrib. Japan (Hokkaido, Honshu, Kyushu and Formosa), Manchuria and Europe.

Remarks. The fungus which occurs on *Acer Miyabei*, *A. palmatum* and *A. pictum* has hitherto been identified to *Sawadaea Aceris*, but the author thinks it had better be changed to *Sawadaea Tulasnei* for the following reason.

The mycelium of the fungus in question has a white silvery lustre, presenting dense meshes along the veinlets of the leaf, the simple appendages are from $\frac{1}{2}$ to $\frac{1}{3}$ of the total number in a perithecium and the size of the asci is smaller than in the case of *Sawadaea bicornis*.

Uncinula Tulasnei was treated as a variety of *U. Aceris* by SALMON, but from the above characters, the present author has come to the conclusion that it had better be elevated to specific rank rather than to be considered as a variety.

The present species has conidia of both types of micro- and macro-forms; the macro-conidia occur in early July and the micro-conidia arise on the same leaves in late August, in the vicinity of Sapporo. After August, the macro-conidia disappear and the micro-conidia are abundantly produced on the leaves. The macro-conidial stage presents a powdery white appearance, and the micro-conidial stage a shining white and compactly smooth appearance, so that one can easily distinguish the two stages with the naked eye.

The perithecia of this fungus have a peculiar character of turning over when mature.

The present species is a most common powdery mildew on Acer in this country, and is very widely distributed.

Sawadaea Negundinis HOMMA, sp. nov.

(Pl. IX, fig. 22)

Amphigena, plerumque hypophylla; mycelio tenui evanido v. effuso-subpersistente; peritheciis magnis, sparsis v. subgregariis.

globosis v. globoso-depressis, 140–182 μ. diam., cellulis 4.8–9.6 μ. diam.; appendicibus 68–90, hyalinis, crassius tunicatis, 72–90 μ. longis, continuis, dichotome v. raro trichotome ramosis v. simplicibus, apice uncinatis v. helicoideis; ascis 6–16 in quoque perithecio, ovatis v. triangularibus, 51.6–67.2 × 33.6–43.2, cum v. sine brevi pedicello, 7–8-sporis; sporidiis subglobosis, ellipsoideis v. reniformis, 16.8–19.2 × 8.4–13.2; conidiis 3–4 concatenatis, intus fibrosin-corpuscula et granula nitida, pallide viridi-gilva continentibus, macro-conidiis ellipsoideis v. oblongo-ellipsoideis, 25.2–32.4 × 16.8–18, micro-conidiis globosis v. subglobosis, 7.2–8.6 × 5.6–7.2.

Hab. On leaves of *Acer Negundo* L. (Toneriobano-kaede)

Hokkaido—Prov. Ishikari: Sapporo (July 21, 1922, Y. HOMMA; Sept. 8, 1922, Y. HOMMA; Sept. 18, 1922, S. ITO; Oct. 5, 1922, Y. HOMMA; Oct. 21, 1922, Y. HOMMA, type; Oct. 4, 1923, Y. HOMMA; Sept. 9, 1924, Y. HOMMA); Maruyama (Oct. 24, 1929, M. TERUI; Oct. 25, 1930, Y. HOMMA); Shinotsumura (Sept. 11, 1933, K. YOSHINO).

Distrib. Japan (Hokkaido).

Remarks. This species has been collected only in the vicinity of Sapporo on the introduced American ash-leaved maple. The author at first identified it as *Sawadaea Aceris*. However, she has found on careful examination that although the mycelium is thin as in that species, the size of the asci and ascospores are smaller and the character of the appendages approaches nearer to that of *Sawadaea Tulasnei;* micro-conidia are present also.

As to the relation to *Sawadaea Tulasnei,* the mycelium of that species is mostly epiphyllous, and densely shining white, while in the present species the mycelium is usually hypophyllous, thinly effused, and the simple appendages reach to about a half of the whole number on a perithecium.

As the result of careful observations, the present fungus could be identified neither to *S. Aceris* nor *S. Tulasnei,* therefore it must be considered as a new species.

Microsphaera LÉV.

Mycelium is superficial, sending haustoria into the epidermal cells of the host plants; haustoria are globose or subglobose in shape;

matured conidia are solitary, almost ellipsoidal in shape, including vacuoles and granules, without well developed fibrosin bodies; perithecia are globose or depressed-globose, always small-sized; appendages are dichotomously branched at the apex; asci and ascospores are several.

This genus can be divided into two sections of *Alni* and *Diffusa*. In the former, the tips of the ultimate branches of appendages are recurved, and in the latter straight and not recurved.

In Japan, 17 species of this genus have been found. Among them 4 species are new to science.

Key to the species of the genus Microsphaera

I. Alni section.
Tips of the ultimate branches of appendages recurved.
- A. Appendages short and regularly branched.
  - a. Primary dichotomous branches of appendages straight.
    - 1. Appendages very regularly 5–6 times dichotomously branched and branches similar in length. Conidia ellipsoidal..*M. Alni* (378)
    - 2. Appendages frequently trichotomously branched .... *M. calocladophora* (382)
    - 3. Inner secondary branches of the appendages generally pointed in the same direction as the primary. Conidia ellipsoidal or barrel-shaped.................... *M. alphitoides* (383)
  - b. Primary dichotomous branches of appendages more or less recurved.
    - 1. Primary branches divided frequently at about the middle or near the base of the appendages............... *M. Ligustri* (386)
    - 2. Primary branches divided always at the apical portion .... *M. divaricata* (387)
- B. Appendages long and flaccid, more or less irregularly branched.
  - a. Appendages more or less regularly branched. Perithecia 112—140μ in diameter and appendages 196—238μ in length .... *M. Coryli* (388)
  - b. Appendages irregularly branched.
    - 1. Perithecia 91—126μ in diameter and appendages 84—175μ in length...................................... *M. Yamadai* (390)
    - 2. Perithecia 91—112μ in diameter and appendages very long and flexuous, 336—434μ in length........... *M. Euphorbiae* (391)

II. Diffusa section.
Tips of the ultimate branches of the appendages not recurved.
- A. Primary branches long.
  - a. Appendages long and twice to sevenfold the diameter of the perithecia.
    - 1. Appendages 128—308 μ in length, light brown colored toward the base..*M. Abeliae* (392)
    - 2. Appendages about 350—500 μ in length, colored throughout nearly to the apex............................ *M. Russellii* (401)
  - b. Appendages short and about the same as the diameter of the perithecia or slightly longer.
    - 1. Tips of ultimate branches rarely recurved, appendages 126—140 μ in length...............................*M. Lonicerae* (392)
    - 2. Tips of ultimate branches straight, appendages 126—161 μ in length...............................*M. pseudo-Lonicerae* (393)
- B. Secondary branches long.
  - a. Tips of ultimate branches more or less narrowed.
    - 1. Branches of the higher order thick.......... *M. Berberidis* (394)
    - 2. Branches of the higher order slender...... *M. Grossulariae* (396)
  - b. Tips of ultimate branches cylindrical.
    - 1. Appendages 5–6 times dichotomously branched...*M. diffusa* (398)
    - 2. Appendages 2–3 times dichotomously branched..*M. Bäumleri* (399)
- C. Primary branches divided in the lower half of the appendages and irregularly 2–3 times dichotomously branched....*M. Viciae-unijugae* (400)

Microsphaera Alni (WALLR.) SALM.

(Pl. X, figs. 1–7)

Monogr. Erysiph. p. 129 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 105 (p.p.), 1902; TAI & WEI, Sinensia, III, p. 116 (p.p.), 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 444 (p.p.), 1900, Ann. Myc. III, p. 250 (p.p.), 1905, and VI, p. 8 (p.p.), 1908; NAMBU, Bot. Mag. Tokyo, XVIII, p. 3, 1904; MATSUM. Ind. Plant. Jap. I, p. 154 (p.p.), 1904; SHIRAI, List, p. 55 (p.p.), 1905; YOSHINO, Bot. Mag. Tokyo, XIX, p. 205, 1905; IDETA, Jap. Phytopath. p. 205 (p.p.), 1911, and Jap. Phytopath. (Suppl. I), p. 211 (p.p.), 1923; SYD. Ann. Myc. XI, p. 114 (p.p.), 1913; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 61 (p.p.), 1914; I. MIYAKE, Bot. Mag. Tokyo, XXVIII, p. 39 (p.p.), 1914; SHIRAI & MIYAKE, List, p. 365 (p.p.), 1917; HARA, Dendropath. p. 11 (p.p.), 1923; SHIRAI & HARA, List, p. 215 (p.p.), 1927).

Syn. *Alphitomorpha penicillata* var. *Alni* WALLR. Berl. Ges. Nat. Freund. I, p. 40, 1819.

Alphitomorpha Alni WALLR. Ann. Wett. Ges. IV, p. 237, 1819.

Erysibe penicillata a *Alni* LINK, in Willd. Sp. Pl. VI, p. 113 (p.p.), 1824; MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837, and Syn. Nouv. Fl. Paris, p. 84 (p.p.), 1837; RABENH. Deutschl. Krypt. Fl. I, p. 236 (p.p.), 1844.

Erysiphe penicillata FR. Syst. Myc. III, p. 243 (p.p.), 1829.

Erysiphe Viburni SCHWEIN. Syn. Fung. Am. Bor. p. 269, 1834; SACC. Syll. Fung. I, p. 21, 1882.

Erysiphe Syringae SCHWEIN. Syn. Fung. Am. Bor. p. 270, 1834; SACC. Syll. Fung. I, p. 21, 1882.

Microsphaera Hedwigii LÉV. Ann. Sci. Nat. III, 15, p. 155, 1851; FUCK. Symb. Myc. p. 81, 1869–70; COOKE, Handb. Brit. Fung. II, p. 648, 1871; COOKE & PECK, Journ. Bot. I, p. 12 (p.p.), 1872; SACC. Syll. Fung. I, p. 11, 1882; OUDEM. Rév. Champ. Pays-Bas, II, p. 90, 1897.

Microsphaera penicillata LÉV. Ann. Sci. Nat. III, 15, p. 155, 1851; KICKX, Fl. Crypt. Fland. I, p. 378, 1867; FUCK. Symb. Myc. p. 81, 1869–70; COOKE, Handb. Brit. Fung. II, p. 649, 1871; SACC. Syll. Fung. I, p. 13 (p.p.), 1882; OUDEM. Rév. Champ. Pays-Bas, II, p. 92, 1897.

Microsphaera Friesii LÉV. Ann. Sci. Nat. III, 15, p. 156, 1851; COOKE & PECK, Journ. Bot. I, p. 12, 1872; SACC. Syll. Fung. I, p. 13, 1882. (TRACY & GALLOW. Journ. Myc. IV, p. 35, 1888).

Erysiphe Alni (not DC.) TULASNE, Selecta Fung. Carpolog. I, p. 203, 1861.

Microsphaera pulchra COOKE & PECK, Journ. Bot. I, p. 12, 1872; SACC. Syll. Fung. I, p. 12, 1882.

Microsphaera penicillata LÉV. var. *Alni* COOKE & PECK, Journ. Bot. I, p. 171, 1872.

Microsphaera sparsa HOWE, in COOKE & PECK, Journ. Bot. I, p. 171, 1872.

Microsphaera Platani HOWE, Bull. Torr. Bot. Club, V, p. 4, 1874; SACC. Syll. Fung. IX, p. 369, 1891.

Microsphaera Viburni HOWE, Bull. Torr. Bot. Club, V, p. 43, 1874; SACC. Syll. Fung. IX, p. 369, 1891.

Podosphaera Hedwigii QUÉL. Champ. Jur. Vosg. p. 534, 1875.

Podosphaera penicillata QUÉL. Champ. Jur. Vosg. p. 534, 1875.

Microsphaera Alni WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 38, 1884; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 421, 1887; ELL. & EVERH. N. Amer. Pyren. p. 27, 1892; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 244, 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 748, 1896; MAGNUS, Erysiph. Tirol. p. 20, 1898; Neger, Krypt. d. Mark Brand. VII, p. 125, 1905; KLIKA, Erysiph. Czechosl. p. 52, 1924; JØRST. Erysiph. Norway, p. 95, 1925; ŠKORIĆ, Erysiph. Croat. p. 53, 1926. (PAMM. Journ. Myc. IV, p. 38, 1888; TRACY and GALLOW. Journ. Myc. IV, p. 35, 1888; GRIFF. Bull. Torr. Bot. Club, XXVI, p. 144, 1899; P. HENN. in ENGL. Bot. Jahrb. XXXII, p. 42, 1903; LAWR. Journ. Myc. XI, p. 106, 1905).

Microsphaera Nemopanthis PECK, Reg. Rep. XXXVIII, p. 102, 1886; SACC. Syll. Fung. addit. ad Vols. I–IV, p. 2, 1886, and SACC. Syll. Fung. IX, p. 368, 1891.

Microsphaera japonica P. HENN. in ENGL. Bot. Jahrb. XXVIII, p. 271, 1901. (SHIRAI, List, p. 55, 1905; SHIRAI & MIYAKE, List, p. 367, 1917).

Microsphaera Alni (FRIES) WINT. in Lind, Danish Fung. p. 163, 1913.

Amphigenous, mostly hypophyllous, mycelium persistent or evanescent, at first forming irregular white patches or growing along the veins on the upper surface of the leaves; matured conidia solitary, ellipsoidal, vacuolate, granulate, 28.8–45.6 × 15.6–36.0 μ in size; perithecia gregarious or scattered, globose or depressed-globose, 86.4–130 μ in diameter; cells 14.4–19.2 × 9.6–14.4 μ in size; appendages 8–26 in number, aseptate or 1-septate, light brown colored toward the base or brown colored under the first septum, 81.6–154 μ in length, 7.2–9.6 μ in width, 4–6 times (usually 5) dichotomously branched, apex of the ultimate branches regularly and distinctly recurved; asci 3–8, oblong or subglobose, with or without a short stalk, 36.4–81.6 × 30.0–60.0 μ; spores 4–8, oblong or ellipsoidal, 14.4–26.4 × 8.4–14.4 μ in size.

Hab. On leaves of *Alnus hirsuta* TURCZ. (Ke-yama-hannoki). Hokkaido—Ishikari. Honshu—Rikuchu, Echigo.

On *Ostrya japonica* SARG. (Asada). Hokkaido—Ishikari.

On *Castanea crenata* SIEB. & ZUCC. (Kuri). Hokkaido—Oshima, Shiribeshi, Iburi, Ishikari, Kitami. Honshu—Rikuchu, Rikuzen, Musashi, Shimozuke, Echigo, Sado, Etchu, Tamba. Shikoku—Iyo. Kyushu—Buzen, Bungo. Korea—Suigen.

On *Syringa japonica* DECNE. (Hashidoi). Hokkaido—Iburi, Ishikari, Kushiro. Honshu—Echigo.

On *Berchemia racemosa* SIEB. & ZUCC. (Kuma-yanagi). Honshu—Rikuchu.

On *Akebia lobata* DECNE. (Mitsuba-akebi). Honshu—Mutsu, Rikuchu, Uzen.

On *Akebia quinata* DECNE. (Akebi). Honshu—Rikuchu, Musashi, Kaga.

On *Cocculus trilobus* DC. (Aotsuzurafuji). Honshu—Bizen.

On *Schizandra chinensis* BAILL. (Chosen-gomishi). Hokkaido—Oshima, Ishikari.

On *Schizandra nigra* MAXIM. (Matsubusa). Honshu—Rikuchu.

On *Lindera praecox* BLUME (Aburachan). Honshu—Rikuchu.

On *Picrasma quassioides* BENN. (Nigaki). Hokkaido—Shiribeshi, Ishikari. Honshu—Rikuchu, Musashi.

On *Staphylea Bumalda* SIEB. & ZUCC. (Mitsuba-utsugi). Honshu—Rikuchu.

On *Rhamnus dahurica* PALL. var. *nipponica* MAKINO (Ohkuroumemotogi). Honshu—Mutsu, Rikuchu.

On *Cornus controversa* HEMSL. (Mizuki). Hokkaido—Ishikari, Kitami. Honshu—Rikuchu, Musashi.

On *Cornus Kousa* BUERG. (Yama-boshi). Hokkaido—Ishikari. Honshu—Rikuchu.

On *Helwingia japonica* DIETER (Hana-ikada). Honshu—Rikuchu, Musashi, Kaga.

On *Rhododendron macrocepalum* MAXIM. (Mochi-tsutsuji). Honshu—Yamashiro.

On *Styrax japonicum* SIEB. & SUCC. (Egonoki). Honshu—Musashi.

On *Lonicera Chamissoi* BUNGE (Chishima-hyotamboku). Hokkaido—Ishikari.

On *Lonicera ciliata* MUHL. Hokkaido—Ishikari.

On *Lonicera Maackii* HERD. (Hana-hyotamboku). Honshu—Rikuchu.

On *Lonicera Morrowii* A. GRAY (Kingin-boku). Hokkaido—Kurile Isls. Shikotan Isl., Ishikari. Honshu—Ugo.

On *Lonicera orientalis* LAM. Hokkaido—Ishikari.

On *Lonicera tatarica* L. Hokkaido—Ishikari.

Distrib. All over the world.

Remarks. This species is a very common powdery mildew parasitic on numerous trees and its range of distribution is almost cosmopolitan. The characters of the present species as limited here in the present paper are that each dichotomous branch of the appendages is straight and all are of about the same length. But the forms have more or less variation according to the difference in the host plants.

The form of conidia on Picrasma is smaller, 28.8–34.4 × 15.6–18.0 μ, and the perithecia are smaller, 85.2–103.2 μ.

In the form parasitic on *Alnus hirsuta*, the original form of *Microsphaera Alni*, the perithecia are 94–126 μ in diameter, cells 15.6–19.2 × 10.8–14.4 μ in size; appendages aseptate or uniseptate, pale brown colored toward the base or light brown colored under the septum when it has a septum, 8–11 in number, 91–115.2 μ in length, always 5–6 times dichotomously branched; asci oblong or subglobose, 3–5 in number, 40.8–55.6×36.0–46.8 μ; ascospores ellipsoidal, 5–8 in number, 16.8–24.0 × 10.8–12.8 μ.

In 1901, *Microsphaera japonica* was described by P. HENNINGS on the form on *Cornus macrophylla* (= *Cornus controversa*) which was collected by K. SHIRAI in Tokyo. The original description of the fungus coincides so exactly with the specimens collected in Hokkaido, that it could not be treated separately from *M. Alni.*

In the forms on *Schizandra chinensis* and *Akebia quinata,* the appendages of the perithecium have very ornate dichotomous branches.

In the form on *Castanea crenata,* the perithecia are large in diameter, 116–130 μ.

On *Cocculus trilobus,* besides *Microsphaera pseudo-Lonicerae,* the typical *Microsphaera Alni* was also found, probably for the first time, in Japan.

In the form on *Rhododendron macrocepalum* which was collected by T. ABE in Kyoto, Prov. Yamashiro, Oct. 25, 1933, the appendages are irregular in form, the ultimate branches are irregularly divided, and their apices are almost straight. But the writer found a small number of the normal form of *M. Alni* on the same leaves. This material seems to be the result of an abnormal growth.

Microsphaera calocladophora ATKINS.

(Pl. X, fig. 8)

Journ. Elisha Mitch. Sci. Soc. VII, p. 73, 1891; ELL. & EVERH. N. Amer Pyren. p. 29, 1892; SACC. Syll. Fung. XI, p. 253, 1895.

Syn. *Erysiphe densissima* SCHW. Syn. Fung. Am. Bot. p. 270, 1834.

Microsphaera densissima (not COOKE & PECK), ELL. & MART. Journ. Myc. I, p. 101, 1885; SACC. Syll. Fung. IX, p. 368, 1891.

Microsphaera Alni var. *calocladophora* SALM. Monogr. Erysiph. p. 153, 1900.

Microsphaera Alni var. *calocladophora* SCHLECHT. ex. in LAWR. Journ. Myc. XI, p. 106, 1905.

Amphigenous, mycelium persistent, effused over the surface of the leaves (mostly young leaves) ; perithecia gregarious, globose or depressed-globose, 91–126 μ in diameter; cells 8.4–14.4 μ in width; appendages 7–14, hyaline or light brown colored toward the base., 84–112 μ long, aseptate, apex 4–6 times dichotomously branched, often trichotomously divided (in this case, branches have a main axis), apices of ultimate branches recurved; asci 3, ellipsoidal or subglobose, with or without short stalk, 42.0–52.8 × 32.6–39.6 μ; spores 7–8 in number, oblong or ellipsoidal, 15.6–17.4 × 10.8–12.0 μ.

Hab. On leaves and shoots of *Quercus alba* L. Hokkaido—Ishikari.
Distrib. Japan (Hokkaido) and North America.

Remarks. In 1834, SCHWEINITZ described two new species of Erysiphe parasitic on Quercus, one of them was named *Erysiphe densissima* SCHW., and the other *Erysiphe quercina* SCHW. In 1872, *E. densissima* was transferred to *Microsphaera densissima* by COOKE & PECK. But those specimens which were included in that species, belonged properly to *E. quercina*. In 1885, ELLIS and MARTIN noted for the first time on the often trichotomously branched characters of the appendages of *M. densissima*. In 1891, a new species parasitic on Quercus was recorded by ATKINSON under the name of *Microsphaera calocladophora*. In 1900, SALMON considered it as a variety of *M. Alni*.

In the present species,the appendages are often trichotomously branched in the first and second divisions, in which case the main axis is found running throughout. By this special form of the appendages the present species can be distinguished from the other species of Microsphaera.

Microsphaera alphitoides GRIFF. & MAUBL.

(Pl. X, figs. 9–11)

Bull. Soc. Myc. France, XXVIII, p. 100–103, 1912; ŠKORIĆ, Erysiph. Croat. p. 53, 1926; BLUMER, Mitt. Naturforsch. Gesellsch. Bern, p. 44, 1925. (Rev. App. Myc. V, p. 65, 1926).

Syn. *Microsphaera penicillata* LÉV. in SACC. Syll. Fung. I, p. 13 (p.p.), 1882.

Microsphaera quercina (not BURR.), GRIFF. Bull. Torr. Bot. Club, XXVI, p. 144, 1899; JØRST. Erysiph. Norway, p. 96, 1925.

Microsphaera Alni SALM. Monogr. Erysiph. p. 129 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 105 (p.p.), 1902; TAI & WEI, Sinensia, III, p. 116 (p.p.), 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 444 (p.p.), 1900, Ann. Myc. III, p. 250 (p.p.), 1905, and VI, p. 8 (p.p.), 1908; MATSUM. Ind. Plant. Jap. I, p. 156 (p.p.), 1904; SHIRAI, List, p. 215, 1905; IDETA, Jap. Phytopath. p. 205 (p.p.), 1911, and Jap. Phytopath. (Suppl. I), p. 211 (p.p.), 1923; I. MIYAKE, Bot. Mag. Tokyo, XXVII, p. 39, 1913, and XXVIII, p. 39 (p.p.), 1914; SYD. Ann. Myc. XI, p. 114 (p.p.), 1913; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 61 (p.p.), 1914; SHIRAI & MIYAKE, List, p. 365 (p.p.), 1914; HARA, Dendropath. p. 11 (p.p.), 1923; SHIRAI & HARA, List, p. 215 (p.p.), 1927).

Microsphaera Alni f. sp. *quercina* NEGER, Naturwiss. Zeitschr. f. Forest- u. Landwirtsch. XIII, p. 3–6, 1915; KLIKA, Erysiph. Czechosl. p. 54 (p.p.), 1924.

Microsphaera Alni SALM. Forma *Quercus-glanduliferae* HARA, Journ. Forest. Assoc. Japan, Tokyo, CCCXCII, p. 64, 1915; TANAKA, Mycolog. XI, p. 82, 1919.

Oidium quercinum THÜM. var. *gemmiparum* FERR. Ann. Myc. VII, p. 69, 1909; SACC. Syl. Fung. XXII, p. 1249, 1913.

Oidium alphitoides GRIFF. & MAUBL. Bull. Soc. Myc. France, XXVI, p. 137, 1910.

Amphigenous, mycelium persistent on the upper surface of the leaves and subpersistent on the under surface, at first forming thin effused film and finally covering over the leaves with thick grayish white mycelial hyphae; matured conidia solitary, ellipsoidal or barrel-shaped, granulate, vacuolate, 30.0–36.0 × 16.8–23.0 μ; perithecia scattered or gregarious, 84–168 μ in diameter, globose or depressed-globose; cells 14.4–28.8 × 10.8–18.0 μ in size; appendages 9–27 in number, aseptate or uniseptate, usually hyaline or brown colored toward the base when it has one septum, 4–6 times dichotomously branched, frequently bifurcate at the basal or upper portion of the appendages, apex of the ultimate branches usually recurved, 84.0–154 μ in length; asci 5–16 in number, ovate or subglobose, with a short stalk, 46.8–72.0 × 36.0–48.0 μ; spores 5–8, usually 8, ellipsoidal or oblong, 15.6–24.0 × 9.6–14.4 μ.

Hab. On leaves and shoots of *Pasania Sieboldii* MAKINO (Shiinoki). Honshu—Suruga.

On *Quercus acutissima* CARR. (Kunugi). Honshu—Rikuchu, Rikuzen, Musashi, Etchu, Shinano. Kyushu—Higo. Korea—Keijo.

On *Quercus alba* L. Hokkaido—Ishikari.

On *Quercus crispula* BLUME (Mizunara). Hokkaido—Oshima, Shiribeshi, Iburi, Ishikari, Kushiro. Honshu—Rikuchu, Rikuzen, Uzen, Musashi, Echigo. Shikoku—Tosa. Kyushu—Higo.

On *Quercus dentata* THUNB. (Kashiwa). Hokkaido—Oshima, Shiribeshi, Iburi, Ishikari, Tokachi, Kushiro. Honshu—Mutsu, Inaba. Kyushu—Higo.

On *Quercus gilva* BLUME (Ichii-gashi). Kyushu—Higo, Ohsumi.

On *Quercus glauca* THUNB. (Aragashi). Honshu—Musashi, Suruga. Shikoku—Iyo.

On *Quercus mongolica* FISCH. (Karafuto-gashiwa). Saghalien—Sakaehama.

On *Quercus myrsinaefolia* BLUME (Shira-kashi). Honshu—Musashi.

On *Quercus phylliraeoides* A. GRAY (Ubame-gashi). Honshu—Musashi, Bitchu. Shikoku—Tosa.

On *Quercus Robur* L. Hokkaido—Ishikari.

On *Quercus serrata* THUNB. (Konara). Hokkaido—Ishikari. Honshu—Rikuchu, Rikuzen, Musashi, Echigo, Etchu, Kaga. Shikoku—Tosa.

On *Quercus stenophylla* MAKINO (Urajiro-gashi). Honshu—Musashi.

On *Quercus Vibreyana* FR. & SAV. (Kuro-kashi). Honshu—Musashi.

Distr. Japan (Saghalien, Hokkaido, Honshu, Shikoku, Kyushu, Formosa and Korea), Manchuria, China and Europe.

Remarks. The powdery mildew parasitic on Quercus in Europe and America was thought for a long time to be one and the same species. In 1910, GRIFFON and MAUBLANC published as *Oidium alphitoides* a powdery mildew on the leaves of Quercus in Europe, and in 1912, it was transferred to the genus Microsphaera following the discovery of its perithecia. It was found to be distinct from *Microsphaera quercina,* the American oak mildew. According to them, the conidia are ovate or barrel-shaped, obtuse at both ends, hyaline, guttulate, 25–35 × 14–19 μ and the perithecia larger in size while the number of appendages and their branches are more numerous, than in the case of *M. quercina.* The present author compared the Japanese specimens with the European (Sydow, Mycotheca Germanica No. 1531) and American specimens (United States Department of Agriculture, Bureau of Plant Industry, No's. 1516, 1517, 1518, 1519, 1521 and 64274). The Oidium of the Japanese specimens is almost like the European (*Oidium alphitoides*), and the barrel-shaped conidia were not seen in the American specimens. The matured Oidium-spores of the oak mildew are usually solitary, but sometimes they are produced in a chain of two or three as a result of environmental conditions. In this case, the terminal spore is ovate or ellipsoidal, and the second and third conidia are barrel-shaped in the Japanese and European forms, while in the American they are always cylindrical. On the character of the perithecia, the diameter of the largest one is 168 μ in the Japanese specimens, and in the American 126 μ, the number of appendages reaches 27 in the former, and in the latter less than 20, but the writer can not recognize any difference in the apical branches, because the appendages of the perithecium of powdery mildew on Quercus are quite variable in shape. From these characters, one can infer that our fungus belongs to the European species.

In 1925, BLUMER (52) noted the difference between *Microsphaera Alni* and *M. alphitoides* based on the measurement of 100 perithecia of each. The average diameter of the perithecia of Microsphaera on the European oak is 131 μ; that of *Microsphaera Alni* on Alnus 98 μ; and *M. Alni* on Viburnum 93 μ. The corresponding number of appendages was 17, 10 to 12 and 6, respectively; therefore, the oak mildew could be distinguished from *Microsphaera Alni* and the name *M. alphitoides* should be adopted.

In 1915, HARA published *Microsphaera Alni* (WALLR.) SALM. form. *Quercus-glanduliferae* on *Quercus glandulifera*, giving for its differential character,—"appendages once branched dichotomously at about the middle. Other characters the same as in the type". This character of the appendages appears not only in the form on *Quercus serrata*, (= *Q. glandulifera*) but is also found in that on *Quercus crispula*.

In the form on *Quercus phylliraeoides* (Tokyo, Meguro, Nov. 13, 1922, S. ISHIYAMA), the appendages of the perithecium are short, 64.8–79.2 μ, and do not reach the diameter of the perithecium even in matured specimens.

Microsphaera Ligustri HOMMA, sp. nov.

(Pl. X, fig. 12)

Amphigena; mycelio epiphyllo persistente, hypophyllo evanido; peritheciis, gregariis 94–98 μ. diam., globosis v. globoso-depressis, cellulis 16.8–21.6 × 12.0–14.4; appendicibus 6–9, hyalinis v. deorsum pallido-brunneis, 112–133 μ longis, continuis v. 1–2-septatis, quater-quinquies dichotome ramosis, ramulis ultimis recurvatis; ascis 4 in quoque perithecio, subglobosis v. ovoideis, 51.6–58.8 × 36.0–50.4, 3–8-sporis; sporidiis ellipsoideis, 24.8–26.4 × 12.0–14.4.

Hab. On leaves of *Ligustrum ovalifolium* HASSK. (Ohba-ibota).
Hokkaido—Prov. Ishikari: Sapporo (Oct. 14, 1895, E. TOKUBUCHI, type).
Distrib. Japan (Hokkaido).

Remarks. The form on *Ligustrum ovalifolium* was included under *Microsphaera Alni* by SALMON in his monograph on the Erysiphaceae. He said, "the form on *Ligustrum medium* has often quite colorless appendages and the compact apical branching characteristic of *M. Alni*; in many perithecia, however, the apex of some of the appendages forks widely, the primary branches being sometimes quite long. Not infrequently, also, the appendages are colored brown near the base, and a few perithecia were observed in which the color, although faint, reached to the base of the apical branching". In the appendages of the present species there are two forms, in one of which the manner of the branching resembles that of *M. Alni,* while in another the primary branches are more or less recurved as in that of *M. divaricata.* Besides, in some the primary branches divide frequently at about the middle or near the base. In these characters, the present species is readily distinguished from *M. Alni.* In *M. divaricata,* the appendages do not bifurcate at the middle or near the base and are shorter, the cells of the perithecial wall are smaller, and the asci and ascospores are also smaller than in *M. Ligustri.* The present species must be placed between *M. Alni* and *M. divaricata,* and should better be treated as a new species.

Microsphaera divaricata (WALLR.) LÉV.

(Pl. X, fig. 13)

Ann. Sci. Nat. III, 15, p. 155, 1851; KICKX, Fl. Crypt. Fland. I, p. 378, 1867; COOKE & PECK, Journ. Bot. I, p. 12, 1872; SACC. Syll. Fung. I, p. 11, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 38, 1884; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 242, 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 749, 1896; LIND, Danish Fung. p. 163, 1913; JØRST. Erysiph. Norway, p. 98, 1925. (FUCK. Symb. Myc. p. 81, 1869–70; HARA, Dendropath. p. 14, 1923).

Syn. *Alphitomorpha divaricata* WALLR. Verhandl. Nat. Freunde, I, p. 39, 1819.

Erysiphe penicillata var. *Rhamni-fragulae* FR. Syst. Myc. III, p. 244, 1829.

Erysiphe divaricata LK. in RABENH. Deutschl. Krypt. Fl. I, p. 236, 1844.

Microsphaera Alni SALM. var. *divaricata* SALM. Monogr. Erysiph. p. 146, 1900, and Bull. Torr. Bot. Club, XXIX, p. 108, 1902; KLIKA, Erysiph. Czechosl. p. 53, 1924. (SALM. Ann. Myc. VI, p. 9, 1908; SHIRAI & MIYAKE, List, p. 365, 1917; SHIRAI & HARA, List, p. 216, 1927).

Amphigenous, mostly epiphyllous, mycelium persistent, covering the upper surface of the leaves with thin effused film; perithecia small, gregarious or scattered, 77–98 μ in diameter, globose or depressed-globose; cells 16.8–18.0 × 9.6–13.2 μ; appendages 5–9 in number, aseptate or uniseptate, hyaline or pale brown colored at the base, becoming thick-walled toward the base, 91.0–126.0 μ in length, dichotomously branched 5–6 times, apex of the ultimate branches recurved, primary and secondary branches recurved and forked very widely; asci 4–6 in number, rhombic subglobose, with or without stalk, 51.2–60.0 × 42.0–50.4 μ; spores 4–8, oblong to ellipsoidal, 19.2–24.0 × 12.0–16.8 μ.

Hab. On leaves of *Palura paniculata* NAKAI var. *pilosa* NAKAI (Sawafutagi). Honshu—Musashi.

Distrib. Japan (Honshu) and Europe.

Remarks. In 1851, this species was transferred to *Microsphaera divaricata* by LÉVEILLÉ from *Alphitomorpha divaricata* WALLR., and in 1900, SALMON treated it as a variety of *M. Alni.*

The present species can be distinguished from *M. Alni* by the longer and very widely bifurcate character of the primary and secondary branches of the appendages.

The first record of this species in Japan is on the form on *Berberis vulgaris* (Morioka, Prov. Rikuchu, Oct. 11, 1906, Coll. K. OKUMURA). Unfortunately, we could not see the specimen on that host, but the form on *Palura paniculata* var. *pilosa* has been found as a new host in this country. This form is evidently of the same type, although the appendages of the perithecium are shorter than those of the European specimens.

Microsphaera Coryli HOMMA, sp. nov.

(Pl. X, fig. 14)

Amphigena, etiam in surculis; mycelio effuso persistente; peritheciis gregariis, 122–140 μ. diam., globosis v. globoso-depressis, cellulis 8.4–12.0 μ. diam.; appendicibus 9–14, flexuosis, flaccidis, deorsum brunneis, 196–238 μ. longis, 1–5-septatis, ter-quinquies dichotome ramosis, ramulis ultimis recurvatis v. erectis; ascis 5 in quoque perithecio, globosis v. subglobosis, brevissime pedicellatis, 45.6–51.8 × 34.8–40.8, 6-sporis; sporidiis ellipsoideis v. oblongis, 16.4–18.0 × 9.6–10.8; conidiis maturis solitariis, ellipsoideis, granulatis, 34.8–45.6 × 21.6–36.

Hab. On leaves of *Corylus heterophylla* FISCH. (Oh-hashibami).

Honshu—Prov. Rikuchu: Mt. Himekamiyama (June 30, 1907, G. YAMADA); Tamayama-mura (Oct. 10, 1909, G. YAMADA), Morioka (Oct. 1, 1916, G. YAMADA).

On *Corylus heterophylla* FISCH. var. *japonica* KOIDZ. (Hashibami). Honshu—Prov. Musashi: Kanagawa (Oct. 26, 1904, N. NAMBU).

On *Corylus mandshurica* MAXIM. (Ohba-tsuno-hashibami). Hokkaido—Prov. Shiribeshi: Takashima (Aug. 7, 1894, E. TOKUBUCHI, type); Otaru (Aug. 1897, G. YAMADA; Sept. 17, 1897, K. MIYABE; July 30, 1905, K. MIYABE); Temiya (Oct. 12, 1903, K. MIYABE); Akaiwa (Aug. 7, 1924, Oid. Y. HOMMA). Prov. Ishikari: Sapporo (Aug. 1900, M. ISHIDA); Mt. Moiwa (June 22, 1924, Oid. Y. HOMMA; July 31, 1924, Oid. H. TAKASUGI; Aug. 29, 1924, Y. HOMMA; May 28, 1925, Oid. Y. HOMMA).

On *Corylus Sieboldiana* BL. (Tsuno-hashibami). Honshu—Prov. Mutsu: Mt. Hakkoda (Aug. 26, 1897, N. HIRATSUKA); Hirosaki (Sept. 4, 1898, N. HIRATSUKA). Prov. Rikuchu; Morioka (Sept. 23, 1904, G. YAMADA & K. SAWADA); Tamayama-mura (Oct. 28, 1906, K. SAWADA). Prov. Shimozuke: Nikko (July 29, 1907, Oid. S. KUSANO). Prov. Echigo: Shobu, Oshima-mura (July 28, 1931, K. ISHIZUKA).

Distrib. Japan (Hokkaido and Honshu).

Remarks. In 1900, SALMON gave the following description for this species in his remarks on *M. Alni*,—"The appendages of most perithecia are rather long, often twice the diameter of the perithecium, and are multiseptate and uniformly colored brown to the commencement of the special branching. The apical branching is rather irregular, the primary branches being frequently long. Nevertheless, even in this form with usually strongly colored appendages, we get occasionally colorless appendages, and a small compact apex branched in the normal manner for *M. Alni*. The wide branching of some of the appendages of these two forms tends to connect them with the var. *divaricata* while the quite sporadic appearance of colored appendages shows that, in *M. Alni*, no value can be attached to this character". As indicated in the above note, the appendages are rather long, reaching 238 μ in length, having 1–5 septa. In the apical branching there are two types, in one of them it resembles that of *M. Alni,* and in the other it is similar to that of *M. Yamadai.* In this species, the appendages can easily be distinguished from those of *M. Alni,* and the diameter of the perithecium is larger than that in the latter species.

On the other hand, this species could not be included under *M. Yamadai,* because its appendages are rather longer and gradually become narrowed toward the apex, and the diameter of the perithecium is larger.

Microsphaera Yamadai (SALM.) SYD.

(Pl. X, figs. 15, 16)

Ann. Myc. XII, p. 160, 1914. (HARA, Dendropath. p. 12, 1923; SHIRAI & HARA, List, p. 217, 1927).

Syn. *Microsphaera Alni,* form. SALM. Ann. Myc. III, p. 246, 1905.

Microsphaera Alni SALM. var. *Yamadai* SALM. Ann. Myc. VI, p. 3, 1908. (SALM. Ann. Myc. VI, p. 9, 1908; SHIRAI & MIYAKE, List, p. 365, 1917).

Microsphaera penicillata LÉV. var. *Yamadai* SACC. & TROT. in SACC. Syll. Fung. XXII, p. 24, 1913. (SHIRAI & MIYAKE, List, p. 367, 1917).

Amphigenous, mostly hypophyllous, mycelium evanescent, disappearing when the perithecia are produced on the leaves; perithecia scattered or subgregarious, 91–126 μ in diameter; cells 10.8–14.4 μ in width; appendages 5–14 in number, aseptate or 1–2-septate, dark brown colored toward the base, 84–175 μ in length, frequently flaccid, flexuous, primary branches long, dichotomously branched 2 or 3 times, usually 3, apex of the ultimate branches recurved and twisted; asci 4–7, usually 6, oblong or ovate, with a short stalk, 43.2–62.4 × 33.6–43.2 μ; spores 4–8 in number, oblong or ellipsoidal, 16.8–21.6 × 8.4–13.2 μ in size.

Hab. On leaves of *Juglans Sieboldiana* MAXIM. (Oni-gurumi). Honshu—Rikuchu.

On *Hovenia dulcis* THUNB. var. *glabra* MAKINO (Kemponashi). Honshu—Mutsu, Rikuchu, Musashi.

Distrib. Japan (Honshu).

Remarks. This fungus was at first included in *M. Alni* by SALMON. He stated as follows: "this form has small perithecia, with few and little-branched appendages; the primary branches are often rather long, and the branches of the high order are short, and often twisted in different planes". Later he transferred it to a new variety of *M. Alni.* On the difference from *M. Alni,* he noted that "the variety is characterized by the little-branched apex of the appendages, which is only once or twice or rarely three times dichotomously divided. As a rule, the branches of the first order are longer than those of higher orders which are often twisted in different planes".

In 1914, this variety was elevated to specific rank by H. and P. SYDOW. After careful observations, the present author has come to a concurrent opinion. It is distinguished from *M. Alni* by the following characters. The perithecia are smaller, the appendages are frequently flaccid and flexuous, primary branches are longer, and 2–3 times dichotomously branched, and the ultimate branches often twisted in different planes.

Microsphaera Euphorbiae (PECK) BERK. & CURT.

(Pl. X, fig. 17)

Grevillea, IV, p. 160, 1876; SACC. Syll. Fung. I, p. 13, 1882; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 418, 1887; ELL. & EVERH. N. Amer. Pyren. p. 26, 1892; SALM. Monogr. Erysiph. p. 164, 1900. (TRACY and GALLOW. Journ. Myc. IV, p. 35, 1888; SALM. Bull. Torr. Bot. Club, XXIX, p. 109, 1902, and Ann. Myc. III, p. 250, 1905; SHIRAI & MIYAKE, List, p. 365, 1917; SHIRAI & HARA, List, p. 216, 1927).

Syn. *Erysiphe Euphorbiae* PECK, Reg. Rep. XXVI, p. 80, 1874; SACC. Syll. Fung. I, p. 18, 1882.

Microsphaera Securinegae TAI & WEI, Sinensia, III, p. 120, 1932.

Amphigenous, mycelium subpersistent, forming thin effused film; perithecia scattered or subgregarious, depressed-globose, 91–112 μ in diameter; cells 15.6–16.8 × 14.4–15.2 μ in size; appendages 10–21 in number, hyaline, aseptate, narrowed, thin-walled, about 336–434 μ in length, frequently angularly bent, 3–4 times dichotomously divided, primary branches are long, branches of the higher order are short and twisted, apex of the ultimate branches recurved; asci 4–6, oblong or ovate, 38.4–46.8 × 25.2–36.0 μ in size; spores 5–7 in number, elongate-ellipsoidal, 19.2–20.0 × 9.6–10.8 μ.

Hab. On leaves of *Securinega fluggeoides* MUELL. ARG. (Hitotsuba-hagi). Honshu—Musashi.

Distrib. Japan (Honshu), China, Middle Asia and North America.

Remarks. The present species is found only on *Securinega fluggeoides,* and has not yet been collected on other plants of *Euphorbiaceae* in this country.

Microsphaera Abeliae HOMMA, sp. nov.

(Pl. X, fig. 18)

Epiphylla; mycelio effuso subpersistente; peritheciis sparsis, globosis v. globoso-depressis, 72–108 μ. diam., cellulis 19.2–26.4 × 14.4–16.8; appendicibus 5–7, 182–308 μ. longis, flaccidis, flexuosis, continuis v. raro 1–5-septatis, pallido-brunneis, deorsum brunneis, bis-quinquies dichotome ramosis, ramulis ultimis irregulariter partitis, rectis; ascis 2–5 in quoque perithecio, ellipsoideis, 48.0–58.8× 31.2–46.8, 6-sporis; sporidiis oblongis, 18.0–21.6×9.6–12.

Hab. On leaves of *Abelia spathulata* SIEB. & ZUCC. (Tsukubane-utsugi). Honshu—Prov. Echigo: Mt. Ijimino (Oct. 10, 1924, Y. HOMMA, type; Aug. 25, 1926, Y. HOMMA); Mt. Kaji (Aug. 29, 1925, Y. HOMMA); Senami (Aug. 23, 1927, Y. HOMMA).

Distrib. Japan (Honshu) .

Remarks. The present species is closely related to *Microsphaera pseudo-Lonicerae* and *M. divaricata.* It is distinguished from *M. pseudo-Lonicerae* by the smaller size of the perithecium, the larger size of its outer wall cells and also by the longer appendages. From *M. divaricata,* the present fungus differs by the straight apex of the ultimate branches, and by the smaller size of asci and ascospores.

Compared with *M. Euphorbiae,* it has longer appendages and smaller asci.

Microsphaera Lonicerae (DC.) WINT.

in RABENH. Krypt. Fl. Deutschl. I, 2, p. 36, 1884; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 243, 1893; JACZ. Bull. l'Herb. Boiss. IV, p. 747, 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 89, 1897; JØRST. Erysiph. Norway, p. 94, 1925; ŠKORIĆ, Erysiph. Croat. p. 52, 1926. (RANOJ. Ann. Myc. VIII, p. 357, 1910).

Syn. *Erysiphe lonicerae* DC. Fl. Fr. VI, p. 107, 1815; TULASNE, Selecta Fung. Carpolog. I, p. 205, 1861.

Erysiphe penicillata var. *lonicerae* FR. Syst. Myc. III, p. 244, 1829.

Erysiphe penicillata var. *caprifoliacearum* RABENH. Deutschl. Krypt. Fl. I, p. 236, 1844.

Microsphaera Ehrenbergii LÉV. Ann. Sci. Nat. III, 15, p. 155, (*Calocladia*) 1851; SACC. Syll. Fung. I, p. 14, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 39, 1884; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 244, 1893; JACZ. Bull. l'Herb. Boiss. IV, p. 748, 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 93, 1897.

Microsphaera Alni var. *lonicerae* SALM. Monogr. Erysiph. p. 142, 1900, and Bull. Torr. Bot. Club, XXIX, p. 107, 1902; KLIKA, Erysiph. Czechosl. p. 53, 1924.

Amphigenous, also on shoots, mycelium subpersistent or evanescent, thin effused film; perithecia gregarious, globose, blackish-brown in color, 80–105 μ in diameter; cells obscure, 16.8–21.6 × 14.4–16.8 μ in size; appendages 10–23 in number, straight or bent, 126–140 μ in length, aseptate, uni- or rarely bi-septate, hyaline or brown colored under the septum, dichotomously branched 4 or 5 times, tips of the ultimate branches always straight, rarely recurved; asci 3–4, subglobose, not stalked, 43.2–57.6 × 36.0–45.6 μ; spores 4–6, oblong or ellipsoidal, 21.6–24.0 × 14.4–15.6 μ in size.

Hab. On leaves and shoots of *Lonicera japonica* THUNB. (Suikazura). Honshu—Rikuchu.

Distrib. Japan (Honshu) and Europe.

Remarks. In the present species, the ultimate branches appear looser than those of *M. Alni,* for the tips of the branches are straight, although some recurved are seen here and there. Most of the specimens on Lonicera which were collected in this country belong to the typical *M. Alni,* from which the form on *L. japonica* is readily distinguished.

Microsphaera pseudo-Lonicerae (SALM.) HOMMA, comb. nov.

(Pl. X, fig. 19)

Syn. *Microsphaera Alni* (WALLR.) SALM. var. *pseudo-Lonicerae* SALM. Ann. Myc. VI, p. 4, 1908; TAI & WEI, Sinensia, III, p. 119, 1932. (SHIRAI & MIYAKE, List, p. 365, 1917; SHIRAI & HARA, List, p. 216, 1927).

Microsphaera penicillata (WALLR.) LÉV. var. *pseudo-Lonicerae* SACC. & TROT. in SACC. Syll. Fung. XXII, p. 24, 1913. (SHIRAI & MIYAKE, List, p. 367, 1917; IDETA, Jap. Phytopath. (Suppl. I), p. 213, 1923).

Amphigenous, mycelium persistent, forming irregular white patches on the upper surface of the leaves; perithecia gregarious or subgregarious, 98–126 μ in diameter, globose or depressed-globose; cells 9.6–16.8 μ in width; appendages 3–13 in number, usually 10, hyaline or brown colored toward the base, short, 124–161 μ in length, thin-walled, aseptate or uni-septate, dichotomously branched 5 or 6 times, tips of the ultimate branches straight; asci 4–6 in number, oval or ovate, with or without stalk, 46.4–52.8 × 38.4–42.0 μ; spores 5–6, usually 6, ellipsoidal or ovate, 19.2 × 10.8–14.4 μ.

Hab. On leaves of *Cocculus trilobus* DC. (Ao-tsuzura-fuji). Honshu—Mutsu, Echigo, Etchu. Shikoku—Tosa.

Distrib. Japan (Honshu and Shikoku) and China.

Remarks. In 1908, SALMON described a powdery mildew on *Cocculus trilobus* which was collected by YOSHINAGA at Misatomura, Prov. Tosa, under the name of *Microsphaera Alni* var. *pseudo-Lonicerae,* from the fact that its appendages closely resemble those of *M. Alni* var. *Lonicerae.*

In the present species, the ultimate branches are straight, and are usually of unequal length. By these characters it is distinguished from *M. Alni.*

Microsphaera Berberidis (DC.) LÉV.

(Pl. X, fig. 20)

Ann. Sci. Nat. III, 15, p. 159, 1851; KICKX, Fl. Crypt. Fland. I, p. 379, 1867; COOKE, Handb. Brit. Fung. II, p. 649, 1871; SACC. Syll. Fung. I, p. 13, 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 36, 1884; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 243, 1893; OUDEM. Rév. Champ. Pays-Bas, II, p. 92, 1897; JACZEW. Bull. l'Herb. Boiss. IV, p. 746, 1898; MAGNUS, Erysiph. Tirol. p. 20, 1898; SALM. Monogr. Erysiph. p. 123, 1900, and Bull. Torr. Bot. Club, XXIX, p. 103, 1902; NEGER, Krypt. d. Mark Brand. VII, p. 128, 1905; LIND, Danish Fung. p. 163, 1913; KLIKA, Erysiph. Czechosl. p. 57, 1924; JØRST. Erysiph. Norway, p. 93, 1925; ŠKORIĆ, Erysiph. Croat. p. 54, 1926. (FUCK. Symb. Myc. p. 82, 1869–70; SALM. Bull. Torr. Bot.

Club, XXVII, p. 444, 1900; MATSUM. Ind. Plant. Jap. I, p. 154, 1904; SHIRAI, List, p. 55, 1905; RANOJ. Ann. Myc. VIII, p. 357, 1910; IDETA, Jap. Phytopath. p. 205, 1911, and Jap. Phytopath. (Suppl. I). p. 212, 1923; I. MIYAKE, Bot. Mag. Tokyo, XXVII, p. 39, 1913; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 64, 1914; SHIRAI & MIYAKE, List, p. 365, 1917; HARA, Dendropath. p. 14, 1923; SHIRAI & HARA, List, p. 216, 1927; MIURA, Fl. Manchuria and East Mongolia, III, p. 138, 1927).

Syn. *Erysiphe Berberidis* DC. Fl. Fr. II, p. 275, 1805; MÉRAT, Nouv. Fl. Paris, p. 75 (p.p.), 1837, and Syn. Nouv. Fl. Paris, p. 84 (p.p.), 1837; DE BARY, Beitr. Morph. Phys. Pilz. I, xiii, p. 51, 1870; TULASNE, Selecta Fung. Carpolog. I. p. 204, 1861.

Erysiphe penicillata LK. var. *Berberidis* LK. in WILLD. Sp. Pl. VI, p. 114, 1824; RABENH. Deutschl. Krypt. Fl. I, p. 236, 1844.

Erysiphe penicillata var. *Berberidis* FR. Syst. Myc. III, p. 244, 1829.

Podosphaera Berberidis LÉV. in QUÉL. Champ. Jur. Vosg. p. 534, 1875.

Amphigenous, mycelium persistent, at first forming irregular white patches on the surface of the leaves, and finally covering over the whole surface; matured conidia solitary, oblong or cylindrical-oblong in shape, vacuolate, granulate, 27.6–39.6 × 13.2–14.4 μ in size; perithecia gregarious or slightly scattered, globose or depressed-globose, 98–119 μ in diameter; cells 9.6–14.4 μ in width; appendages 9–13 in number, light brown colored at the base, aseptate or uniseptate, 126–140 μ in length, dichotomously branched 4–6 times, frequently branches of the higher order more or less irregularly divided, and the apex of the ultimate branches always straight, thin-walled throughout; asci 4–7 in number, ellipsoidal or subglobose, short-stalked, 46.4–49.2 × 32.4–36.0 μ; spores 3–5, elongate-ovate or ellipsoidal, 18.0–21.6 × 9.6–14.4 μ.

Hab. On leaves and shoots of *Berberis amurensis* RUPR. (Ohbamegi). Hokkaido—Ishikari. Honshu—Rikuchu.

On *Berberis Regeliana* KOEHNE (Hiroha-hebinoborazu). Hokkaido—Oshima, Shiribeshi, Ishikari, Hidaka. Honshu—Rikuchu.

On *Berberis Thunbergii* DC. var. *Maximowiczii* FRANCH. & SAV. (Megi). Hokkaido—Ishikari. Honshu—Musashi.

Distrib. Japan (Hokkaido and Honshu) and Europe.

Remarks. This fungus appears on both surfaces of the leaves and shoots, frequently covering the whole surface of the host plant. At the time when the perithecia are abundantly produced, the surface of the host plants becomes changed to gray color.

According to SCHRÖTER's description, the appendages are said to reach 400 μ in length, but we could not find such a long one amongst our specimens.

Microsphaera Grossulariae (WALLR.) LÉV.

(Pl. X, fig. 21)

Ann. Sci. Nat. III, 15, p. 160, 1851; KICKX, Fl. Crypt. Fland. I, p. 380, 1867; COOKE, Handb. Brit. Fung. II, p. 649, 1871; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 37, 1884; ELL. & EVERH. N. Amer. Pyren. p. 24, 1892; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 244, 1893; JACZEW. Bull. l'Herb. Bois. IV, p. 747, 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 90, 1897; PRILL. Malad. Pl. Agr. II, p. 31, 1897; MAGNUS, Erysiph. Tirol. p. 20, 1898; SALM. Monogr. Erysiph. p. 157, 1900, and Bull. Torr. Bot. Club, XXIX, p. 108, 1902; Neger, Krypt. d. Mark Brand. VII, p. 128, 1905; LIND, Danish Fung. p. 163, 1913; KLIKA, Erysiph. Czechosl. p. 57, 1924; JØRST. Erysiph. Norway, p. 92, 1925; ŠKORIĆ, Erysiph. Croat. p. 54, 1926. (FUCK. Symb. Myc. p. 81, 1869–70; SALM. Bull. Torr. Bot. Club, XXVII, p. 445, 1900, Ann. Myc. III, p. 250, 1905, and VI, p. 9, 1908; MATSUM. Ind. Plant. Jap. I, p. 154, 1904; SHIRAI, List, p. 55, 1905; IDETA, Jap. Phytopath. p. 206, 1911, and Jap. Phytopath. (Suppl. I), p. 213, 1923; SYD. Ann. Myc. XI, p. 114, 1913; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 59, 1914; SHIRAI & MIYAKE, List, p. 367, 1917; HARA, Dendropath. p. 14, 1923; SHIRAI & HARA, List, p. 216, 1927).

Syn. *Alphitomorpha penicillata* var. *Grossulariae* WALLR. Berl. Ges. Nat. Freund. Verh. I, p. 40, 1819.

Erysibe penicillata var. *Grossulariae* LK. in WILLD. Sp. Pl. VI, p. 114, 1824; RABENH. Deutschl. Krypt. Fl. I, p. 236, 1844.

Erysiphe penicillata var. *Grossulariae* FR. Syst. Myc. III, p. 224, 1829.

Erysiphe Grossulariae (LÉV.) DE BARY, Beit. Morph. Phys. Pilz. I, xiii, p. 52, 1870.

Microsphaera Van-Bruntiana GERARD, Bull. Torr. Bot. Club, VI, p. 31, 1875; SACC. Syll. Fung. I, p. 14, 1882.

Podosphaera Grossulariae (LÉV.) QUÉL. Champ. Jur. Vosg. p. 534, 1875.

Microsphaera sambucicola P. HENN. in ENGL. Bot. Jahrb. XXIX, p. 148, 1901. (SHIRAI, List, p. 55, 1905; SHIRAI & MIYAKE, List, p. 367, 1917).

Amphigenous, mostly hypophyllous, also on shoots, mycelium evanescent or subpersistent, forming thinly effused film; matured conidia solitary, oblong or ellipsoidal, vacuolate, granulate, 30.0–34.8 × 16.8–18.0 μ; perithecia scattered, sometimes gregarious, 108–130 μ in diameter; cells 9.6–12.0 μ; appendages 12–22 in number, aseptate or 1-septate, brown colored at the base, 98–136 μ in length, 4–5 times deeply bifurcate, apex of the ultimate branches straight; asci 4–7 in number, ovate to ellipsoidal, stalked, 50.4–66.0 × 31.2–43.2 μ in size; spores 4–5, oblong, ellipsoidal or ovate, 15.0–24.0 × 10.8–13.2 μ, rarely 12.0–7.2 μ in size.

Hab. On leaves and shoots of *Sambucus Buergeriana* BLUME var. *Miquelii* NAKAI (Yezo-niwatoko). Saghalien—Kaizuka-mura. Hokkaido—Iburi, Ishikari, Kushiro. Honshu—Rikuchu, Rikuzen, Musashi, Shimozuke.

On *Sambucus Sieboldiana* BLUME var. *typica* NAKAI (Niwatoko). Honshu—Rikuchu, Ugo, Musashi, Shimozuke, Echigo, Yamashiro, Inaba.

Distrib. Japan (Saghalien, Hokkaido, Honshu and Formosa), Europe and New Zealand.

Remarks. In 1901, P. HENNINGS described a new species of Microsphaera parasitic on *Sambucus racemosa* (coll. S. KUSANO, in Tokyo) under the name of *Microsphaera sambucicola* P. HENN. According to his remarks it is distinguished from *M. Grossulariae* by the smaller number of asci, the shorter appendages, and the larger ascospores. Fortunately, the writer has examined the co-type specimen of *M. sambucicola,* and also the several specimens which were identified by SALMON as *M. Grossulariae.* Moreover, we have examined numerous specimens of the form on Sambucus collected in the different parts in this country. No remarkable differences could be found between them.

The present species is closely related to *Microsphaera Berberidis* and *M. diffusa;* but it is distinguished from both of them by the more deeply bifurcate character of the apical branches of the appendages, by the digitate mode of branching, and also by the shorter length of the primary branches.

Microsphaera diffusa Cooke & Peck

(Pl. X, fig. 22)

Journ. Bot. I, p. 13, 1872; Sacc. Syll. Fung. I, p. 12, 1882; Burr. & Earle, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 416, 1887; Ell. & Everh. N. Amer. Pyren. p. 24, 1892; Salm. Monogr. Erysiph. p. 161, 1900. (Pamm. Journ. Myc. IV, p. 38, 1888; Tracy & Gallow. Journ. Myc. IV, p. 35, 1888; Salm. Ann. Myc. VI, p. 9, 1908; Lawr., Journ. Myc. XI, p. 106, 1905; Shirai & Miyake, List, p. 365, 1917; Hara, Dendropath. p. 14, 1923; Shirai & Hara, List, p. 216, 1927).

Amphigenous, mostly epiphyllous, mycelium evanescent, thinly effused in cobweb-like fashion; matured conidia solitary, globose or subglobose, vacuolate, granulate, 29.6–31.2 × 21.6–25.2 μ; perithecia scattered, globose or depressed-globose, 105–126 μ in diameter; cells 12.0–14.4 μ in width; appendages 10–14 in number, hyaline or light brown colored toward the base, 140–180 μ in length, sometimes angularly bent, aseptate or uni-septate, dichotomously or subdichotomously branched 4 or 5 times, branches of the higher orders irregularly bifurcate and subnodulose, tips of the ultimate branches cylindrical or subclavate and straight; asci 3–8 in number, subglobose or obovate, short-stalked, 44.4–50.4 × 33.0–40.0 μ; spores 4 or 5, oblong or ellipsoidal, 18.0–21.6 × 8.4–10.8 μ in size.

Hab. On leaves of *Magnolia obovata* Thunb. (Hoonoki). Hokkaido—Oshima, Ishikari. Honshu—Rikuchu, Musashi.

Distrib. Japan (Hokkaido and Honshu) and North America.

Remarks. The present species can easily be distinguished from the related species by the characteristic mode of branching of the appendages. They are angularly bent at about the middle portion, the branches of the higher orders are irregularly branched, and the ultimate branches are often arranged in different planes and are subnodulose, cylindrical or subclavate.

This species resembles *Microsphaera Grossulariae*, but the appendages are longer and the apex of the ultimate branches is usually broader.

Salmon noted that the appendages are widely variable in number (4–30), but in the form which has been collected in Japan, they are 10–14 in number.

Microsphaera Bäumleri P. MAGNUS

(Pl. XI, figs. 1, 2)

Bericht. Deutsch. Bot. Gesell. XVII, p. 148, 1899; SALM. Monogr. Erysiph. p. 170, 1900, and Bull. Torr. Bot. Club, XXIX, p. 109, 1902. (HOMMA, Sapporo, Nat. Hist. Soc. XI, p. 171, 1930).

Syn. *Microsphaera Marchica* P. MAGN. Bericht. Deutsch. Bot. Gesell. XVII, p. 149, 1899.

Erysiphe Polygoni DC. in SALM. Bull. Torr. Bot. Club, XXVII, p. 443 (p.p.), 1900.

Trichocladia Bäumleri (MAGNUS) NEGER, Krypt. d. Mark Brand. VII, p. 123, 1905; KLIKA, Erysiph. Czechosl. p. 61, 1924; ŠKORIĆ, Erysiph. Croat. p. 50, 1926.

Microsphaera Polygoni (DC.) SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 56 (p.p.), 1914. (SHIRAI & MIYAKE, List, p. 225 (p.p.), 1917; SHIRAI & HARA, List, p. 217 (p.p.), 1927).

Amphigenous, mostly hypophyllous, also on stems, mycelium subpersistent; matured conidia solitary, elongate-ellipsoidal or cylindrical, vacuolate, granulate, 31.2–37.2 × 16.8–19.2 μ; perithecia subgregarious, globose or depressed-globose, 96–140 μ in diameter; cells 9.6–14.4 × 8.4–12.0 μ in size; appendages 8–20 in number, flaccid and more or less flexuous, aseptate or uni-septate, hyaline or brown colored under the septum, about 266–462 μ in length, simple or dichotomously branched 2 or 3 times, apex of the ultimate branches straight; asci 5–8 in number, subglobose or ovate, stalked, 51.6–67.2 × 31.2–40.8 μ; spores 3–5 in number, oblong, 15.6–24.0 × 9.6–14.0 μ.

Hab. On leaves of *Robinia pseudacacia* L. (Hari-enju). Hokkaido—Ishikari.

On *Vicia Cracca* L. var. *japonica* MIQ. (Kusa-fuji). Saghalien—Rutaka, Pupunii, Alexandrowsk, Akashiki, Rakuma. Hokkaido—Oshima, Shiribeshi, Iburi, Ishikari, Kitami, Hitaka. Honshu—Mutsu, Uzen, Musashi, Echigo.

On *Vicia japonica* A. GRAY (Hiroha-kusafuji). Hokkaido—Shiribeshi. Honshu—Mutsu.

On *Vicia nipponica* MATSUM. (Yotsuba-hagi). Honshu—Shimozuke.

Distrib. Japan (Saghalien, Hokkaido, Honshu and Formosa), Manchuria and Europe.

Remarks. Up to the present time, the form on *Vicia Cracca* has been included in *Erysiphe Polygoni.* While examining the numerous specimens parasitic on Leguminosae, the writer found that the form on *Vicia Cracca* has appendages sometimes dichotomously branched at the apex when entirely matured. Also, it was observed that the appendages of this species take a much longer time than in the case of the related species to complete their growth. In the matured materials, about one half of the appendages are dichotomously branched. In the immatured materials, the appendages are always simple, and in this case they can not be distinguished from those of Erysiphe. Because of the characters of the appendages, the present species belongs evidently to Microsphaera being related to *M. Alni* var. *ludens* and *M. Astragali.* In the former, the appendages are more ornate, and in the latter, the primary branches of the appendages are rather widely branched.

In 1899, P. HENNINGS recorded two species of *Microsphaera Bäumleri* (on *Vicia sylvatica*) and *M. Marchica* (on *Vicia cassubica*). Concerning *M. Marchica,* the author is rather inclined to consider it as a form of the immature stages of *M. Bäumleri.*

In the form on *Vicia Cracca,* the appendages are long, flaccid and more or less flexuous, the apical branches are irregularly branched dichotomously 2 or 3 times when matured, and the apex of the ultimate branches is straight.

In the form on *Robinia pseudacacia,* the apex of the appendages is very rarely twice dichotomously branched which mode of branching is similar to that in the form on *Vicia Cracca,* besides other characters being the same.

Microspheera Viciae-unijugae HOMMA, sp. nov.

(Pl. XI, fig. 3)

Syn. *Erysiphe Polygoni* DC. in SALM. Bull. Torr. Bot. Club, XXVII, p. 443 (p.p.), 1900, Ann. Myc. III, p. 249 (p.p.), 1905, and VI, p. 8 (p.p.), 1908.

Microsphaera Polygoni (DC.) SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 56 (p.p.), 1914. (SHIRAI & MIYAKE, List, p. 225 (p.p.), 1917; SHIRAI & HARA, List, p. 217 (p.p.), 1927; MIURA, Fl. Manchuria and East Mongolia, III, p. 137 (p.p.), 1927).

Amphigena; mycelio effuso persistente; peritheciis sparsis v. subgregariis, globosis v. globoso-depressis, 98–133 μ. diam., cellulis 15.6–21.6 × 8.4–14.4; appendicibus numerosis, 30–50 cr., hyalinis v. deorsum brunneis, perithecii diametrum paullo v. duplo superantibus, continuis v. raro 1-septatis, flexuosis, irregulariter bifurcatis, ramulis ultimis inaequalibus, erectis; ascis 6–9 in quoque perithecio, ellipsoideis v. ovatis, brevissime pedicellatis, 50.4–68.4 × 30.0–46.8, 4–7-sporis; sporidiis longo-ellipsoideis, 16.8–21.6 × 9.6–19.2; conidiis maturis solitariis, longo-ellipsoideis v. cylindraceis, granulatis, 34.2–46.8 × 14.4–18.

Hab. On leaves of *Vicia unijuga* AL. BR. (Nanten-hagi)

Hokkaido—Prov. Ishikari: Sapporo (Oct. 8, 1890, E. TOKUBUCHI; Oct. 5, 1895, N. HIRATSUKA; Oct. 25, 1896, Oid. G. YAMADA); Maruyama (Oct. 15, 1903, T. MIYAGI; Oct. 25, 1930, Y. HOMMA); Makomanai (Oct. 5, 1904, T. MIYAGI).

Honshu—Prov. Musashi: Konodai (Oct. 15, 1904, T. MIYAGI); Komaba (Oct. 26, 1927, S. KUSANO). Prov. Bizen: Okayama (Dec. 2, 1929, S. IGATA, type). Prov. Inaba: Nakanogo-mura (Oct. 18, 1930, Y. TOCHINAI).

On *Vicia Tanakae* FR. & SAV. (Ohba-kusafuji)

Shikoku—Prov. Tosa: Kajiki, Konotani-mura (Sept. 1909, T. YOSHINAGA).

Distrib. Japan (Hokkaido, Honshu, Shikoku and Formosa) and China.

Remarks. The form on *Vicia unijuga* was included in *Erysiphe Polygoni* by SALMON. In Dec. 1929, an excellent specimen was kindly sent to us by Mr. IGATA from Okayama. In the young stage of this specimen, the appendages are hyaline, flexuous, almost simple and interwoven in the mycelial hyphae; in this case, it resembles *Erysiphe Pisi.* When matured, the appendages become light brown in color under middle portion, and branches are gradually developed. The branches are irregularly bifurcate, the apex of the ultimate branches being straight. From the above characters, the writer believes that the present fungus should better be transferred to Microsphaera rather than to be included in Erysiphe. It is related to *Microsphaera Bäumleri* on Vicia, from which it is distinguished by the appendages being exceedingly numerous and shorter in length and with the primary branches dividing near the base.

Microsphaera Russellii CLINT.

(Pl. X, fig. 23)

in PECK, Reg. Rep. XXVI, p. 80, 1874; SACC. Syll. Fung. I, p. 12, 1882; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 415, 1887; ELL. & EVERH. N. Amer. Pyren. p. 23, 1892; SALM. Monogr. Erysiph. p. 163, 1900. (TRACY & GALLOW. Journ. Myc. IV, p. 35, 1888; PAMM. Journ. Myc. IV, p. 38, 1888; SAWADA, Agr. Exp. Stat. Formosa, Bull.

IX, p. 58, 1914, and XIX, p. 174, 1919; Ideta, Jap. Phytopath. (Suppl. I) p. 213, 1923; SHIRAI & HARA, List, p. 217, 1927).

Syn. *Oidium Oxalidis* McAlp. Roy. Soc. Victoria, p. 219, 1894; SACC. Syll. Fung. XIV, p. 1041, 1899; LIND, Danish Fung. p. 165, 1913.

Amphigenous, also on shoots, mycelium persistent, at first forming white patches, and finally covering over the surface of the leaves; matured conidia solitary, ellipsoidal, elongate-ellipsoidal or cylindrical, granulate, vacuolate, 31.2–40.8 × 14.4–19.2 μ.

"Perithecia scattered, 70–118 μ in diameter, globose-depressed, cells small, 6–14 μ wide; appendages 5–14, 3–7 times the diameter of the perithecium, flaccid, septate, smooth, colored nearly to the apex when mature, apex 2–4 times dichotomously branched, branching very irregular and lax, primary branches usually long and forking widely, tips of ultimate branches not recurved; asci 4–9, narrowly to broadly ovate or (in small perithecia) ovate-globose, shortly stalked, 42–56 × 24–32 μ; spores 3–5, usually 4, 18–22 × 10–12 μ". (Salmon, Monogr. Erysiph. p. 163).

Hab. On leaves of *Oxalis corniculata* L. (Katabami). Hokkaido—Oshima, Ishikari. Honshu—Kozuke, Echigo, Etchu. Kyushu—Higo, Satsuma, Hiuga.

Distrib. Japan (Hokkaido, Honshu, Kyushu and Formosa) and North America.

Remarks. This species is found widely as a parasite on the wild Oxalis. The host plants wither much earlier in autumn than the healthy ones. The perithecial stage has not yet been collected in this country.

Oidium belonging to Microsphaera

On *Mahonia Fortunei* FEDDE (Hosoba-no-hiiraginanten). Honshu—Etchu.

Subfam. Phyllactinieae PALLA

Mycelial hyphae have internal and external forms. Special branches from the superficial mycelium passing through the stomata enter into the intercellular spaces of the mesophyll. When such internal hyphae have reached a certain length, they send haustoria into the surrounding spongy parenchyma or rarely into the palisade cells.

Key to the genera of the subfam. Phyllactinieae

1. Appendages acicular, conidiophores straight............... *Phyllactinia* (403)
2. Apex of the appendages uncinate, conidiophores form spirals at the base.. *Uncinulopsis* (418)

Phyllactinia LÉV.

Mycelial hyphae have two forms, external and interior, sending special branches from the external mycelium through the stomata into the intercellular spaces of the mesophyll and producing haustoria in the surrounding parenchyma cells. The matured conidia are clavate, solitary, arising on the long conidiophore. Perithecia are large, depressed-globose to lenticular, standing up with the reflexed appendages on the host surface and turning over when matured. The upper part of the perithecium is crowned with colorless shining cells, some of which grow into the so-called penicillata-cells. Appendages of the perithecium are acicular in form and bulbous at the base. Asci are many and spores number two or three.

In 1900, SALMON treated the numerous species of the genus which had been published up to that time as one species under the specific name, *Phyllactinia corylea* (PERS.) KARST. As the result of careful observations on the numerous specimens which have been collected at different parts of this country and of comparison with the American and European specimens, the writer has come to the conclusion that SALMON's *Phyllactinia corylea* must be divided into two sections of *Corylea* and *Fraxinii*. The former almost always has evanescent mycelia while the latter almost always has persistent ones.

The genus includes 9 species in this country.

Key to the species of the genus Phyllactinia

I. Corylea section.
Outer mycelium usually evanescent.
1. Perithecia 120—210 μ in diameter, asci 8—18 in number and spores 2—3 .... *P. corylea* (404)
2. Perithecia 183—238 μ in diameter, asci 9—14 in number, and spores always 2 .... *P. moricola* (407)

II. Fraxinii section.
Outer mycelium usually persistent.
1. Perithecia 175—273 μ in diameter, asci 12—30 in number .... *P. Fraxinii* (409)
2. Perithecia 182—266 μ in diameter, asci 6—13 in number........ .... *P. kakicola* (411)
3. Perithecia 224—273 μ in diameter, asci 15—21 in number and spores always 2 .... *P. Pyri* (412)
4. Perithecia 200—280 μ in diameter, asci about 9 in number...... .... *P. Actinidiae-formosanae* (414)
5. Perithecia 266—322 μ in diameter, asci 38 in number .... *P. quercus* (414)
6. Perithecia 294—364 μ in diameter, asci 15—20 in number .... *P. imperialis* (416)
7. Perithecia 345—415 μ in diameter, asci 20—24 in number....... .... *P. Actinidiae-latifoliae* (417)

Phyllactinia corylea (PERS.) KARST.

(Pl. XI, figs. 5-9)

Act. Soc. Faum. Fl. Fenn. II, p. 92, 1885; SALM. Monogr. Erysiph. p. 224 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 200 (p.p.), 1902; NEGER, Krypt. d. Mark Brand. VII, p. 134 (p.p.), 1905; KLIKA, Erysiph. Czechosl. p. 69 (p.p.), 1924; ŠKORIĆ, Erysiph. Croat. p. 55 (p.p.), 1926. (TAI & WEI, Sinensia III, p. 124 (p.p.), 1932; SALM. Bull. Torr. Bot. Club, XXVII, p. 445 (p.p.), 1900, Ann. Myc. III, p. 251 (p.p.), 1905, and VI, p. 10 (p.p.), 1908; MATSUM. Ind. Plant. Jap. I, p. 160, 1904; SHIRAI, List, p. 68 (p.p.), 1905; YOSHINO, Bot. Mag. Tokyo, XVIII, p. 3, 1906; IDETA, Jap. Phytopath. p. 215 (p.p.), 1911, and Jap. Phytopath. (Suppl. I), p. 217 (p.p.), 1923; SHIRAI & MIYAKE, List, p. 443 (p.p.), 1917; Hara, Dendropath. p. 28 (p.p.), 1923; SHIRAI & HARA, List, p. 266 (p.p.), 1927).

Syn. *Sclerotium Erysiphe* b. *corylea* PERS. Syn. Fung. p. 124, 1801.

Sclerotium suffulta REBENT. Prod. Fl. Neomarch. p. 360, 1804.

Erysiphe coryli HEDW. f. ex DC. Fl. Fr. II, p. 272, 1805.

Erysiphe guttata LK. in WILLD. Sp. Pl. VI, p. 116 (p.p.), 1824; MÉRAT, Nouv. Fl. Paris, p. 74 (p.p.), 1837, and Syn. Nouv. Fl. Paris, p. 83 (p.p.), 1837; RABENH. Deutschl. Krypt. Fl. I, p. 234 (p.p.), 1844; DE BARY, Beitr. Morphol. Phys. Pilz. I, xiii, p. 52 (p.p.), 1870.

Erysiphe guttata FR. Syst. Myc. III, p. 245 (p.p.), 1829; Tulasne, Selecta Fung. Carpolog. I, p. 194 (p.p.), 1861.

Phyllactinia guttata LÉV. Ann. Sci. Nat. III, 15, p. 144 (p.p.), 1851; KICKX, Crypt. Fl. Fland. I, p. 384, 1867; COOKE, Handb. Brit. Fung. II, p. 646 (p.p.), 1871; COOKE & PECK, Journ. Bot. I, p. 11, 1872; LIND, Danish Fung. p. 164 (p.p.), 1913. (FUCK. Symb. Myc. p. 79 (p.p.), 1869–70).

Phyllactinia Candollei LÉV. Ann. Sci. Nat. III, 15, p. 150, 1851; SACC. Syll. Fung. I, p. 5, 1885.

Phyllactinia guttata WALLR. in QUÉL. Champ. Jur. Vosg. p. 535 (p.p.), 1875.

Phyllactinia suffulta SACC. Mick. II, p. 50 (p.p.), 1880; SACC. Syll. Fung. I, p. 5 (p.p.), 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 42 (p.p.), 1884; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 411 (p.p.), 1887; ELL. & EVERH. N. Amer. Pyren. p. 20 (p.p.), 1892; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 246 (p.p.), 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 736 (p.p.), 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 85 (p.p.), 1897; JØRST. Erysiph. Norway, p. 103 (p.p.), 1925.

Phyllactinia suffulta REBENT. in PRILL. Malad. Pl. Agr. II, p. 29 (p.p.), 1897.

Phyllactinia corylea KARST. var. *rigida* SALM. Ann. Myc. III, p. 500 (p.p.), 1905.

Phyllactinia Sapii SAWADA, Depart. Agr. Govern. Research Inst. Formosa, Japan, Rep. XLIX, p. 53 and 81, 1930, and LXI, p. 37, 1933.

Ovulariopsis monospora SACC. & D. SACC. Syll. Fung. XVIII, p. 507, 1906; LIND. in RABENH. Krypt. Fl. Deutschl. IX, p. 727, 1910.

Amphigenous, mostly hypophyllous, mycelium evanescent; matured conidia solitary, clavate or broadly clavate, about 75.6 × 19.2 μ, granulate, vacuolate; perithecia gregarious or scattered, depressed-globose to lenticular, 120–210 μ in diameter; cells 12.0–16.8 × 10.8–13.2 μ in size; appendages 6–11 in number, usually 8, straight, needle-shaped, sharply pointed at the apex and bulbous at the base, 196–420 μ in length, hyaline, aseptate; penicillate cells formed at the apical portion of the perithecium, stalk-cells 24.0–26.4 × 8.4–9.6 μ in size, branches about 11–20 in number, 24.0–25.2 μ in length; asci 8–18 in number, variable in forms, elongate-ellipsoidal or elongate-ovate, stalked, 62.4–92.4 × 30.0–45.6 μ; spores 2 or 3, oblong or ovate, 28.8–40.8 × 16.8–25.4 μ.

Hab. On leaves and young branchlets of *Corylus mandshurica* MAXIM. (Ohba-tsunohashibami). Hokkaido—Ishikari.

On *Corylus Sieboldiana* BL. (Tsuno-hashibami). Hokkaido—Ishikari.

On *Ostrya japonica* SARG. (Asada). Hokkaido—Ishikari.

On *Hamamelis japonica* SIEB. & ZUCC. (Mansaku). Honshu—Rikuchu.

On *Amelanchier asiatica* ENDL. (Zaifuriboku). Honshu—Inaba, Aki.

On *Cydonia sinensis* THOUIN. (Kwarin). Kyushu—Higo.

On *Caesalpinia japonica* SIEB. & ZUCC. (Jaketsu-ibara). Honshu—Hitachi. Shikoku—Tosa.

On *Picrasma quassioides* BENN. (Nigaki). Hokkaido—Ishikari. Honshu—Rikuchu.

On *Sapium sebiferum* ROXB. (Nankin-haze). Formosa—Shinchiku.

On *Rhododendron Albrechtii* MAXIM. (Murasaki-yashio-tsutsuji). Hokkaido—Ishikari.

Distrib. Japan (Hokkaido, Honshu, Shikoku, Kyushu and Formosa), China, Europe and North America.

Remarks. The specific name of *Phyllactinia corylea* used in this paper is of a strict sense and not similar to that advocated by SALMON. In this species, the development of the outer mycelia is scanty and finally evanescent, the diameter of the perithecia is smaller than that of the other related species, and asci, asco-spores and conidia are also smaller in size.

In 1900, SALMON published on the conidial stages of Phyllactinia, and he noted in his paper that conidia "varying in shape from clavate, clavate-oblong or clavate-obovate to clavate-elongate or clavate-spatulate or rarely clavate-fusiform or lemon-shaped, and rounded, acute, bluntly apiculate or rarely subacuminate at the apex, and varying in size from 45–85 × 15–25 μ" are found among them. He recorded three varieties of Phyllactinia based on the characters of the conidia,—*Phyll. corylea* var. *angulata,* var. *rigida,* and var. *subspiralis.* The first variety includes the form on Quercus, Ulmus and Fagus, and its conidia are angulate in form. On the second variety parasitic on *Parmentiera alata,* he noted: "the conidiophore is thick-walled, rigid and setiform, up to 500 μ long and about 5 μ wide". The third type is the form on *Dalbergia sissoo,* and the conidiophore has the true spiral in the lower part. In the above three forms, a part of var. *rigida* forms the conidial stage of *Phyll. corylea.*

In the form on *Amelanchier japonica,* the asci and ascospores are largest in this species. Asci are 74.4–92.4 ×33.6–45.6 μ, and spores are 34.8–40.8 × 19.2–26.4 μ.

In 1930, *Phyllactinia Sapii* SAWADA on *Sapium sebiferum* ROXB. (coll. in Formosa, Shinchiku, Dec. 15, 1923, K. SAWADA) was published by SAWADA. The author was able to examine the co-type specimen by his kindness. In size the perithecia, asci, ascospores and conidia are similar to those of *Phyllactinia corylea,* but SAWADA treated it as a distinct species on the ground that the conidia did not infect the several other host plants. This species may better be recognized as a physiologic form.

Phyllactinia moricola **(P. HENN.) HOMMA**

(Pl. XI, fig. 10)

Trans. Sapporo Nat. Hist. Soc. XI, p. 174, 1930.

Syn. *Phyllactinia suffulta* (REB.) SACC. var. *moricola* P. HENN. in ENGL. Bot. Jahrb. XXVIII, p. 271, 1901; SACC. Syll. Fung. XVI, p. 399, 1902. (MATSUM. Ind. Plant. Jap. I, p. 160, 1904).

Phyllactinia corylea KARST. in SALM. Monogr. Erysiph. p. 224 (p.p.), 1900; TAI & WEI, Sinensia, III, p. 124 (p.p.), 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 445 (p.p.), 1900, Ann. Myc. III, p. 251 (p.p.), 1905, and VI, p. 10 (p.p.), 1908; SHIRAI, List, p. 68 (p.p.), 1905; IDETA, Jap. Phytopath. p. 215 (p.p.), 1911, and Jap. Phytopath. (Suppl. I), p. 217 (p.p.), 1923; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 72 (p.p.), 1914, and XIX, p. 189 (p.p.), 1919; SHIRAI & MIYAKE, List, p. 443 (p.p.), 1917; HARA, Dendropath. p. 28 (p.p.), 1923; SHIRAI & HARA, List, p. 266 (p.p.), 1927; MIURA, Fl. Manchuria and E. Mongolia, III, p. 140 (p.p.), 1927).

Phyllactinia suffulta P. HENN. in ENGL. Bot. Jahrb. XXXIV, p. 600, 1905.

Phyllactinia moricola (P. HENN.) SAWADA, Depart. Agr. Govern. Research Inst. Formosa, Japan, Rep., XLIX, p. 84, 1930, and LXI, p. 34, 1933.

Phyllactinia Broussonetiae-Kaempferi SAWADA, Depart. Agr. Govern. Research Inst. Formosa, Japan, Rep., XLIX, p. 87, 1930.

Ovulariopsis moricola G. DELACR. Bull. Soc. Myc. France, XIX, p. 345, 1903; SACC. Syll. Fung. XVIII, p. 506, 1906.

Amphigenous, mostly hypophyllous, mycelium generally evanescent, rarely more or less persistent; conidiophores long, matured conidia solitary, large, clavate or broadly clavate, not papillate or rarely papillate, granulate, 62.4–72.0 × 24.0–31.2 μ; perithecia scattered, depressed-globose to lenticular, 182–238 μ in diameter; cells 13.2–21.6 × 7.2–15.6 μ; appendages 7–13 in number, usually 8, straight, needle-shaped, sharply pointed at the apex, bulbous at the base, 210–378 μ in length, hyaline, aseptate; penicillate cells, stalk-cells 33.6–40.8 × 12.0–19.2 μ in size, branches 11–36 in number, and 21.6–36.0 μ in length; asci 5–16 in number, elongate-ovate or cylindrical, stalked, 75.0–88.8 × 31.2–45.6 μ; spores 2, ellipsoidal, 27.6–40.0 × 19.2–26.4 μ.

Hab. On leaves of *Broussonetia Kaempferi* SIEB. (Tsuru-kozo). Kyushu—Hizen.

On *Broussonetia Kazinoki* SIEB. (Kozo). Honshu—Musashi.

On *Morus bombycis* KOIDZ. (Yama-guwa). Hokkaido—Shiribeshi, Iburi, Ishikari, Kitami. Honshu—Mutsu, Rikuchu, Ugo, Iwaki, Musashi, Shimozuke, Etchu, Echizen, Kaga, Shinano, Mino, Inaba. Shikoku—Iyo, Tosa. Kyushu—Higo.

Distrib. Japan (Hokkaido, Honshu, Shikoku, Kyushu, Korea and Formosa), Manchuria, China, Philippines, Indo-China, Burma and Madagascar.

Remarks. The form on Morus was included in *Phyllactinia corylea*, or *Phyllactinia suffulta* or *Phyllactinia guttata* for a long time. In 1901, P. HENNINGS recorded it as a new variety of *Phyllactinia suffulta*. This variety was founded on the specimen collected by Prof. M. MIYOSHI on *Morus alba* in Tokyo in Oct. 1899. His description is "mycelio hypophyllo, effuso, crassiusculo cretaceo vel flavidulo, villosulo; peritheciis sparsis, globuloso-depressis ca. 180–220 μ atrobrunneis; appendicibus (8–13), hyalinis subulatis ca. 120–150 μ longis basi vesiculoso inflatis ca. 30 μ crassis; ascis (5–16) clavatis, basi stipitatis curvulis 2-sporis, ca. 60–65 × 30 μ; sporis ellipsoideis 30–40 × 16–28 μ aurantiaco-oleosis. Diese Varietät ist von der typischen Art schon äusserlich durch das dickfilzige, weisse bis gelbliche Mycel gut verschieden". Mycelium on most of the leaves of *Morus bombycis* is evanescent, but occasionally on the thickish leaves it is persistent forming a thick felt-like mycelial layer. In this species, the diameter of the perithecium is larger than that of typical *Phyllactinia corylea*. In both of these species, the infected portions of the host leaves are changed to a yellowish color.

Phyllactinia parasitic on *Broussonetia Kaempferi* collected in Prov. Hizen, was considered by SAWADA as a new species, under the name of *Phyllactinia Broussonetiae-Kaempferi*. The present writer could not distinguish it by the characters of the perithecial stage from *Phyllactinia moricola*, although SAWADA affirmed that the form did not infect mulberry-leaves. It is better to consider it as a physiologic form.

Phyllactinia Fraxini (DC.) HOMMA, comb. nov.

(Pl. XI, figs. 11, 12)

Syn. *Erysiphe fraxini* DC. Fl. Fr. II, p. 273, 1805.

Erysiphe betulae DC. Fl. Fr. VI, p. 107, 1915.

Erysiphe guttata LK. in WILLD. Sp. Pl. VI, p. 116 (p.p.), 1924; MÉRAT, Nouv. Fl. Paris, p. 74 (p.p.), 1837, and Syn. Nouv. Fl. Paris, p. 83 (p.p.), 1837; RABENH. Deutschl. Krypt. Fl. I, p. 234 (p.p.), 1844; DE BARY, Beitr. Morphol. Phys. Pilz. I, xiii, p. 52 (p.p.), 1870.

Erysiphe guttata FR. Syst. Myc. III, p. 245 (p.p.), 1829; TULASNE, Selecta Fung. Carpolog. I, p. 194, 1861.

Erysiphe lenticularis RABENH. Deutschl. Krypt. Fl. I, p. 234, 1844.

Phyllactinia guttata LÉV. Ann. Sci. Nat. III, 15, p. 144 (p.p.), 1851; COOKE, Handb. Brit. Fung. II, p. 646 (p.p.), 1871; LIND, Danish Fung. p. 164 (p.p.), 1913. (FUCK. Symb. Myc. p. 79 (p.p.), 1869–70).

Phyllactinia guttata WALLR. in QUÉL. Champ. Jur. Vosg. p. 535 (p.p.), 1875.

Phyllactinia suffulta SACC. Mich. II, p. 50 (p.p.), 1880, SACC. Syll. Fung. I, p. 5 (p.p.), 1882; WINT. in RABENH. Krypt. Fl. Deutschl. I, 2, p. 42 (p.p.), 1884; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 411 (p.p.), 1887; ELL. & EVERH. N. Amer. Pyren. p. 20 (p.p.), 1892; SCHRÖT. in COHN's Krypt. Fl. Schles. III, p. 246 (p.p.), 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 736 (p.p.), 1896; OUDEM. Rév. Champ. Pays-Bas, II, p. 85 (p.p.), 1897; MAGNUS, Erysiph. Tirol. p. 22 (p.p.), 1898; JØRST. Erysiph. Norway, p. 103 (p.p.), 1925.

Phyllactinia suffulta REBENT. in PRILL. Malad. Pl. Agr. II, p. 29 (p.p.), 1897.

Phyllactinia corylea KARST. in SALM. Monogr. Erysiph. p. 224 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 200 (p.p.), 1902; NEGER, Krypt. d. Mark Brand. VII, p. 134 (p.p.), 1905; KLIKA, Erysiph. Czechosl. p. 69 (p.p.), 1924; ŠKORIĆ, Erysiph. Croat. p. 55 (p.p.), 1926; TAI & WEI, Sinensia, III, p. 124 (p.p.), 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 445 (p.p.), 1900, Ann. Myc. III,

p. 251 (p.p.), 1905, and VI, p. 10 (p.p.), 1908; SHIRAI, List, p. 68 (p.p.), 1905; SYD. Ann. Myc. VII, p. 170, 1909; IDETA, Jap. Phytopath. p. 215 (p.p.), 1911, and Jap. Phytopath. (Suppl. I), p. 217 (p.p.), 1923; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 72 (p.p.), 1914, and XIX, p. 186 (p.p.), 1919; SHIRAI & MIYAKE, List, p. 443 (p.p.), 1917; HARA, Dendropath. p. 28 (p.p.), 1923; SHIRAI & HARA, List, p. 266 (p.p.), 1927).

Phyllactinia corylea KARST. var. *rigida* SALM. Ann. Myc. III, p. 500 (p.p.), 1905.

Hypophyllous, very rarely amphigenous, mycelium persistent, forming thick white patches; matured conidia solitary, clavate or broadly clavate, papillate or not, 52.8–91.2 × 18.0–27.6 μ, granulate, vacuolate, sometimes including well-developed fibrosin bodies; perithecia gregarious, large, depressed-globose to lenticular, 175–273 μ in diameter; cells 12.0–24.0 × 9.6–20.4 μ in size; appendages 8–21 in number, straight, bulbous at the base, aseptate or very rarely septate (form on *Fraxinus mandshurica* var. *japonica*), 210–476 μ in length; penicillate-cells, stalk-cells 28.8–45.6 × 9.6–13.2 μ in size, sometimes dichotomously branched at the apical portion, branches 14–20 in number, 14.4–40.8 μ in length; asci 12–30 in number, elongate-ellipsoidal or elongate-ovate, stalked, 63.6–100.6 × 26.4–45.6 μ; spores 2 or 3 in number, usually 2, very rarely 4, 27.6–45.6 × 16.8–31.2 μ in size.

Hab. On leaves and stems of *Juglans Sieboldiana* MAXIM. (Onigurumi). Hokkaido—Ishikari. Honshu—Rikuchu.

On *Alnus alnobetula* HARTIG var. *fruticosa* WINKL. (Miyama-hannoki). Hokkaido—Iburi.

On *Alnus hirsuta* TURCZ. (Keyama-hannoki). Hokkaido—Ishikari.

On *Alnus hirsuta* TURCZ. var. *sibirica* SCHNEID. (Yama-hannoki). Hokkaido—Iburi, Ishikari. Honshu—Musashi, Kozuke.

On *Alnus japonica* SIEB. & ZUCC. (Hannoki). Honshu—Rikuchu, Musashi, Echigo. Shikoku—Sanuki.

On *Alnus japonica* SIEB. & ZUCC. var. *arguta* CALL. (Yezo-hannoki). Hokkaido—Ishikari. Honshu—Musashi.

On *Alnus koreana* NAKAI (Hiroha-keyama-hannoki). Hokkaido—Ishikari.

On *Alnus obtusata* MAKINO (Kawara-hannoki). Shikoku—Tosa.

On *Betula Tauschii* KOIDZ. (Shirakamba). Hokkaido—Ishikari.

On *Magnolia praecocissima* KOIDZ. (Kobushi). Honshu—Rikuchu, Ugo, Musashi.

On *Magnolia praecocissima* KOIDZ. var. *borealis* KOIDZ. (Kitakobushi). Hokkaido—Ishikari.

On *Schizophragma hydrangeoides* SIEB. & ZUCC. (Iwagarami). Hokkaido—Ishikari.

On *Actinidia arguta* PLANCH. (Kokuwa). Hokkaido—Ishikari, Kushiro.

On *Actinidia polygama* MAXIM. (Matatabi). Hokkaido—Ishikari.

On *Fraxinus mandschurica* RUPR. (Yachidamo). Saghalien—Ochiai. Hokkaido—Ishikari, Kushiro. Honshu—Ugo.

On *Fraxinus pubinervis* BLUME (Toneriko). Honshu—Echigo.

On *Fraxinus Sieboldiana* BLUME (Aodamo). Honshu—Echigo.

Distrib. Japan (Saghalien, Hokkaido, Honshu, Shikoku, Kyushu and Formosa), Manchuria, China, Europe, Africa and North America.

Remarks. This species is the most common powdery mildew on deciduous trees, especially often attacking the young plants of the nursery. In 1928, the writer observed the Fraxinus seedlings in the experimental nursery of this University, very badly attacked by the mildew. At first, white patches appeared on the under surface of the leaves of these young trees, and gradually spread on the upper surface, and at last numerous perithecia were produced on the mycelial masses. Some of the seedlings succumbed entirely.

The special characters of this species are the presence of the evident white mycelial patches on the under surface of the leaves, and of the perithecia produced on these dense white masses which can easily be recognized with the naked eye. This species is distinguished from *Phyllactinia corylea* and *Phyllactinia moricola* by the size of the perithecia and the persistent mycelium. In *Phyllactinia quercus* the diameter of the perithecia is larger than in the case of the present species.

In the present species, there are two or three spores in an ascus, but usually two. The spores in the two-spored asci are larger, 33.6–40.8 × 25.2–28.8 μ, while those in the three-spored ones are smaller, 27.6–28.8 × 16.8–17.6 μ.

In the form on *Fraxinus mandschurica*, the appendages sometimes have a slight swelling at the upper part of the bulbous base, and are sometimes 1 to 3 septate. (coll. in Sapporo, Oct. 19, 1923).

In the form on *Magnolia praecocissima* var. *borealis*, the asci and ascospores are yellowish in color caused by the numerous yellowish drops inclosed in the cell.

Phyllactinia kakicola SAWADA

Depart. Agr. Govern. Research Inst. Formosa, Japan, Rep. XLIX, p. 51, and 80, 1930, and LXI, p. 33, 1933.

Syn. *Phyllactinia corylea* (PERS.) KARST. in SALM. Ann. Myc. III, p. 251 (p.p.), 1905, and VI, p. 10 (p.p.), 1908; TAI & WEI, Sinensia, III, p. 124 (p.p.), 1932. (SHIRAI & MIYAKE, List, p. 443 (p.p.), 1917; IDETA, Jap. Phytopath. (Suppl. I), p. 217 (p.p.), 1923; HARA, Dendropath. p. 28 (p.p.), 1923; SHIRAI & HARA, List, p. 266 (p.p.), 1927).

Hypophyllous, mycelium persistent or rarely evanescent; "conidia clavate, papillate, 60–116 × 27–44 μ in size" (acc. to Sawada, p. 51); perithecia gregarious, depressed-globose to lenticular, 182–226 μ in diameter; cells 14.4–21.6 × 14.4–20.4 μ in size; appendages 8–13 in number, hyaline, aseptate, 250–301 μ in length; penicillate cells, stalk-cells 40.8–50.4 × 13.2–16.8 μ in size, branches about 16–25 in number, 21.6–24.0 μ in length; asci 6–13 in number, ellipsoidal or elongate-ellipsoidal, 60.0–84.0 × 26.4–36.0 μ in size; spores always 2, oblong or ellipsoidal, 33.6–36.0 × 18.0–19.2 μ in size.

Hab. On leaves of *Diospyros Kaki* L. f. (Kaki). Honshu—Musashi, Echigo, Etchu, Echizen, Mino, Bizen, Inaba. Kyushu—Buzen, Higo.

On *Diospyros Lotus* L. (Mame-gaki). Honshu—Rikuchu.

Distrib. Japan (Honshu, Kyushu and Formosa) and China.

Remarks. The species parasitic on *Diospyros Kaki* was first recorded by SALMON in 1905 as *Phyllactinia corylea*, which was collected in Tokyo in 1904 by S. KUSANO.

In 1930, this fungus was separated from *Phyllactinia Corylea* by SAWADA and was named *Phyllactinia kakicola*. The conidia and ascospores of the latter are larger than those of the former and the conidia did not infect *Morus*, *Broussonetia papyrifera*, *Pirus serotina*, *Sapium sebiferum*, *Ampelopsis heterophylla*, and *Cephalanthus occidentalis*.

Phyllactinia Pyri (CAST.) HOMMA, comb. nov.

Syn. *Erysiphe Pyri* CAST. Cat. Pl. Mars. p. 190, 1845.

Phyllactinia guttata b. *Pyri* FUCK. Symb. Myc. p. 79, 1869–70.

Phyllactinia suffulta SACC. Syll. Fung. I, p. 5 (p.p.), 1882.

Phyllactinia suffulta SACC. f. *Pyri* REHM. Ascomyc. ex. No. 797, 1885.

Phyllactinia corylea KARST. in SALM. Monogr. Erysiph. p. 224 (p.p.), 1900, Bull. Torr. Bot. Club, XXIX, p. 200 (p.p.), 1902, and Ann. Myc. VI, p. 10 (p.p.), 1908; ŠKORIĆ, Erysiph. Croat. p. 55 (p.p.), 1926; TAI & WEI, Sinensia, III, p. 124 (p.p.), 1932. (SAWADA, Agr. Exp. Stat. Formosa, Bull. XIX, p. 189 (p.p.), 1919; IDETA, Jap.

Phytopath. (Suppl. I), p. 217 (p.p.), 1923; HARA, Dendropath. p. 28 (p.p.), 1923; SHIRAI & HARA, List, p. 266 (p.p.), 1927; MIURA, Fl. Manchuria and E. Mongolia, III, p. 140 (p.p.), 1932).

Phyllactinia Pyri-serotinae SAWADA, Depart. Agr. Govern. Research Inst. Formosa, Japan, Rep. XLIX, p. 59 and 83, 1930, and LXI, p. 36, 1933.

Hypophyllous, mycelium persistent or rarely evanescent; "conidia solitary, clavate, not papillate, 63–104 × 20–32 μ in size" (Acc. to Sawada, p. 60); perithecia gregarious or sometimes scattered, depressed-globose to lenticular, 224–273 μ in diameter; cells 15.6–16.8 × 13.2–14.4 μ in size; appendages 8–12 in number, aseptate, hyaline, 316–376 μ in length; penicillate cells, stalk-cells 19.2–33.6 × 12.0–14.4 μ in size, branches wide, 5 or 6 in number, 26.4–36.0 μ in length; asci 15–25 in number, ellipsoidal, stalked, reaching 24 μ in length, 69.6–86.4 × 31.2–38.8 μ in size; spores 2, oblong or ellipsoidal, 33.6–38.4 × 16.8–21.6 μ in size.

Hab. On leaves of *Pirus communis* L. (Seiyo-nashi). Honshu—Echigo. On *Pirus sinensis* LINDL. var. *culta* MAKINO (Nashi). Honshu—Rikuchu, Musashi, Echigo, Bitchu, Inaba. Shikoku—Iyo. Kyushu—Hizen.

Distrib. Japan (Honshu, Shikoku, Kyushu and Formosa), China and Europe.

Remarks. SAWADA proved that this species does not infect *Morus multicaulis*, but does infect *Pirus Lindleyi*, and that the conidia of Phyllactinia on *Alnus formosana, Diospyros Kaki, Sapium sebiferum* and *Broussonetia papyrifera* do not infect *Pirus serotina*. Besides, the conidia of the present species have a constriction at the middle portion, and their internal mycelium is composed of three cells, and produces a tubercular process near the apex. Compared with "*Erysiphe Pyri* CAST." on *Pirus communis* it is always 2-spored in an ascus. From the above mentioned characters, the present fungus was regarded as a new species by SAWADA.

The writer has studied the form on *Pirus communis* which was collected in this country, and found it to be similar to the form on *Pirus sinensis*. Then, it seemed that the present species should be compared with the original specimen of Phyllactinia on the European *Pirus communis*. Very kindly, a part of the specimens of *Phyllactinia suffulta* (REBENT.) SACC. f. *Pyri* REHM on Pyrus of "REHM's Ascomyceten, No. 797" was given to the writer by Sir ARTHUR HILL, the Director of the Royal Botanic Gardens, Kew, upon request. The result of the careful examination of this specimen is as follows:

Hypophyllous, mycelium persistent; perithecia 182–224 μ; cells 16.8–24.0 × 12.0–16.8 μ in size; appendages 8–10 in number, 280 μ in length; asci 13–20 in number, 68.4–76.8 × 33.6–37.2 μ in size; spores two, 31.2–36.0 × 16.0–16.8 μ in size. In this form, 2 spores were included in an ascus, although the spores had been recorded as 2–4 in number in the original description of H. REHM. The form of our collections and the European form are similar in characters in all essential points.

Phyllactinia Actinidiae-formosanae SAWADA

Depart. Agr. Govern. Research Inst. Formosa, Japan, Rep. XLIX, p. 56 and 82, 1930, and LXI, p. 29, 1933.

Hypophyllous, mycelium evanescent; "conidia solitary, clavate or elongate-obovate, 52–104 × 23–36 μ in size, vacuolate, granulate, rounded at the apex" (acc. to Sawada, p. 56); perithecia gregarious or scattered, depressed-globose to lenticular, 200–280 μ in diameter; cells obscure; appendages 9–15 in number, 287–564 μ in length, hyaline, blunt at the apex; asci about 9, stalked, ellipsoidal or ovate, 52.8–57.6 × 24.0–26.4 μ; spores immatured.

Hab. On leaves of *Actinidia formosana* Hay. (Taiwan-sarunashi). Formosa—Daihoku.

Distrib. Japan (Formosa).

Remarks. The present species is related to *Phyllactinia Fraxinii* on *Actinidia arguta*. In the form on *Actinidia arguta*, the conidia have a distinct papilla at the apex, the asci are more numerous and larger, besides, the appendages are acute at the apex.

Phyllactinia quercus (MÉR.) HOMMA, comb. nov.

(Pl. XI, fig. 13)

Syn. *Erysiphe quercus* MÉRAT, Rév. Fl. Par. p. 459, 1843.

Phyllactinia guttata LÉV. Ann. Sci. Nat. III, 15, p. 144 (p.p.), 1851; COOKE, Handb. Brit. Fung. II, p. 646 (p.p.), 1871. (FUCK. Symb. Myc. p. 80 (p.p.), 1869–70).

Phyllactinia suffulta SACC. Mich. II, p. 50 (p.p.), 1880; SACC. Syll. Fung. I, p. 5 (p.p.), 1882; WINT. in RABENH. Krypt. Fl.

Deutschl. I, 2, p. 42 (p.p.), 1884; BURR. & EARLE, Bull. Ill. Stat. Lab. Nat. Hist. II, p. 441 (p.p.), 1887; ELL. & EVERH. N. Amer. Pyren. p. 20 (p.p.), 1892; SCHRÖT. in COHN'S Krypt. Fl. Schles. III, p. 246 (p.p.), 1893; JACZEW. Bull. l'Herb. Boiss. IV, p. 736 (p.p.), 1896; MAGNUS, Erysiph. Tirol. p. 22 (p.p.), 1898.

Phyllactinia corylea KARST. in SALM. Monogr. Erysiph. p. 224 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 200 (p.p.), 1902; NEGER, Krypt. d. Mark. Brand. VII, p. 134 (p.p.), 1905; TAI & WEI, Sinensia, III, p. 124 (p.p.), 1932. (SALM. Bull. Torr. Bot. Club, XXVII, p. 445 (p.p.), 1900, Ann. Myc. III, p. 251 (p.p.), 1905; SHIRAI, List, p. 68 (p.p.), 1905; Ideta, Jap. Phytopath. p. 251 (p.p.), 1911; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 72 (p.p.), 1914; SHIRAI & MIYAKE, List. p. 443 (p.p.), 1917; SHIRAI & HARA, List, p. 266 (p.p.), 1927).

Hypophyllous, mycelium subpersistent; perithecia scattered, depressed-globose to lenticular, 266–322 μ in diameter; cells 13.2–13.6 × 9.6–10.6 μ in size; appendages 16–21 in number, hyaline, straight, bulbous at the base, aseptate, needle-shaped, 252–329 μ in length; asci numerous, about 38 in number, stalked, reaching 21.6 μ in length, elongate-ellipsoidal, 69.6–93.6 × 28.8–38.4 μ; spores usually 2, rarely 3, ellipsoidal, frequently including well-developed fibrosin bodies, 30.0–44.4 × 20.4–25.2 μ in size.

Hab. On leaves of *Castanea crenata* SIEB. & ZUCC. (Kuri). Honshu—Hitachi, Izu. Kyushu—Higo.

On *Quercus serrata* THUNB. (Konara). Kyushu—Higo.

On *Quercus variabilis* BLUME (Abemaki). Kyushu—Higo.

Distrib. Japan (Honshu and Kyushu), China, Europe and North America.

Remarks. In *Quercus serrata* and *Castanea crenata*, many species of Erysiphaceae are frequently found parasitic on the same leaf, but the present species can easily be distinguished from others by its larger parithecia. In this species, the size of the perithecia is greater than that of *Phyllactinia Fraxini* and the mycelial patches are more or less thinner. Compared with *Phyllactinia imperialis*, the diameter of the perithecium is smaller in the species under consideration and the asci are 38 to a perithecium, while in *Phyllactinia imperialis*, they are 15–20.

Phyllactinia imperialis MIYABE, in sched. Herb. Hokkaido Imp. Univ.

(Pl. XI, fig. 14)

Syn. *Phyllactinia corylea* KARST. in SALM. Ann. Myc. IV, p. 10 (p.p.), 1908. (SHIRAI & MIYAKE, List, p. 443 (p.p.), 1917; IDETA, Jap. Phytopath. (Suppl. I), p. 217 (p.p.), 1923; SHIRAI & HARA, List, p. 266 (p.p.), 1927; HARA, Dendropath. p. 28 (p.p.), 1932).

Amphigenous, mostly hypophyllous, mycelium persistent, at first forming white patches on the leaves and finally effused over the lower surface, and turning to a brownish color; matured conidia solitary, very large, vacuolate, granulate, broadly clavate or lemon-shaped, not papillate, 60.0–76.8 × 24.0–40.8 μ; perithecia gregarious or scattered, depressed-globose to lenticular, 294–364 μ in diameter; cells 20.9–28.5 × 19.0–28.8 μ in size; appendages 19–25 in number, straight, simple, with sharp apex and bulbous base, 154–476 μ in length, aseptate; penicillate cells, stalk-cells 50.4–72.0 × 12.0–26.4 μ in size, frequently bifurcate at the upper part, branches about 14–20 in number, 33.6 μ in length; asci 15–20 in number, elongate-ovate, stalked, 79.2–98.2 × 34.8–45.6 μ; spores always 2, oblong or ovate, 33.6–40.8 × 19.2–26.4 μ.

Hab. On leaves of *Paulownia tomentosa* STEUD. (Kiri). Hokkaido—Shiribeshi, Ishikari. Honshu—Mutsu, Rikuchu, Rikuzen, Ugo, Musashi, Echigo, Etchu, Echizen, Kaga, Yamashiro, Inaba. Shikoku—Iyo. Kyushu—Higo.

Distrib. Japan (Hokkaido, Honshu, Shikoku and Kyushu).

Remarks. The form on *Paulownia tomentosa* was named *Phyllactinia imperialis* by Prof. MIYABE in 1900. In this fungus, the perithecia and conidia are remarkably large in size.

In 1900, SALMON noted, "Professor MIYABE has sent me specimens of a very beautiful form on *P. corylea* from Japan, growing on *Paulownia imperialis*. The form is remarkable for its large size. Many of the perithecia reach a diameter of 350 μ; the appendages are more numerous than usual, being sometimes as many as 25, when they are arranged so closely round the perithecium that their bulbous bases touch one another. In these perithecia the asci and spores show, likewise, a tendency to be larger than usual. Intermixed with these large perithecia, however, are others which, in the smaller size of all their parts, agree perfectly in every respect with ordinary *Phyl. corylea*. Altogether, we cannot consider that the *Phyllactinia* on *Paulownia* is anything but a luxuriant form of *P. corylea*, which it would be inadvisable to separate even as a variety. It is most probable that further search on other Japanese plants would bring to light a complete series of forms of *Phyllactinia* intermediate in size between this large form on *Paulownia* and those of normal size". The writer has made very careful comparative studies on this species using many specimens from every part of this country. As the result of the observation, it clearly should be recognized as a distinct species from the following characters: the conidia are much larger and broadly clavate or lemon-shaped, with rounded apex, the diameter of the perithecia is remarkably large, reaching 364 μ and appendages are 19–25 in number.

The leaves of *Paulownia tomentosa* fall early in autumn when affected, thereby greatly injuring the growth of the tree.

Phyllactinia Actinidiae-latifoliae SAWADA

Depart. Agr. Govern. Research Inst. Formosa, Japan, Rep. XLIX, p. 57 and 82, 1930, and LXI, p. 30, 1933.

Hypophyllous, mycelium persistent, at first forming white patches and finally becoming a light brown color; "conidia solitary, fusiform-ellipsoidal or spindle-shaped, not papillate, granulate, vacuolate, 50–102 × 22–35 μ in size". (acc. to Sawada, p. 58) ; perithecia scattered, depressed-globose to lenticular, 350–434 μ in diameter; cells 14.4–16.8 × 10.8–12.0 μ in size; appendages 18–24 in number, straight, blunt at the apex, 280–574 μ in length; penicillate-cells, stalk-cells 16.8–21.6 × 4.8–7.2 μ in size, branches 8–11 in number, 19.2–24.0 μ in length; asci 20–24 in number, elongate-ellipsoidal or cylindrical, stalked, 64.8–84.6 × 21.6–28.8 μ; spores immatured.

Hab. On leaves of *Actinidia latifolia* NAKAI (Birodo-sarunashi). Formosa—Daihoku.

Distrib. Japan (Formosa).

Remarks. Mr. SAWADA kindly gave the writer a very beautiful co-type specimen. This made it possible to make a careful comparative study with the other species on Actinidia. The perithecia and conidia of the present species are much larger and the appendages are more numerous than those of the other species. Compared with

Phyllactinia imperialis which has a large perithecium, that of the present form is even larger. According to the description of SAWADA, the asci are said to be immature, but the present writer found that the asci are already produced in many perithecia, although the ascospores are in an immature stage.

Ovulariopsis belonging to Phyllactinia

Ovulariopsis Alni-formosanae SAW.
  On *Alnus formosana* (Burkill.) MAK. (Taiwan-hannoki)
Ovul. Asclepiadis-curassavicae SAW.
  On *Asclepias curassavica* L. (Towata)
Ovul. Ampelopsidis-heterophyllae SAW.
  On *Ampelopsis heterophylla* S. & Z. (No-budo)
Ovul. Ampelopsidis-ciliatae SAW.
  On *Ampelopsis heterophylla* S. & Z. var. *ciliata* NAKAI (Ke-nobudo)
Ovul. Cephalanthi SAW.
  On *Cephalanthus occidentalis* L. (Tamakasanoki)
Ovul. Caricae SAW.
  On *Carica Papaya* L. (Papaya).
Ovul. Macarangae SAW.
  On *Macaranga Tanarius* (L.) MUELL. Arg. (Ohbagi)
Ovul. Salicis-Warburgi SAW.
  On *Salix glandulosa* SEEM. var. *Warburgi* (SEEM.) KOIDZ. (Taiwan-yanagi)
Ovul. Broussonetiae-papyriferae SAW.
  On *Broussonetia papyrifera* VENT. (Kajinoki)

The above 9 species of Ovulariopsis were described by SAWADA in the Reports of the Department of Agriculture Government Research Institute Formosa, Japan, No. 49, 1930 and No. 61, 1933.

Uncinulopsis SAWADA

Mycelial hyphae in two forms, external and internal, sending special branches from the external mycelium through stomata into intercellular spaces of the mesophyll and producing haustoria in the surrounding cells. Conidiophore formed from the external mycelium, is long, producing true spirals at the base. Matured conidia solitary, elongate-ellipsoidal or clavate. Perithecia large, lenticular in shape; appendages numerous, simple, uncinate at the apex; asci many and spores 2–4 in number.

The genus includes a single species, *Uncinulopsis Shiraiana,* in this country.

Uncinulopsis Shiraiana (P. Henn.) Hara

(Pl. XI, fig. 4)

Dendropath. p. 26, 1923; Tai & Wei, Sinensia, III, p. 122, 1932.

Syn. *Uncinula polychaeta* (not of B. & C.) Salm. Monogr. Erysiph. p. 113 (p.p.), 1900, and Bull. Torr. Bot. Club, XXIX, p. 101, 1902. (Matsum. Ind. Plant. Jap. I, p. 178, 1904; Salm. Ann. Myc. III, p. 253, 1905, and VI, p. 12, 1908; Shirai, List, p. 103, 1905; Yoshino, Bot. Mag. Tokyo XIX, p. 206, 1905; Ideta, Jap. Phytopath. p. 214, 1911; Shirai & Miyake, List, p. 677, 1917).

Uncinula Shiraiana P. Henn. in Engl. Bot. Jahrb. XXIX, p. 148, 1901; Sacc. Syll. Fung. XVI, p. 400, 1902. (Shirai, List, p. 103, 1905; Shirai & Miyake, List, p. 679, 1917).

Phyllactinia corylea Karst. var. *subspiralis* Salm. Ann. Myc. III, p. 501 (p.p.), 1905.

Phyllactinia subspiralis Sawada, Agric. Exp. Stat. Formosa, Bull. IX, p. 75, 1914.

Uncinulopsis subspiralis Sawada, Trans. Form. Nat. Hist. Soc. XXIII, p. 34, 1916, and Agric. Exp. Stat. Formosa, Bull. XIX, p. 182, 1919.

Hypophyllous, mycelium persistent, forming dense white masses; matured conidia solitary, elongate-ellipsoidal or clavate-ellipsoidal, not papillate, 45.6–57.6 × 14.4–18.0 μ in size; conidiophore long, thin-walled, forming sinistrorse spirals, 3 or 4 times at the base; perithecia scattered, large, lenticular in shape, 196–322 μ in diameter; cells 16.8–21.6 × 10.8–13.2 μ in size; appendages very numerous, hyaline, aseptate, variable in length, 112–210 μ, rarely 72 μ, simple, slender, flexuous, apex uncinate or helicoid; asci 20–40 in number, elongate-ovate or elongate-ellipsoidal, stalked, 72.8–92.0 × 24.0–36.0 μ; spores 3–4, usually 3, very rarely 2, subglobose, oblong or ovate, 19.2–30.0 × 13.2–21.6 μ.

Hab. On leaves of *Celtis sinensis* Pers. (Enoki). Honshu—Musashi, Hitachi, Etchu, Kaga, Suruga, Mino, Kai, Bitchu, Inaba, Hoki. Shikoku—Awa. Kyushu—Hizen, Higo, Satsuma. Formosa—Daihoku.

Distrib. Japan (Honshu, Shikoku, Kyushu and Formosa) and China.

Remarks. The first record of the presence of the present species in Japan was by Salmon in 1900, based on the specimen sent by Prof. Miyabe, accompanied with a note, "*Uncinula* n. sp. related to

U. polychaeta, but trisporous, on *Celtis sinensis* (as *Aphananthe aspera*), Tokyo, Japan, October 29, 1895 (K. SENGOKU)". It was noted by SALMON that in this Japanese specimen most of the asci are 3-spored, although there may be frequently found 2-spored ones, and the fungus is evidently to be referred to *U. polychaeta.*

In 1901, P. HENNINGS published a new species under the name of *Uncinula Shiraiana* parasitic on *Celtis sinensis* which was collected in Tokyo, Oct. 26, 1899, by S. KUSANO. He noted that this species is distinguished from the American *Uncinula polychaeta* by the more numerous asci, and by the presence of 3 or 4 yellowish colored spores.

In 1905, SALMON reported a new variety, *subspiralis* of *Phyllactinia corylea* on *Dalbergia Sissoo* as the result of studies on the conidial stage of *Phyllactinia corylea,* and remarked that the perithecial stage of this fungus was still unknown.

In 1914, SAWADA reported that the conidial stage on *Celtis sinensis* belongs to *Phyllactinia corylea* var. *subspiralis* SALM. and he elevated it to specific rank as *Phyllactinia subspiralis* (SALM.) SAWADA.

In the form on *Dalbergia Sissoo,* the conidia are about 52.5–102.5 × 12.5–28.8 μ in size, and in the form on *Celtis sinensis,* they are 45.6–57.6 × 14.4–18.0 μ in size. Further, in the latter, the number of spirals in less than in the former. Therefore, the present writer could not recognize these two forms as the same species.

In 1916, SAWADA found a small number of the perithecia of the fungus in question on *Celtis sinensis* collected by Y. FUJIKURO. These perithecia are entirely similar in character to those of Uncinula. For the above reasons, he established a new genus, Uncinulopsis. He transferred his *Phyllactinia subspiralis* to the new genus and named it, *Uncinulopsis subspiralis* SAWADA. The perithecial stage of this fungus had been named *Uncinula Shiraiana* by P. HENNINGS in 1901, and K. HARA transferred it to the Uncinulopsis of SAWADA in 1923.

On the other hand, the writer compared *Uncinulopsis Shiraiana* with *Uncinula polychaeta* on *Celtis mississippiensis* (Starkville, Miss. U.S.A. Oct. 1894, S. M. TRACY), on *Celtis occidentalis* (Starkville, Miss., Nov. 15, 1895, S. M. TRACY), and on *Celtis reticulata* (Georgtown, Texas, Aug. 27, 1909, F. D. HEALD & F. A. WOLF), and also with *Uncinula polychaeta* which was collected in this country, especially with those which were identified as *Uncinula polychaeta* by SALMON. The perithecia are entirely similar to those of Uncinula in all these specimens, but the typical club shaped conidia were found on *Celtis occidentalis.* Also, in the form on *Celtis reticulata,* the inner mycelium was recognized. From the above mentioned facts, we may infer that polychaeta should be included in the genus Uncinulopsis. In the American *Uncinulopsis polychaeta* (B. & C.) HOMMA, the asci are cylindrical in shape, and the ascospores are elongate-oblong or cylindrical; the width of the asci and ascospores is narrower, the number of the ascospores is always 2, also the appendages are frequently remarkably flexuous, and more or less wider. *Uncinulopsis polychaeta* is easily distinguished from *Uncinulopsis Shiraiana.*

Subfam. Leveilluleae ARN.

Mycelium is endophytic, sending haustoria into the surrounding mesophyll cells of the leaf tissue. Matured conidia (Oidiopsis) are produced solitary on the conidiophores arising from the inner hyphae passing through the slits of the stomata.

One genus, Leveillula.

Leveillula ARN.

The perithecial stage of the genus has not yet been collected in this country.

In 1902, SCALIA (155) described a new genus Oidiopsis in Mucedinaceae. In this genus, the conidiophores are produced through the stomata from the inner mycelium, and the conidia are produced at the apex. The conidia are subclavate in shape. The form on *Asclepias curassavica* was included in this genus under the name of *Oidiopsis sicula* SCALIA.

In 1905 (144), SALMON published a paper on an endophytic species of the Erysiphaceae in which he noted on the endophytic habit of *Erysiphe taurica* parasitic on *Euphorbia lanata, Psoralea drupacea, Clematis songarica, Verbascum* sp., *Odontospermum aquaticum* and *Nepeta podostachys.* In 1906, (145) he determined that the conidial stage of *Erysiphe taurica* belongs to Oidiopsis. He found that *Oidium gigasporium* on *Ballota rupestris* is really the conidial stage of *E. taurica* proved by the presence of the perithecial stage of the fungus on *Ballota rupestris,* and moreover such a relation was confirmed by the discovery of the occurrence of both perithecial and conidial stages of *E. taurica* on many other host plants. SALMON transferred Oidiopsis from Mucedinaceae to Erysiphaceae, making necessary emendations on its characters and he changed *Erysiphe taurica* LÉV. to *Oidiopsis taurica* (LÉV.) SALM.

In 1921 (49), ARNAUD published his opinion, that the genus Oidiopsis ought to be retained as a genus of Mucedinaceae, as it is a case of Oidium. He therefore proposed a new genus Leveillula from the characters of the perithecial stage, and *Oidiopsis taurica* was included in this genus as *Leveillula taurica.*

Genus Oidiopsis was emended in the characters of the asco-stage by SALMON, but the writer wished to retain it as the name of the conidial stage with Oidium and Ovulariopsis. We have followed in this paper the opinion of ARNAUD and accepted the name Leveillula.

This genus includes one species.

Leveillula taurica (LÉV.) ARNAUD

(Pl. XI, fig. 15)

Ann. d. Epiph. VII, p. 92, 1921; ŠKORIĆ, Erysiph. Croat. p. 56, 1926.

Syn. *Erysiphe taurica* LÉV. in DÉMIDOFF's Voy. Russ. Mérid. (bot.) p. 119, 1842, and Ann. Sci. Nat. III, 15, p. 161, 1851; SACC. Syll. Fung. I, p. 16, 1882; SALM. Monogr. Erysiph. p. 215, 1900, and Bull. Torr. Bot. Club, XXIX, p. 197, 1902; NEGER, Krypt. d. Mark Brand. VII, p. 115, 1905; KLIKA, Erysiph. Czechosl. p. 63, 1924.

Oidiopsis sicula SCALIA, Rendiconti del Congresso Bot. Palermo, p. 10, 1902; SACC. Syll. Fung. XVIII, p. 507, 1906.

Erysiphe Asterisci P. MAGN. Hedw. XLIV, p. 16, 1905.

Oidiopsis taurica (LÉV.) SALM. emend. Ann. Bot. XX, p. 187, 1906; FOËX, Ann. L'Ecole nat. d'Agric. Montp. VIII, p. 176, 1909; SAWADA, Agr. Exp. Stat. Formosa, Bull. IX, p. 77, 1914. (DOIDGE, Roy. Soc. South Afr. V, p. 243, 1915; SHIRAI & HARA, List, p. 237, 1927).

Hypophyllous, mycelium intercellular; conidiophores simple or branched, produced as special branches from the inner mycelium and sent out through the stomata; matured conidia solitary, cylindrical, clavate or elongate-ovate in shape, granulate, 50.4–72.0 × 14.4–21.6 μ. "Perithecia scattered or gregarious, usually more or less immersed in the persistent mycelium, large, 135–240 μ in diameter, usually about 200 μ, soon becoming concave, cells obscure; appendages usually very numerous, densely interwoven, rather short, more or less vaguely branched, colorless or brown, sometimes very short or even obsolete; asci 7–38, usually about 20, large, from narrowly cylindrical to ovate, usually long pedicellate, 75–110 (usually about 90) × 28–40 μ; spores 2, large, variable in size, usually about 32 × 18 μ, but varying from 28–40 × 14–22 μ, sometimes slightly curved." (Salm. Monogr. Erysiph. p. 216).

Hab. On leaves of *Capsicum annuum* L. (Togarashi). Formosa—Daihoku, Roshusho.

Distrib. Tropical and subtropical regions of the world.

Remarks. In 1824, the present species was published under the name of *Erysiphe taurica* by LÉVEILLÉ. Since then, for a long time this fungus was included in Erysiphe by all authors. In 1906, it was transferred to *Oidiopsis taurica* by SALMON, and in 1921, it was revised as *Leveillula taurica* by ARNAUD.

In 1933, K. SAWADA described two new species of *Oidiopsis Capsici* and *O. Papaveris*. The perithecial stage has not yet been found in either species. They will be treated here tentatively as the conidial stage of *Leveillula taurica.*

This species is widely distributed mostly in the tropics. The specimen which was kindly sent to Prof. MIYABE by Mr. K. SAWADA was in the conidial stage.

Conidial stages of Erysiphaceae

In the following four species, the perithecial stages have not yet been collected in this country.

Erysiphe Cinnamomi SAWADA

Agr. Exp. Stat. Formosa Bull. XIX, p. 144, 1919; HARA, Dendropath. p. 4, 1923.

Amphigenous, mostly hypophyllous, mycelium persistent or evanescent; conidiophores 20.4–55.2μ in length, matured conidia produced in a chain, ellipsoidal, granulate, 25.2–31.2 × 14.4–16.8μ.

Hab. On leaves of *Cinnamomum nominale* Hayata (Kusunoki-damashi). Formosa—Daito, Daihoku.

Remarks. SAWADA established the present species based on the characters of the conidial stage only. The present writer was able to examine the specimen of this species by his kindness, but she could not very well distinguish it from the conidial stage of *Erysiphe Cichoracearum,* as the conidia of *E. Cichoracearum* are widely variable in shape and size.

Microsphaera Mougeotii LÉV.

in P. HENN. Engl. Bot. Jahrb. XXXIV, p. 600, 1905. (SHIRAI, List, p. 55, 1905; SHIRAI & MIYAKE, List, p. 367, 1917; IDETA, Jap. Phytopath. p. 206, 1911; HARA, Dendropath. p. 14, 1923; SHIRAI & HARA, List, p. 217, 1927).

Amphigenous, mostly epiphyllous, mycelium persistent or evanescent; matured conidia produced in a chain, ellipsoidal, granulate, 24.0–26.4 × 14.4–15.6μ.

Hab. On leaves of *Lycium chinense* Mill. (Kuko). Honshu—Musashi, Inaba. Shikoku—Tosa.

Remarks. In 1905, the mildew on *Lycium chinense* which was collected in Kochi, May 14, 1902, by T. YOSHINAGA was identified as *Microsphaera Mougeotii* by P. HENNINGS. The co-type specimen was kindly sent us from Mr. YOSHINAGA. We examined the specimen carefully, but the perithecia could not be found on it. Perhaps, P. HENNINGS may have determined it by the characters of the conidial stage, although he said nothing about them. The numerous specimens of the present fungus collected in different parts of this country are all in the conidial stage and are lacking in the perithecial stage. The conidia of this fungus are produced in a perfect chain, showing that the fungus belongs to the genus *Erysiphe* rather than to *Microsphaera*.

Microsphaera Astragali (DC.) TREV.

in SAWADA, Agr. Exp. Stat. Formosa Bull. IX, p. 57, 1914; SHIRAI & MIYAKE, List, p. 365, 1917; SHIRAI & HARA, List, p. 216, 1927.

Amphigenous, mycelium evanescent or subpersistent, thinly effused; conidiophores 26.4–48.0 μ in length, matured conidia solitary, ellipsoidal or ovate, vacuolate, granulate, 28.0–43.2 × 12.0–20.4 μ in size.

Hab. On leaves of *Astragalus sinicus* L. (Genge). Honshu—Etchu, Bizen, Bitchu. Formosa—Daihoku.

Remarks. The writer could not distinguish whether the present fungus belongs to *Microsphaera Astragali* or *Erysiphe Pisi* by the conidial characters only, as both of these species have such similar characters in conidia.

Oidium Euonymi-japonicae (ARC.) SACC.

in SALM. Ann. Myc. III, p. 1, 1905; SACC. Syll. Fung. XVIII, p. 506, 1906, and Ann. Myc. VIII, p. 346, 1910; LIND. in RABENH. Krypt. Fl. Deutschl. IX, p. 726, 1910; LIND, Danish Fung. p. 165, 1913. (SHIRAI & HARA, List, p. 397, 1917).

Syn. *Oidium leucoconium* DESM. var. *evonymi-japonicae* ARCANG. Proc. Verb. Soc. Toscana Sci. Nat. XII, p. 108, 1900.

Microsphaera Euonymi-japonicae (SALM.) HARA, Bull. Agr. Soc. Shizuoka Prefecture, No. 282, p. 29–30, 1921.

Uncinula Euonymi-japonicae (SALM.) HARA, Dendropath. p. 22, 1923.

Amphigenous, mostly epiphyllous, mycelium persistent, forming dense white masses; conidiophores 39.2–75.0 μ in length, matured conidia solitary or in a chain, granulate, ellipsoidal in shape, 21.6–38.0 × 13.2–15.6 μ.

Hab. On leaves of *Euonymus japonicus* Thunb. (Masaki). Honshu—Musashi, Awa, Sagami, Echigo, Etchu, Suruga, Bitchu. Kyushu—Higo.

Remarks. In 1905, SALMON noted that the conidia are borne either singly at the apex of the conidiophore, or in chains of two or three. In 1921, K. HARA transferred it to *Microsphaera Euonymi-japonicae* (SALM.) HARA for the reason that the conidia are solitary and granulate and have no fibrosin bodies. In 1923, the same author noted it again under the name of *Uncinula Euonymi-japonicae*

(SALM.) HARA because of the conidial characters. In all Japanese specimens, the fungus is found always in the conidial stage as is in the case of Europe. The conidia are solitary, or two or three in a chain, as the apical conidium falls off more easily than in the case of other related species. Judging from the conidial characters, the fungus may most likely belong to Uncinula but it seems to the writer better to consider it as a species of Oidium, until its perithecial stage is collected.

Conclusion

General Part

1. The conidia are produced in the same way in all genera of Erysiphaceae, that is, in a chain. The conidia of Uncinula, Microsphaera, Erysiphe (Polygoni section), Phyllactinia, Uncinulopsis, and Leveillula have been thought to be produced solitarily at the tips of septated conidiophores. But two or three immature conidia are always found just under a matured spore.

2. In the structure of the perithecium, that of Cystotheca is most simple, and that of Uncinulopsis and Phyllactinia is most complex.

3. The perithecia of *Sphaerotheca fuliginea* parasitic on *Taraxacum ceratophorum* are produced on the hyphae originated from a single conidium.

4. When the conidia of *Erysiphe graminis* f. sp. *Tritici* were inoculated on the immune and susceptible varieties of wheat, the infection-tube produced from the appressorium of the germ-tube penetrated into the cell wall of the epidermis in both varieties. But, in the susceptible varieties, the haustoria were formed in the epidermal cells after two or three days from the inoculation, while in the immune varieties, they were never produced.

5. When the physiological condition of the host plant was divided into three stages of the growth, maturity and senility, the infection of the conidia did not take place in the early growing stage nor in the late senile stage, the mycelial growth was most vigorous in the mature stage, and the formation of perithecia generally took place in the early senile stage.

6. *Triticum dicoccum, Emmer* 3933, *T. dicoccum, Khapli* 6400, *T. boatum* and *Russian* No. 38 proved to be immune to *Erysiphe graminis* f. sp. *Tritici* which was collected in the experimental field of this University. Other species and varieties of wheat, which were used in the present experiments, proved to be either resistant or susceptible.

7. The susceptible and resistant varieties could be distinguished by the difference in the morphological characters of the leaf, such as the number of hairs on the surface of the leaf, and the thickness of the epidermal wall.

Systematic Part

8. In the present paper, the writer has reported on seventy-four species of Japanese powdery mildew fungi, belonging to eleven genera. Among them, *Microsphaera Ligustri, M. Coryli, M. Abeliae, M. Viciae-unijugae, Sawadaea Negundinis, Uncinula bifurcata, U. Picrasmae, U. Betulae* and *U. Nishidana* were added as new to science. Besides, as far as possible the conidial diagnoses have been added to the description of each species.

9. Each species was determined by its morphological characters and the species which were established because of the physiological characters were included under the original species as specialized forms.

10. In the determination of the species, numerous specimens collected in every part of this country were studied paying attention to variation in form and color and especially to the abnormal forms.

11. Cystotheca is regarded here as a genus belonging to the Erysiphaceae.

12. Japanese oak-mildew (*Microsphaera alphitoides*) is similar to the European oak-mildew and differs evidently from the American.

13. Typhulochaeta is the only genus endemic to Japan.

Host index

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Explanation of Plates

In the explanation of plates unless otherwise stated, all figures are magnified × 230.

Plate IV, A

Formation of conidia

Fig. 1. *Sphaerotheca fuliginea* on *Taraxacum ceratophorum.*
  a. Young conidiophore. b. Spore-mother cell on conidiophore.
  c–e. Chain of spores on spore-mother cell.
Fig. 2. *Podosphaera tridactyla* on *Prunus triflora.*
  Chain of spores on spore-mother cell; two nuclei in conidiophore.
Fig. 3. *Erysiphe Cichoracearum* on *Plantago major* var. *asiatica.*
  a. Young conidiophore. b. Spore-mother cell on conidiophore.
  c–e. Chain of spores on spore-mother cell.
Fig. 4. *Erysiphe graminis* on *Triticum vulgare.*
  a–c. Young conidiophore.
  d. Spore-mother cell on conidiophore.
  e–j. Chain of spores on spore-mother cell.
Fig. 5. *Erysiphe Polygoni* on *Polygonum aviculare.*
  a–c. Young conidiophore.
  d. Spore-mother cell on conidiophore.
  e–h. Chain of spores on spore-mother cell.
Fig. 6. *Uncinula Actinidiae* on *Actinidia arguta.*
  a. Young conidiophore.
  b. Spore-mother cell on conidiophore.
  c. Young conidium on spore-mother cell.
Fig. 7. *Microsphaera alphitoides* on *Quercus crispula.*
  a–b. Young conidiopohre.
  c. Spore-mother cell on conidiophore.
  d–e. Young conidium on spore-mother cell.
Fig. 8. *Phyllactinia imperialis* on *Paulownia tomentosa.*
  a–b. Young conidium on spore-mother cell.
  c–d. Chain of spores on spore-mother cell.

Plate IV, B

Structure of perithecia, × 250.

Fig. 1. *Cystotheca Wrightii* on *Quercus glauca.*
Fig. 2. *Cystotheca lanestris* on *Quercus serrata.*
Fig. 3. *Sphaerotheca fuliginea* on *Taraxacum ceratophorum.*
Fig. 4. *Podosphaera tridactyla* on *Prunus triflora.*
Fig. 5. *Typhulochaeta japonica* on *Quercus serrata.*
Fig. 6. *Uncinulopsis Shiraiana* on *Celtis sinensis.*

Fig. 7. *Erysiphe Cichoracearum* on *Plantago major* var. *asiatica*.
Fig. 8. *Uncinula Actinidiae* on *Actinidia arguta*.
Fig. 9. *Microsphaera Alni* on *Picrasma quassioides*.
  a. Perithecium.
  b. Young appendage.
Fig. 10. *Sawadaea Tulasnei* on *Acer pictum*.
Fig. 11. *Phyllactinia imperialis* on *Paulownia tomentosa*. •
  a. Perithecium, × 130.
  b. Penicillate cell.

Plate V

Formation of perithecia in *Sphaerotheca fuliginea* on *Taraxacum ceratophorum*

Fig. 1–2. Male and female branches, × 720.
Fig. 3–4. Antheridium and ascogonium, × 720.
Fig. 5. Antheridial and ascogonial hyphae coiled each other, × 510.
Fig. 6. Male and female nuclei in ascogonium, × 720.
Fig. 7. Young ascus, including two nuclei, × 720.
Fig. 8. Young ascus, including a large nucleus, × 720.

Plata VI, A

Formation of perithecia in *Sphaerotheca fuliginea* on *Taraxacum ceratophorum*

Fig. 1. Male and female branches, × 340.
Fig. 2–3. Antheridium and ascogonium, using the living sample, Fig. 2, × 340, fig. 3, × 300.
Fig. 4–5. Primary perithecial wall cells from stalk-cell of ascogonium, × 340.
Fig. 6–7. Male and female nuclei in ascogonium, × 340.
Fig. 8. Primary wall closed at upper part of ascogonium, using the living sample, × 300.
Fig. 9. Conjugated nucleus, × 340.
Fig. 10. Two nuclei formed by division, × 340.
Fig. 11. Two cells from ascogonium, × 340.
Fig. 12–13. Three cells from ascogonium, × 340.
Fig. 14. Young ascus including a large nucleus and binucleated perithecial wall cells, × 340.
Fig. 15. Two nuclei in ascus, × 340.
Fig. 16. Four nuclei in ascus, × 340.
Fig. 17. Outer and inner perithecial walls and young appendage, × 340.

Plate VI, B

Formation of perithecia

Fig. 1. *Cystotheca lanestris* on *Quercus serrata.*
a. Antheridium and ascogonium. b. Primary perithecial wall cells. c. Four cells from ascogonium, × 340.

Fig. 2. *Podosphaera tridactyla* on *Prunus triflora.*
a. Antheridium and ascogonium, using the living sample, × 300. b. Primary wall closed at upper part of ascogonium, using the living sample, × 300. c. Two cells from ascogonium, × 340. d. Four cells from ascogonium, × 340. e. Young ascus, × 340.

Fig. 3. *Erysiphe Cichoracearum* on *Plantago major* var. *asiatica.*
a. Male and female branches, using the living sample, × 300. b. Antheridium and ascogonium, using the living sample, × 300. c. Primary perithecial wall cells from stalk cell of ascogonium, using the living sample, × 300. d. Two nuclei in ascogonium, × 340. e. Two cells from ascogonium, × 340. f. Three cells from ascogonium, × 340. g. Ascogenous hypha in young perithecium, × 340. h. Young ascus from ascogenous hypha, × 340.

Fig. 4. *Uncinula Actinidiae* on *Actinidia arguta.*
a–b. Antheridium and ascogonium, using the living samples, × 300. c. Two cells from ascogonium, × 340. d. Three cells from ascogonium, × 340. e. Three perithecial walls, × 340.

Fig. 5. *Sawadaea Tulasnei* on *Acer pictum,* × 340.
a. Antheridium and ascogonium. b–d. Primary perithecial wall cells from stalk-cell. e. Two cells from ascogonium. f. Four asci.

Fig. 6. *Typhulochaeta japonica* on *Quercus serrata,* × 340.
a–b. Primary perithecial wall cells from stalk-cell. c. Ascogonium enclosed in primary perithecial wall. d. Ascogonium enclosed in two perithecial walls.

Fig. 7. *Microsphaera Alni* on *Picrasma quassioides,* × 340.
a. Antheridium and ascogonium. b. Two nuclei in ascogonium. c. Two cells from ascogonium. d. Three cells from ascogonium; two nuclei in second cell. e. Third perithecial wall cells formed from second wall. f. Fourth or fifth perithecial wall cells formed from third or fourth walls. g. Three young asci.

Plate VI, C

Infection with conidia of *Erysiphe graminis* parasitic on *Triticum vulgare.*

Fig. 1. Conidia after 1 day from inoculation.
Fig. 2. Conidia after 2 days from inoculation.
Fig. 3. Conidia after 3 days from inoculation.
Fig. 4. Conidia after 5 days from inoculation.
Fig. 5. Conidia after 7 days from inoculation.
Figs. 1–5, × 210.

Fig. 6. Penetration tube and incipient haustorium after 4 days from inoculation.

Fig. 7. Incipient haustorium after 5 days from inoculation.

Fig. 8–9. Haustoria after 10 days from inoculation.
6–8, × 340.

Fig. 10. Infection spots on stripped epidermis.
9–10, × 210.

Plate VI, D

Haustoria and inner mycelia.

Fig. 1. *Cystotheca lanestris* on *Quercus serrata*, × 340.
Fig. 2. *Sphaerotheca fuliginea* on *Taraxacum ceratophorum*, × 340.
Fig. 3. *Podosphaera tridactyla* on *Prunus triflora*, × 340.
Fig. 4. *Erysiphe Cichoracearum* on *Plantago major* var. *asiatica*, × 340.
Fig. 5. *Sawadaea Tulasnei* on *Acer pictum*, × 340.
Fig. 6. *Typhulochaeta japonica* on *Quercus serrata*, × 340.
Fig. 7. *Uncinula Actinidiae* on *Actinidia arguta*, × 340.
Fig. 8. *Microsphaera Alni* on *Picrasma quassioides*, × 340.
Fig. 9. *Uncinulopsis Shiraiana* on *Celtis sinensis*, × 340.
Fig. 10. *Phyllactinia imperialis* on *Paulownia tomentosa*, × 340.
Fig. 11. *Leveillula taurica* on *Capsicum annuum*, × 250.

Plate VII

Fig. 1. *Cystotheca Wrightii* on *Quercus glauca*.
a. Perithecia, × 85. b. Inner wall cells of perithecium. c. Hairs. d. Ascus. e. Conidia.

Fig. 2. *Cystotheca Wrightii* on *Pasania cuspidata*.
Conidia.

Fig. 3. *Cystotheca lanestris* on *Quercus major*.
a. Perithecium, × 85. b. Outer wall cells of perithecium. c. Inner wall cells of perithecium. d. Hairs. e. Ascus. f. Ascospores. g. Conidia.

Fig. 4. *Sphaerotheca Humuli* on *Agrimonia pilosa*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus. d. Ascospores. e. Conidia.

Fig. 5. *Sphaerotheca Humuli* on *Aruncus sylvester* var. *vulgaris*.
Ascus and ascospores.

Fig. 6. *Sphaerotheca Humuli* on *Spiraea Thunbergii*.
a. Perithecium, × 40. b. Appendages. c. Ascus.

Fig. 7. *Sphaerotheca Humuli* on *Veronica sibirica*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus. d. Two asci included in a perithecium.

Fig. 8. *Sphaerotheca Epilobii* on *Epilobium Behringianum.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendage. d. Ascus and ascospores.

Fig. 9. *Sphaerotheca Epilobii* on *Epilobium montanum.*
Conidia.

Fig. 10. *Sphaerotheca fuliginea* on *Taraxacum ceratophorum.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia.

Fig. 11. *Sphaerotheca fuliginea* on *Cucurbita moschata* var. *Toonas.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendage. d. Ascus. e. Conidia.

Fig. 12. *Sphaerotheca fuliginea* on *Adenocaulon bicolor.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia.

Fig. 13. *Sphaerotheca fuliginea* on *Phtheirospermum japonicum.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores.

Fig. 14. *Sphaerotheca fuliginea* on *Bidens pilosa.*
Branching appendage.

Fig. 15. *Sphaerotheca fuliginea* on *Siegesbechia orientalis.*
Branching appendage.

Fig. 16. *Sphaerotheca Mors-Uvae* on *Ribes grossularia.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia.

Fig. 17. *Sphaerotheca japonica* on *Stephanandra incisa.*
Perithecium, × 40.

Fig. 18. *Sphaerotheca pannosa* on *Rosa multiflora.*
Conidia.

Fig. 19. *Podosphaera leucotricha* on *Malus baccata* var. *mandschurica.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia.

Fig. 20. *Podosphaera tridactyla* on *Prunus triflora.*
a. Perithecium, × 100. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia.

Fig. 21. *Podosphaera spiralis* on *Ulmus japonica.*
a. Perithecium, × 100. b. Wall cells of perithecium. c. Ascus and ascospores.

Fig. 22. *Podosphaera Oxyacanthae* on *Spiraea salicifolia.*
a. Perithecium, × 100. b. Wall cells of perithecium. c. Ascus and ascospores.

Fig. 23. *Erysiphe Pisi* on *Desmodium podocarpum.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Asci and ascospores.

Fig. 24. *Erysiphe Pisi* on *Pisum sativum.*
Conidia and conidiophore.

Plate VIII

Fig. 1. *Erysiphe Pisi* on *Falcata japonica*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia.

Fig. 2. *Erysiphe Pisi* on *Alnus firma*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus.

Fig. 3. *Erysiphe Heraclei* on *Seseli Libanotis*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Ascus and ascospores.

Fig. 4. *Erysiphe Heraclei* on *Quercus glauca*.
a. Perithecium, × 40. b. Ascus and ascospores.

Fig. 5. *Erysiphe Heraclei* on *Torilis Anthriscus*.
Conidia and conidiophores.

Fig. 6. *Erysiphe Polygoni* on *Polygonum aviculare*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia and conidiophores.

Fig. 7. *Erysiphe Polygoni* on *Elsholtzia Patrini*.
a. Perithecium, × 40. b. Ascus. c. Conidia and conidiophores. d. Haustorium.

Fig. 8. *Erysiphe Polygoni* on *Sedum Telephium* var. *purpureum*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia.

Fig. 9. *Erysiphe Aquilegiae* on *Paeonia japonica*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Appendages.

Fig. 10. *Erysiphe Aquilegiae* on *Aquilegia flabellata* var. *pumila*.
Conidia.

Fig. 11. *Erysiphe Aquilegiae* on *Caltha palustris* var. *gigas*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Asci and ascospores.

Fig. 12. *Erysiphe graminis* on *Hordeum sativum*.
a. Perithecium, ×40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia and conidiophore.

Fig. 13. *Erysiphe Cichoracearum* on *Artemisia vulgaris* var. *kamtschatica*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Asci and ascospores. d. Conidia and conidiophore.

Fig. 14. *Erysiphe Cichoracearum* on *Plantago major* var. *asiatica*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia.

Fig. 15. *Erysiphe Galeopsidis* on *Lamium album* var. *barbatum*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Asci. d. Conidia and conidiophore.

Fig. 16. *Uncinula Clintonii* on *Celtis sinensis*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores.

Fig. 17. *Uncinula Clintonii* on *Tilia japonica.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendage. d. Asci and ascospores.

Fig. 18. *Uncinula Clintonii* on *Aphananthe aspera.*
a. Perithecium, × 100. b. Asci and ascospores.

Fig. 19. *Uncinula Zelkowae* on *Zelkowa serrata.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Ascus and ascospores. e. Conidia.

Fig. 20. *Uncinula clandestina* on *Ulmus japonica.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendage. d. Asci and ascospores.

Fig. 21. *Uncinula Delavayi* on *Cedrela sinensis.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Ascus and ascospores.

Fig. 22. *Uncinula bifurcata* on *Quercus serrata.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Ascus and ascospores.

Fig. 23. *Uncinula australiana* on *Lagerstroemia indica.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendage. d. Conidia.

Fig. 24. *Uncinula Sengokui* on *Celastrus articulata.*
a. Appendages. b. Ascus and ascospores. c. Conidia.

Plate IX

Fig. 1. *Uncinula Salmoni* on *Fraxinus mandschurica* var. *japonica.*
a. Wall cells of perithecium. b. Appendages. c. Ascus and ascospores.

Fig. 2. *Uncinula Picrasmae* on *Picrasma quassioides.*
a. Wall cells of perithecium. b. Appendages. c. Ascus and ascospores.

Fig. 3. *Uncinula Actinidiae* on *Actinidia polygama.*
a. Appendages. b. Ascus and ascospores. c. Conidia.

Fig. 4. *Uncinula verniciferae* on *Rhus vernicifera.*
a. Wall cells of perithecium. b. Appendages. c. Asci and ascospores.

Fig. 5. *Uncinula Salicis* on *Salix Hultenii* var. *angustifolia.*
a. Perithecium, × 40. b. Appendages. c. Conidia and conidiophore.

Fig. 6. *Uncinula Salicis* on *Salix gracilistyla.*
a. Perithecium, × 40. b. Appendages.

Fig. 7. *Uncinula Salicis* on *Populus Sieboldii.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Ascus.

Fig. 8. *Uncinula simulans* on *Rosa multiflora.*
a. Appendages. b. Asci.

Fig. 9. *Uncinula curvispore* on *Fagus japonica.*
a. Wall cells of perithecium. b. Appendages. c. Ascus.

Fig. 10. *Uncinula septata* on *Quercus serrata.*
a. Wall cells of perithecium. b. Appendages. c. Ascus.

Fig. 11. *Uncinula geniculata* on *Styrax Obassia.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Ascus and ascospores.

Fig. 12. *Uncinula Betulae* on *Betula Tauschii.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Ascus and ascospores.

Fig. 13. *Uncinula carpinicola* on *Carpinus laxiflora.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores.

Fig. 14. *Uncinula Fraxini* on *Fraxinus longicuspis.*
a. Wall cells of perithecium. b. Appendages. c. Asci and ascospores.

Fig. 15. *Uncinula Miyabei* on *Alnus japonica.*
a. Perithecium, × 100. b. Wall cells of perithecium. c. Ascus and ascospores. d. Conidia.

Fig. 16. *Uncinula Miyabei* on *Alnus hirsuta* var. *sibirica.*
Appendages.

Fig. 17. *Uncinula Mori* on *Morus bombycis.*
a. Perithecium, × 100. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores.

Fig. 18. *Uncinula Nishidana* on *Sterculia platanifolia.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Ascus and ascospores.

Fig. 19. *Typhulochaeta japonica* on *Quercus serrata.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores.

Fig. 20. *Sawadaea Aceris* on *Acer cissifolium.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores.

Fig. 21. *Sawadaea Tulasnei* on *Acer pictum.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores. e. Macro-conidia and conidiophore. f. Micro-conidia and conidiophore.

Fig. 22. *Sawadaea Negundinis* on *Acer Negundo.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendage. d. Asci and ascospores. e. Macro-conidia and conidiophore. f. Micro-conidia and conidiophore.

Plate X

Fig. 1. *Microsphaera Alni* on *Alnus hirsuta.*
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendage. d. Asci and ascospores. e. Conidia and conidiophore.

Fig. 2. *Microsphaera Alni* on *Castanea crenata*.
a. Appendage. b. Ascus and ascospores. c. Conidia and conidiophore.

Fig. 3. *Microsphaera Alni* on *Syringa japonica*.
Appendage.

Fig. 4. *Microsphaera Alni* on *Schizandra chinensis*.
a. Wall cells of perithecium. b. Appendages. c. Ascus and ascospores.

Fig. 5. *Microsphaera Alni* on *Picrasma quassioides*.
a. Wall cells of perithecium. b. Appendages. c. Ascus and ascospores.

Fig. 6. *Microsphaera Alni* on *Cornus controversa*.
a. Wall cells of perithecium. b. Appendages. c. Ascus and ascospores.

Fig. 7. *Microsphaera Alni* on *Lonicera tatarica*.
a. Wall cells of perithecium. b. Appendages. c. Asci and ascospores.

Fig. 8. *Microsphaera calocladophora* on *Quercus rubra*.
a. Wall cells of perithecium. b. Appendages. c. Ascus and ascospores.

Fig. 9. *Microsphaera alphitoides* on *Quercus crispula*.
a. Appendages. b. Ascus and ascospores. c. Conidia and conidiophore.

Fig. 10. *Microsphaera alphitoides* on *Quercus dentata*.
a. Appendage. b. Conidia and conidiophore.

Fig. 11. *Microsphaera alphitoides* on *Quercus serrata*.
a. Wall cells of perithecium. b. Appendages. c. Ascus and ascospores.

Fig. 12. *Microsphaera Ligustri* on *Ligustrum medium*.
a. Wall cells of perithecium. b. Appendages. c. Asci and ascospores.

Fig. 13. *Microsphaera divaricata* on *Symplocos crataegoides*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Ascus and ascospores.

Fig. 14. *Microsphaera Coryli* on *Corylus rostrata* var. *mandshurica*.
a. Perithecium, × 40. b. Appendages. c. Ascus and ascospores. d. Conidia.

Fig. 15. *Microsphaera Yamadai* on *Hovenia dulcis*.
a. Appendage. b. Ascus and ascospores.

Fig. 16. *Microsphaera Yamadai* on *Juglans Sieboldiana*.
Appendages.

Fig. 17. *Microsphaera Euphorbiae* on *Securinega flueggeoides*.
a. Perithecium, × 40. b. Appendage. c. Ascus and ascospores.

Fig. 18. *Microsphaera Abeliae* on *Abelia spathulata*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores.

Fig. 19. *Microsphaera pseudo-Lonicerae* on *Cocculus trilobus*.
a. Wall cells of perithecium. b. Appendage. c. Asci and ascospores.

Fig. 20. *Microsphaera Berberidis* on *Berberis vulgaris*.
a. Perithecium, × 100. b. Wall cells of perithecium. c. Appendage. d. Asci and ascospores. e. Conidia.

Fig. 21. *Microsphaera Grossulariae* on *Sambucus racemosa*.
a. Wall cells of perithecium. b. Appendage. c. Asci and ascospores. d. Conidia.

Fig. 22. *Microsphaera diffusa* on *Magnolia obovata*.
a. Wall cells of perithecium. b. Appendages. c. Asci and ascospores. d. Conidia.

Fig. 23. *Microsphaera Russelii* on *Oxalis corniculata*.
Conidia and conidiophore.

Plate XI

Fig. 1. *Microsphaera Bäumleri* on *Vicia Cracca*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores. e. Conidia and conidiophore.

Fig. 2. *Microsphaera Bäumleri* on *Robinia pseudacacia*.
a. Appendages. b. Asci and ascospores.

Fig. 3. *Microsphaera Viciae-unijugae* on *Vicia unijuga*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores. e. Conidia and conidiophore.

Fig. 4. *Uncinulopsis Shiraiana* on *Celtis sinensis*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendages. d. Asci and ascospores. e. Conidia and conidiophores.

Fig. 5. *Phyllactinia corylea* on *Corylus rostrata*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendage. d. Penicillate cell.

Fig. 6. *Phyllactinia corylea* on *Amelanchier japonica*.
Asci and ascospores.

Fig. 7. *Phyllactinia corylea* on *Caesalpinia sepiaria*.
Appendages.

Fig. 8. *Phyllactinia corylea* on *Hamamelis japonica*.
Appendages.

Fig. 9. *Phyllactinia corylea* on *Rhododendron Albrechtii*.
Appendages.

Fig. 10. *Phyllactinia moricola* on *Morus bombycis*.
a. Perithecium, × 40. b. Appendage. c. Asci and ascospores. d. Conidia. e. Penicillate cell.

Fig. 11. *Phyllactinia Fraxini* on *Fraxinus mandshurica* var. *japonica*.
a. Perithecium, × 40. b. Wall cells of perithecium. c. Appendage. d. Asci and ascospores.

Fig. 12. *Phyllactinia Fraxini* on *Actinidia arguta*.
a. Perithecium, × 40. b. Appendage. c. Asci and ascospores. d. Conidia and conidiophores. e. Penicillate cells.

Fig. 13. *Phyllactinia Quercus* on *Castanea crenata.*
a. Perithecium, × 40. b. Appendage. c. Asci and ascospores.

Fig. 14. *Phyllactinia imperialis* on *Paulownia tomentosa.*
a. Perithecium, × 40. b. Appendage. c. Asci. d. Conidia. e. Penicillate cell.

Fig. 15. *Leveillula taurica* on *Capsicum annuum.*
Conidia and conidiophores.

Plate IV.

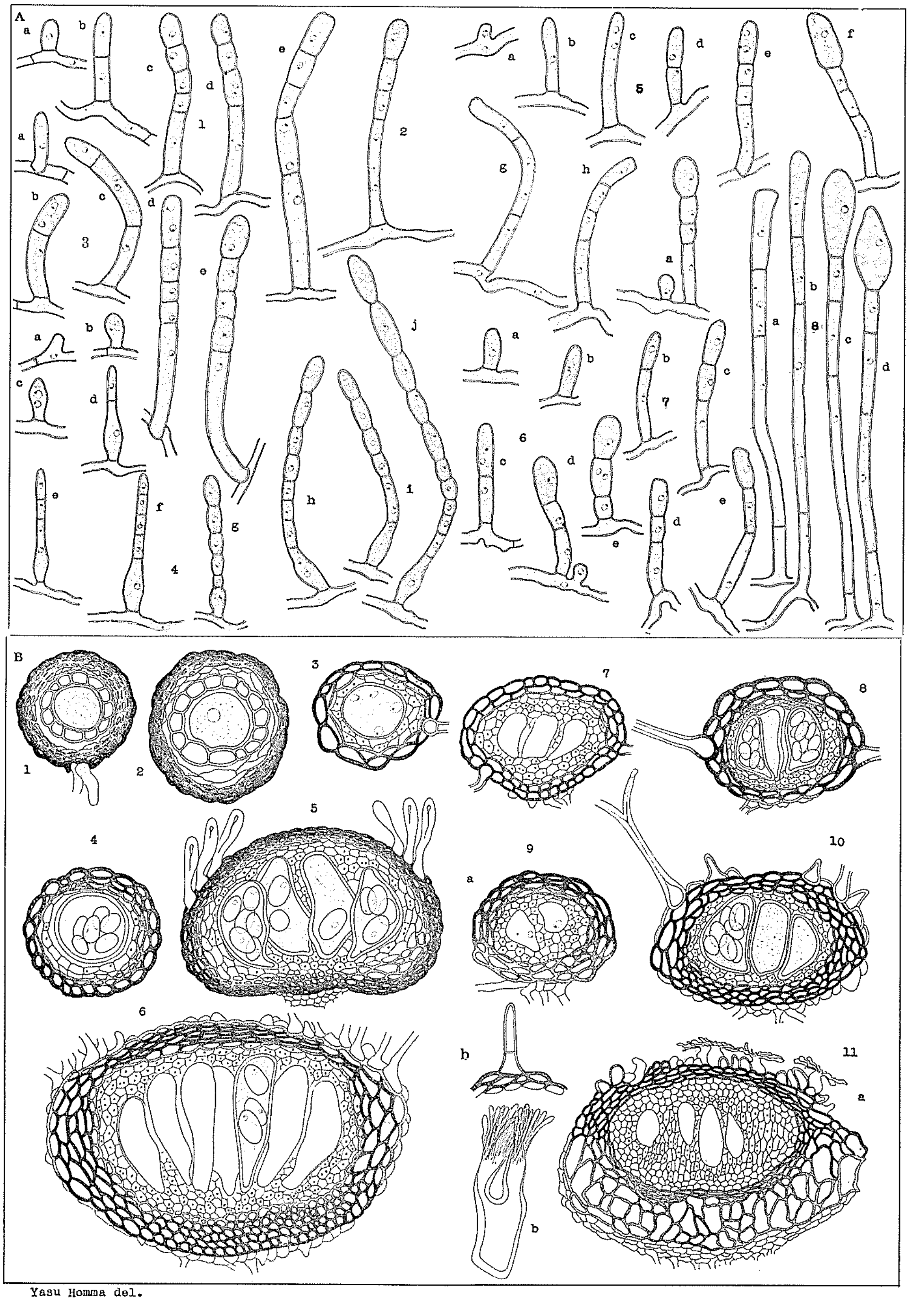

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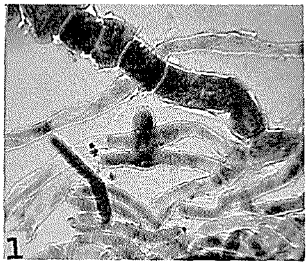
Plate V.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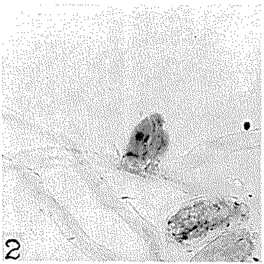
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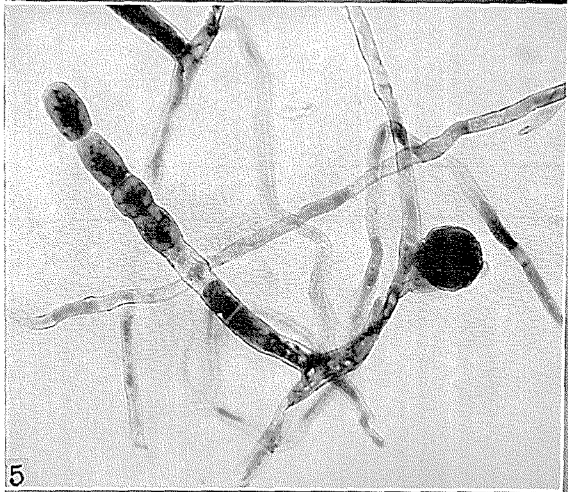
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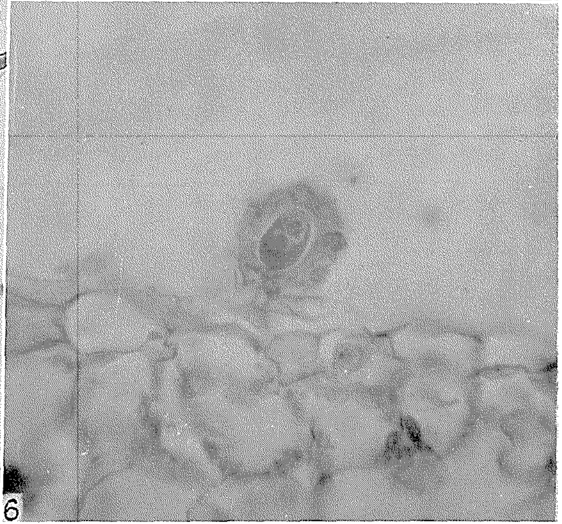
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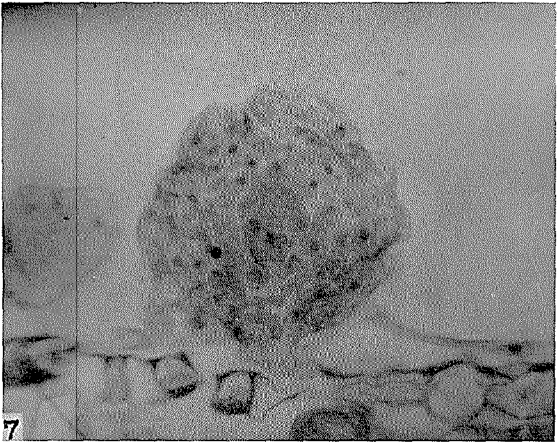
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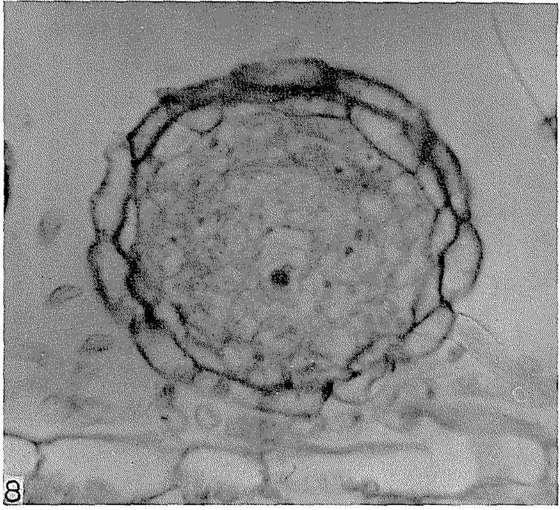
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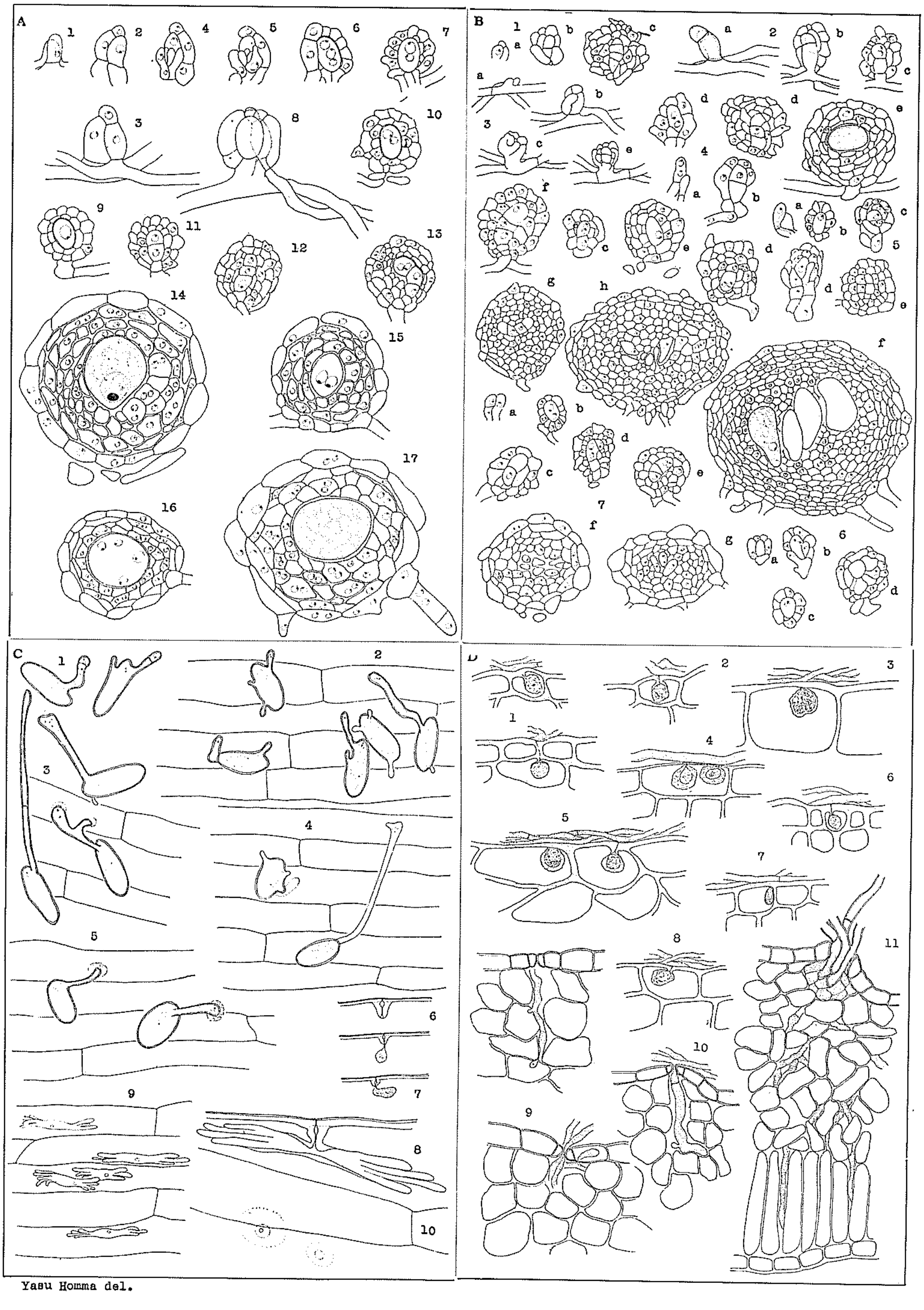

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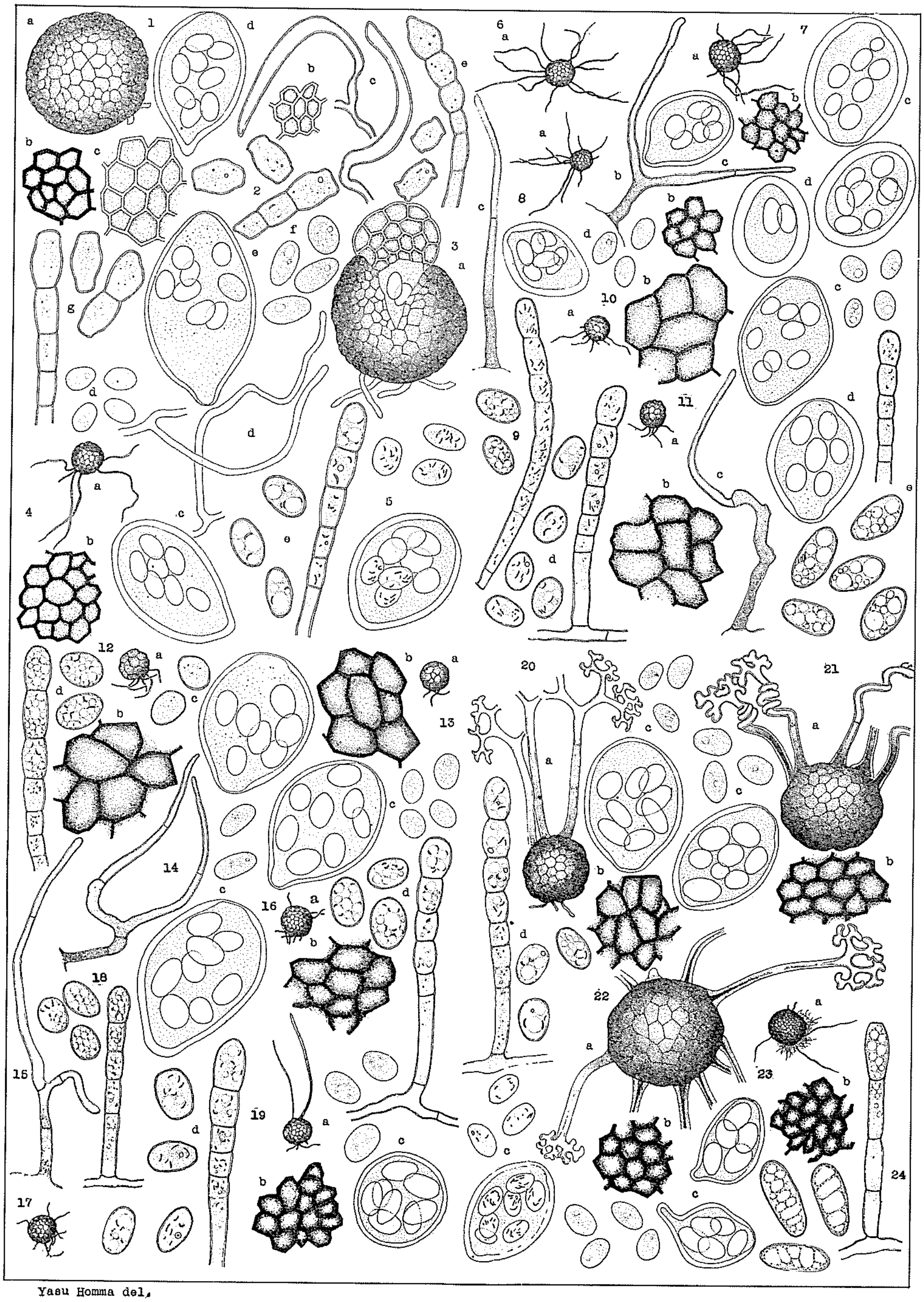

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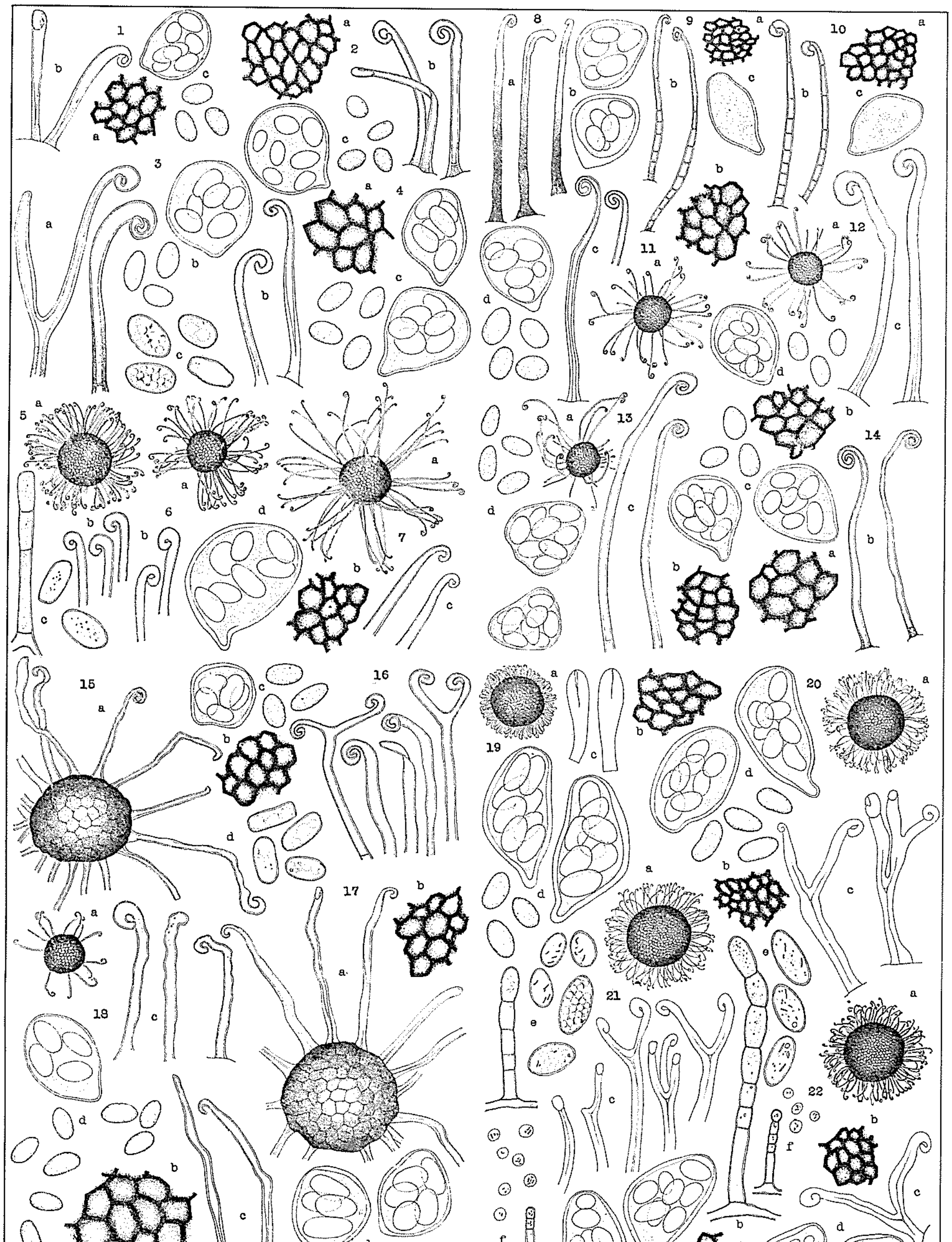

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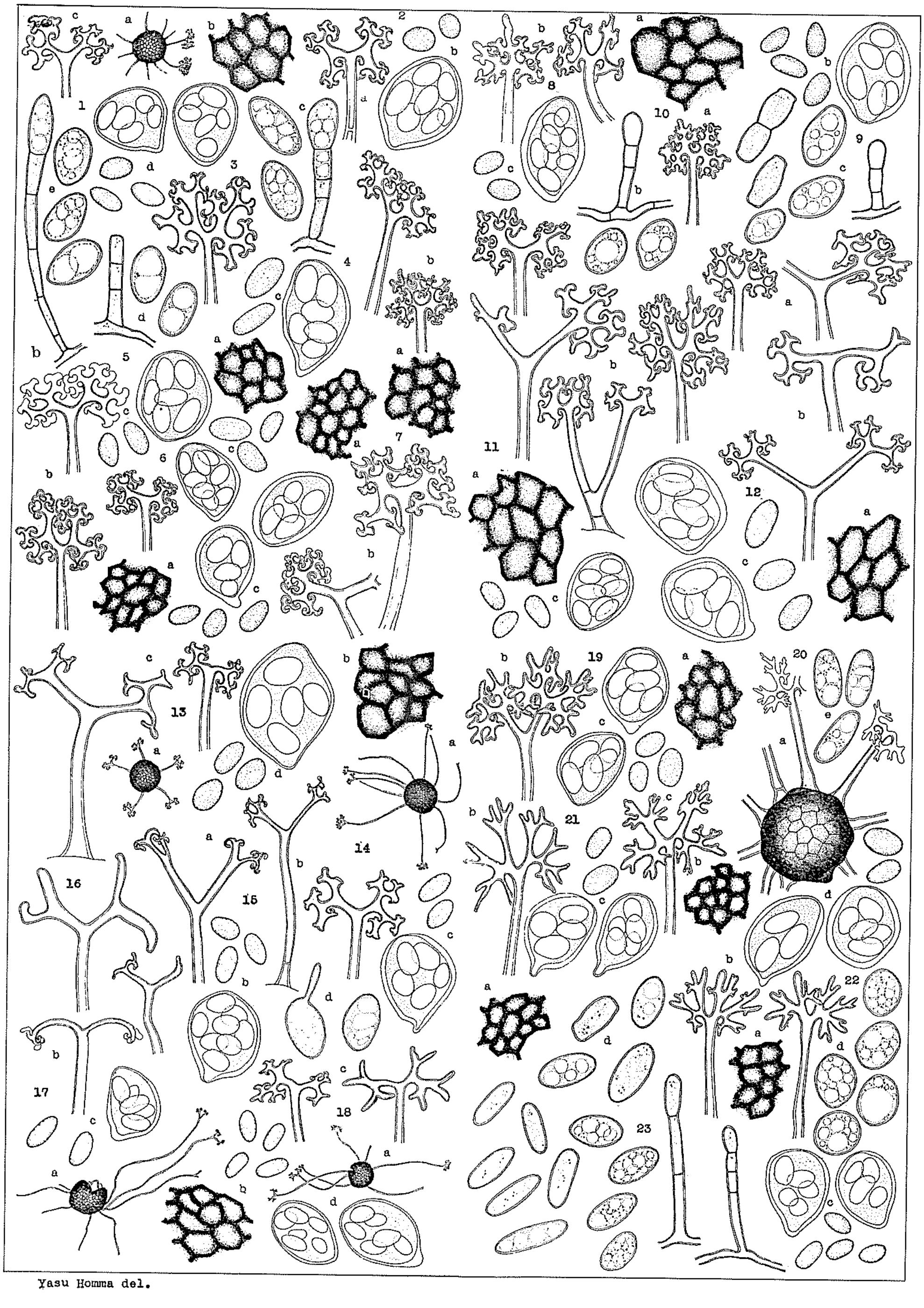
Plate X.



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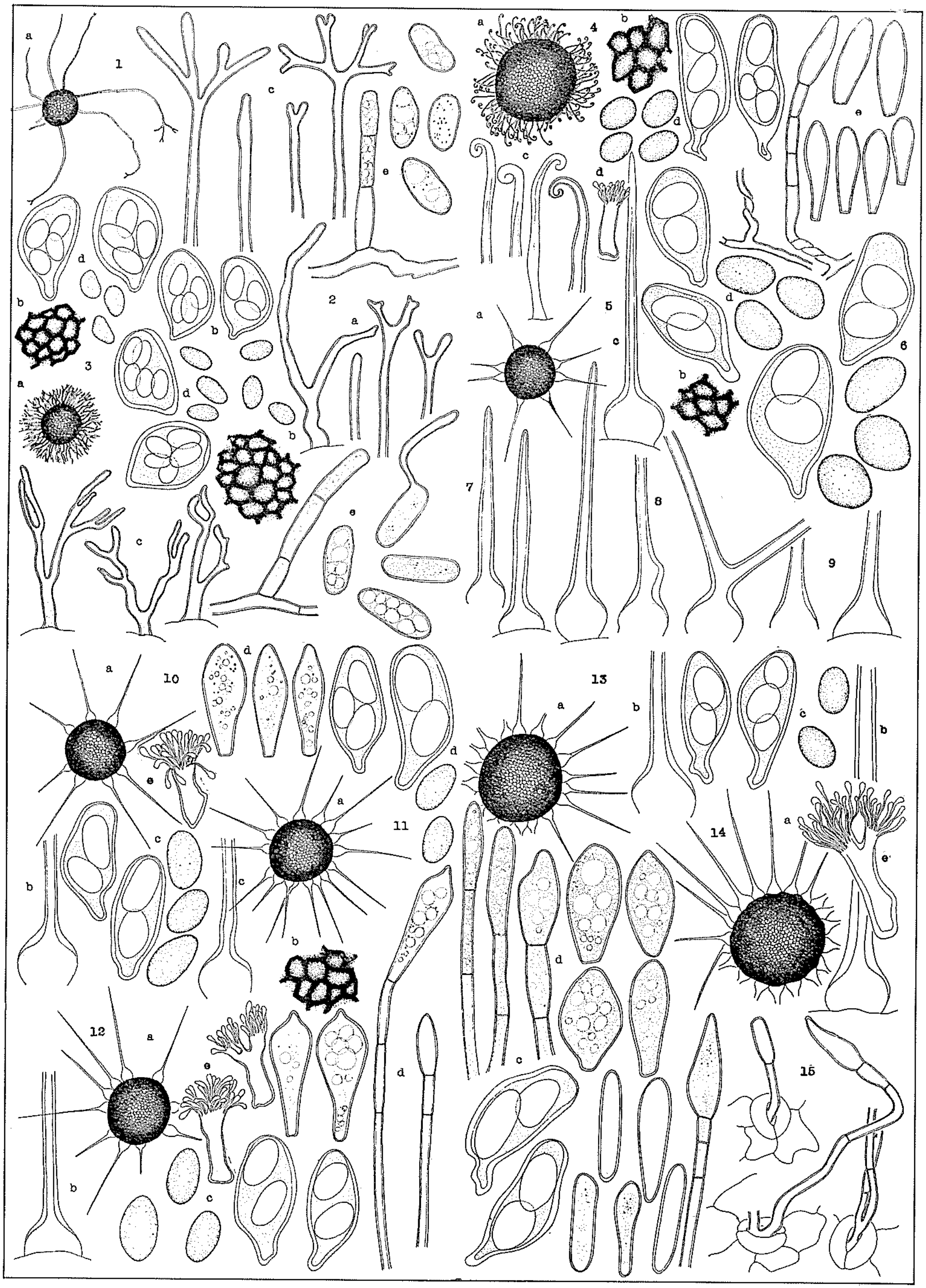

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