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Iowa Erysiphaceae

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IOWA ERSIPHACEAE.

BY J. P. ANDERSON.

INTRODUCTION.

The Erysiphaceæ are popularly known as blights, white or powdery mildews. They are parasitic on quite a large variety of plants and during the summer are often quite conspicuous factors of the vegetation, covering the leaves or other parts with a white mycelium which sometimes gives the host an almost hoary appearance.

The plant body proper consists of numerous branching, septate, usually white, much interwoven threads called the mycelium. These threads are superficial and adhere to and derive nutriment from the host by means of haustoria which arise from the mycelial threads and penetrate the epidermis of the host. An exception to this is found in *Phyllactinia* in which special branches of the mycelium enter the stomata of the host and send haustoria into the surrounding cells.

During the summer and early fall the asexual reproductive bodies or conidia are formed. They are cylindrical, oval or barrel-shaped, colorless cells filled with protoplasm. They are formed by constriction at the ends of short, erect, simple, club-shaped, septate, colorless branches of the mycelium known as fertile hyphæ or conidiophores. The conidia are often found in chains, several from the end of the same hypha having fallen away together. The conidia are produced in immense numbers throughout the growing season, are light and easily carried by the wind, and serve for the rapid increase and wide distribution of the parasite as they germinate quickly under favorable conditions. In germinating the conidium sends out a slender tube which upon the proper host and under the proper conditions, soon develops into a new mycelium.

Later in summer or in autumn the true reproductive bodies or perithecia are formed. These perithecia contain the ascospores or

resting spores whose function seems to be to carry the fungus over from year to year.

The development of the perithecium is as follows: At the point where two hyphæ cross, or at the place where two neighboring hyphæ touch each develops a small upright branch which is soon separated from the parent hypha by a partition. One of these branches swells into an oval shape and becomes the carpogonium. The other elongates and applies itself closely to the carpogonium, curving above so that its end lies on the apex of the carpogonium. The upper part is then cut off by a septum and forms the antheridium. At the time of fertilization the wall between the two organs dissolves and the nucleus of the antheridium passes over and unites with nucleus of the carpogonium. A new wall is afterwards formed between the two organs.

The development of the walls of the future perithecium begins when the two nuclei unite. From the stalk cell of the carpogonium a number of hyphal branches grow upward forming a single layer around the carpogonium. Later the stalk cell swells and a second series internal to the first grow up in a similar manner.

When the perithecia are about half grown certain cells of the outer wall begin to grow out into appendages. These cells are situated either apically, equatorially, or basally. These appendages vary in character and with the number of asci form the character on which the genera are based. They are probably concerned with the distribution of the perithecia.

The perithecia when mature vary from globose to cup-shaped or pezzoid. They are generally globose-depressed. The perithecia contain one to many asci each ascus containing two to eight colorless spores.

With the formation of the perithecia the mycelium sometimes completely disappears. Frequently, however, it is persistent.

The asci are liberated by the irregular rupture of the wall of the perithecium. The ascospores seem incapable of germination before passing through a resting stage. In a damp atmosphere or water they send out germ tubes, which on the epidermis of a suitable host plant penetrate and form a haustorium from which center the ordinary vegetative mycelium is produced.

Economically the Erysiphaceæ are very important. They injure many species of cultivated and native plants. As examples we need only cite the mildews infecting the grape, gooseberry, rose, cherry, plum, apple, and various forest and ornamental trees. They work injury by impairing the function of the leaf and causing a

premature dropping. Frequently other soft parts are also attacked which renders the injury to the host much greater. The loss to farmers and horticulturists through this source is often much greater than is at first apparent. The weakening of the vitality of the plant brings a less abundant harvest.

The choice of hosts by the various species of Erysiphaceæ is varied. Some, e. g. *Uncinula geniculata* on *Morus rubra*, are confined to one host plant. Others, e. g. *Uncinula circinata* on species of *Acer*, are confined to a single genus. Still others, e. g. *Uncinula salicis* on Salicaceæ, are confined to one family. Lastly, some grow on a great variety of host plants, e. g. *Erysiphe polygoni*.

Sometimes perithecia, when crushed, instead of emitting the usual asci emit a stream of small oblong spores $6.5-10.5 \times 3.5-6$ micra immersed in a colorless gelatinous substance. In such cases smaller bodies oval to pyriform in shape will also be found. These rupture irregularly and emit the same kind of spores. Often these bodies are found where no perithecia have formed. They belong to a plant parasitic on the mildew. By careful examination the delicate hyphae of the parasite may be seen within the hyphae of the mildew. If the mildew attacked is in the perithecial stage the perithecium is filled with its fruits. If the mildew is in the conidial stage the attack of the parasite seems to prevent the formation of perithecia but the fruits of the parasite are often found in abundance. This parasite is *Ampelomyces quisqualis* Caseti. (See plate I.) It undoubtedly serves to hold the mildew in check. It seems to attack all species of Erysiphaceae. During the past two years it has been abundant in Decatur County, infesting the mildews on the following hosts:

- Aster cordifolius* L.
- Aster laevis* L.
- Aster multiflorus* Ait.
- Aster salicifolius* Lam.
- Adicea pumila* (L) Raf.
- Ambrosia trifida integrifolia* (Muhl.) T. & G.
- Carduus altissimus* L.
- Cucumis sativa* L.
- Hydrophyllum virginicum*.
- Lactuca canadensis* L.
- Lactuca floridana* (L.) Gaertner.
- Lactuca sagittifolis* Ell.
- Monarda fistulosa* L.
- Physalis heterophylla* Nus.

Rosa sp.
Rudbeckia laciniata L.
Solidago canadensis L.
Verbena urticifolia L.

In some cases, e. g. on the species of *Lactuca*, every specimen collected and examined proved to be infested by the *Ampelomyces* while in other instances, e. g. *Verbena urticifolia* only an occasional specimen was found.

Often conidia bearing mycelium is found on a host and no perithecia are formed. In Decatur County I have found conidia on the following hosts not reported under any species in this work. In the absence of perithecia it is impossible to definitely determine the species to which they belong:

Asclepias tuberosa L.
Aster multiflorus Ait.
Brassica sp. (Turnip.)
Cucumis sativa L.
Diospyros virginianum L.
Geum virginicum L.
Lactuca canadensis L.
Lactuca floridana (L.) Gaertn.
Lactuca sagittifolia Ell.
Monarda fistulosa L.
Physalis heterophylla Nus.
Potentilla monspeliensis L.
Rudbeckia laciniata L.
Rudbeckia triloba L.
Solanum carolinense L.
Solidago ulmifolia.
Xanthium canadense Mill.

To these should be added the following reported by Prof. Fink at Fayette in 1893:

Chrysanthemum sp. (Curt.)
Grindelia squarrosa (Pursh) Dunal.
Mesadenia tuberosa (Nutt.) Britt.
Phlox sp.
Physostegia virginiana (L.) Benth.
Roupa sylvestris (L.) Bess.
Sisymbrium officinale Scop.

On the same host plant perithecia may be formed one season but not another. During 1904 I looked for perithecia on *Verbena hastata* and *V. urticifolia* but found none although nearly every plant of the hosts were more or less affected with the conidial

stage of *E. cichoracearum*. In 1905 I found perithecia in abundance on both hosts.

The data contained in this paper are mainly the result of two years' observation on the family in Decatur County, together with an examination of the collections at the Iowa State College at Ames and the State University at Iowa City. The herbarium of Prof. B. Fink of Grinnell was also examined and the writer made some collections in Fremont and Ringgold counties. Unfortunately, a large portion of the collections at the State University were unavailable at the time of the writer's visit in June, 1905.

Synonyms are given only so far as the Iowa literature consulted is concerned. Following the name of the host plant are given in their order the locality, time, and collector of specimens on that host. If any of these items are lacking its place is taken by an X. The name of the collector is in parenthesis. An asterisk (*) indicates the writer has not seen the specimen so indicated but it has been reported in the literature consulted. The measurements given in the descriptions are adopted from Salmon's monograph of the family.

ACKNOWLEDGMENTS.

The writer's thanks are due to Prof. B. Fink of Grinnell for the privilege of examining his private collection, mostly from the vicinity of Fayette; to Profs. Macbride and Shimek for courtesies extended when examining the collections at the State University; to Prof. Pammel and his assistants of the State College for the privilege of examining the collections at Ames and assistance rendered; to Miss King of the botanical department at Ames who executed most of the drawings; and to others who assisted in various ways. Dr. Macbride has given much valuable information in regard to *Phyllactinia corylea tomentosa*.

LIST OF IOWA WORKS CONSULTED.

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- Fink, B.—Blights, Orchids and Ferns of Fayette, Iowa. Bull. Upper Iowa Uni., Jan., 1894.
- Hitchcock, A. S.—Partial list of Iowa Powdery Mildews. Bulletin. Iowa Agri. College, Nov., 1886.
- Pammel, L. H.—Powdery Mildew of the Apple. Cont. Bot. Dept. Iowa State College. Iowa Acad. Sciences, VII, 1899.

ERYSIPHACEAE, LEV.

Parasitic on living plants. For further description see introduction.

KEY TO GENERA OF ERYSIPHACEAE.

- Ascus Solitary—
 Appendages of perithecium basal, floccose, similar to the mycelium..... *Sphaerotheca*

 Appendages of perithecium or some of them dichotomously branched at apex*Podospaera*
 Asci Several—
 Appendages of perithecium floccose, similar to the mycelium and frequently interwoven with it.....*Erysiphe*
 Appendages of perithecium uncinately or coiled at apex.....*Uncinula*
 Appendages of perithecium dichotomously branched at apex.....*Microsphaera*
 Appendages of perithecium rigid, acicular, with a bulbous base....*Phyllactinia*

SPHAEROTHECA, LEV.

Perithecia subglobose, ascus solitary, usually containing eight spores. Appendages simple, threads resembling the mycelium and often interwoven with it, rarely obsolete.

Key to Iowa Species of *Sphaerotheca*.

- Mycelium persistent, thick and dense, with the perithecia more or less immersed.
 Mycelium white, becoming gray or pale brown.....3. *S. pannosa*
 Mycelium becoming dark brown.....4. *S. mors-uvae*
 Mycelium evanescent, subsistent, or persistent, not thick and dense.
 Inner wall of perithecium separating from outer.....5. *S. phytoptophila*
 Inner wall of perithecium scarcely separating.
 Cells of outer wall 10-20 micra wide.....1. *S. humuli*
 Cells of outer wall 20-30 micra wide.....2. *S. humuli fulginea*

1. *Sphaerotheca humuli*, (DC.) Burrill.

Sphaerotheca castagnei Lev. in part. Bessey, The Erysiphei and Prel. List Ames Flora. Hitchcock, Partial List Iowa Powdery Mildews. Fink, Blights, etc., of Fayette.

Sphaerotheca pruinosa C. & P. Bessey, The Erysiphei.

Sphaerotheca humuli (DC.) Burr. Fink, Blights, etc., of Fayette.

Sphaerotheca epilobi (Lk.) Sacc. Fink, in E. & E. N. A. Fungi.

Amphigenous; mycelium usually evanescent, sometimes persistent, forming white spots or patches on the upper surface of the leaf. Perithecia usually gregarious, sometimes scattered, 58-120 micra in diameter, cells small, 10-20 micra wide; appendages very variable as to length and color, sometimes even obsolete; ascus broadly elliptical to subglobose, 45-90x50-72 micra, spores 8, 20-25-12-18 micra.

On *Agrimonia hirsuta* (Muhl.) Bicknell, Ames, Oct. 15, 1878 (Bessey); Fayette (Fink).

On *Epilobium coloratum* (Muhl.), Ames, Aug. 25, 1894 (Combs); Fayette, Aug. 29, 1894 (Fink).

On *Rhus glabra* L. Iowa City, X (X).

On *Rosa arkansana* Porter, Ames, 1892 (Carver); Decatur Co., Oct., 1905 (Anderson).

This species is the destructive hop mildew. In Europe at times great losses are sustained by the hop grower through its ravages. It is found on the hop in some parts of America but has never been reported on that host in Iowa.

2. *Sphaerotheca humuli fulginea* (Schlecht), Salmon.

Sphaerotheca castaguei Lev. in part. Bessey, The Erysiphei, and Prel. List Ames Flora. Fink, Blights, etc., of Fayette. Hitchcock. Partial list Iowa Powdery Mildews.

As in *S. humuli* but the perithecia usually smaller, wall generally harder and more brittle; cells larger 20-30 micra or more wide; appendages pale to dark brown, usually short.

On *Bidens laevis* (L.), B. S. P. Ames, Aug. 25, 1894 (Combs).

On *Bidens frondosa* L., Ames, Aug. 22, 1877 (Bessey); Aug. 30, 1890 (Brown); Aug. 25, 1894 (Combs); *Aug., 1886 (Hitchcock); Decatur Co., 1904 and 1905 (Anderson); Fayette, Sept., 1893 (Fink).

On *Bidens involucrata* (Nutt), Britton, Decatur Co., Oct., 1905 (Anderson).

On *Bidens* sp., Ames, Oct. 1, 1892 (X).

On *Erechitites hieracifolia* (L.), Raf., Ames, Oct. 12, 1878 (Bessey); Decatur Co., Oct. 10, 1904 (Anderson); Johnson Co., Sept. 16, 1899 (Shimek).

On *Leptandra virginica* (L.) Nutt, Ames, Sept. 21, 1878 (Bessey); Aug. 27, 1892 (Carver); Decatur Co., 1904 and 1905 (Anderson); Iowa City, Aug., 1888 (Macbride).

On *Leptilon canadense* (L.) Britt. *Fayette (X), (Fink).

On *Prunella vulgaris* L. Ames, Oct. 17, 1882 (Bessey).

On *Sonchus oleraceus*, L. *Fayette (Fink).

On *Taraxacum taraxacum* (L.), Karst. Ames, Sept. 4, 1894 (Combs); Decatur Co., Oct., 1904 (Anderson); Iowa City, Oct. 18, 1886 (Macbride); Oct. 3 (Bloom).

The variety is much more common in Iowa than the type. The type of the species is seldom collected while the variety is very common. Being confined to weeds it works no injury to man in Iowa.

3. *Sphaerotheca pannosa* (Wallr.), Lev.

Mycelium abundant on the stem leaves, petiole, calyx, etc., but the perithecia nearly always occurring on the stem, calyx or petiole, white, becoming gray to pale brown. Perithecia more or less immersed in the dense persistent mycelium, globose to pyriform, 85-120 micra in diameter, cells about 10 micra

On *Celtis accidentalis* L., on the distortions caused by the Phytoptus. Ames, Jan., 1889 (Halsted).

This was distributed as No. 2336 of Ellis & Everhart's North American Fungi.

PODOSPHAERA, Kunze.

Perithecia globose or globose depressed; ascus solitary; spores 8. Appendages or some of them dichotomously branched at the apex. In *P. leucotricha* the appendages are of two kinds.

Key to Iowa Species of *Podosphaera*.

Appendages of one kind.....1. *P. oxycanthae*
 Appendages of two kinds.....2. *P. leucotricha*

1. *Podosphaera oxycanthae* (DC.), DeBary.

Podosphaera kunzei Lev. Bessey, The Erysiphei.

Podosphaera minor Howe, Bessey, The Erysiphei.

Podosphaera tridaetyla DBy. Bessey, Prel. List, Ames Flora. Hitchcock, Partial List Iowa Powdery Mildews.

Podosphaera oxycanthae (DC.), DBy. Fink, Blights, etc., of Fayette.

Amphigenous, mycelium variable, persistent or evanescent; perithecia scattered or gregarious in clinging masses, 64-90 micra in diameter, cells 10-18 micra wide; appendages 4-30 in number, ½-6 times the diameter of the perithecium, septate, dark brown for more than one-half their length, apex 2-4 times dichotomously branched, branches usually short, often swollen, tips recurved; ascus 58-99x45-75 micra; spores 18-30x10-17 micra.

On *Crataegus coccinea* L. Ames, X (X), Iowa City, July 9, 1894 (Shimek).

On *Crataegus punctata* Jacq. *Ames, July, 1886 (Hitchcock); Iowa City, Aug., 1886 (Hitchcock).

On *Crataegus tomentosa* L. *Ames, July, 1886 (Hitchcock); Iowa City, Oct. 23, 1886 (Macbride).

On *Prunus americana* Marsh. Ames, 1891 (Raymond); Sept., 1890 (X); Decatur Co., Oct., 1904 (Anderson).

On *Prunus avium* L. Decatur Co., Aug. 31, 1905 (Anderson).

On *Prunus besseyi* Bailey. Decatur Co., Oct., 1904 (Anderson).

On *Prunus cerasus* L. Ames, Sept. 1, 1877 (Bessey), 1891 (Raymond), Sept., 1892 (Carver), Aug. 20, 1894 (Sexton), Sept. 13, 1894 (Stewart & Stewart), July 22, 1896 (Carver); Decatur Co., Aug., 1904 and 1905 (Anderson); Greenfield, Sept. 13, 1893 (Stewart); Iowa City, Oct. 1, 1886 (Macbride), 1895 (Shimek).

On *Prunus pumila* L. Ames, July 20, 1894 (Sexton), Aug. 31, 1894 (Stewart & Stewart), Oct. 19, 1892 (Carver).

On *Prunus* sp., Ames, Sept. 9, 1892 (Pammel); Fayette, Sept., 1893 (Fink); *Ames, July, 1886 (Hitchcock).

On *Sanguisorba canadensis* L. Forest City, July 17, 1896 (Shimek).

This is a very common species, especially on the cultivated cherry (*Prunus cerasus*). It distorts the leaf and causes premature drop-

ping thereby greatly weakening the vitality of the tree. On *Prunus cerasus* the perithecia usually occur on the under side of the leaf, while on the other hosts they are often found on the upper surface.

2. *Podosphaera leucotricha* (Ell. & Ever.), Salmon.

Sphaerotheca mali Burr. Fink, Blights, etc., of Fayette. Pammel, Powdery Mildew of the Apple, Cont. Bot. Dept. I. S. C., Iowa Acad. Sci., VII, 1899.

Mycelium, on the young stem petiole, and leaves, persistent, thin, effused; perithecia densely gregarious, rarely scattered, 75-90 micra in diameter, cells 10-16 micra wide; appendages of two kinds; apical appendages 3-11, 4-7 times the diameter of the perithecium, becoming thick walled, dark brown in the lower half, paler toward the tip, apex undivided or blunt, rarely once or twice dichotomously forked; basal appendages short, tortuous, pale brown; simple or irregularly branched; ascus 55-70x44-50 micra; spores 22-26x12-14 micra. On *Malus malus* (L.) Britt. Ames, *July, 1894 (Pammel); Sept. 4, 1894 (Combs); Oct., 1894 (Carver); Fayette, Oct., 1893 (Fink).

This species often attacks young seedlings in the nursery and at times does considerable damage. It is generally classed as a *Sphaerotheca* but we feel inclined to agree with Mr. Salmon in placing it here. The appendages certainly show characteristics of both genera but the rigid apical appendages are certainly very unlike the appendages in *Sphaerotheca*. The occasional forking of the tips of the appendages certainly indicate that it is a *Podosphaera*.

ERYSIPHE, Hedw. f.

Perithecium containing several asci, each ascus 2-8 spored; appendages, threads similar to the mycelium and often interwoven with it. The appendages are rarely bosoletic, or in the European *E. tortilis*, brown, assurgent and fasciculate.

Key to Iowa Species of Erysiphe.

- Asci, 2-spored.
 Perithecia, large, 135-240 micra in diameter, becoming pizzoid...5. *E. taurica*
 Perithecia, 80-140 micra in diameter.
 Haustoria lobed.....3. *E. galeopsidis*
 Haustoria, not lobed.....2. *E. cichoracearum*
 Asci, 3-8 spored.
 Perithecia, 5-180 micra in diameter, usually about 90 micra.....1. *E. polygoni*
 Perithecia, 130-280 micra in diameter, usually 180-200 micra....4. *E. graminis*

Erysiphe polygoni, DC.

See Plate III.

Erysiphe communis (Wallr.), Fr. Bessey, The Erysiphei, and Prel. List Ames Flora. Fink, Blight, etc., of Fayette.

wide, appendages few, sometimes obsolete, very short, tortuous, pale brown, septate. Ascus 88-115x0-75 micra. Spores 8, 20-27x12-15 micra.

On *Rosa blanda* Ait. Fayette, Aug., 1894 (Fink).

On *Rosa* sp., Decatur Co., Nov. 18, 1905 (Anderson).

This species has been much confused with *S. humuli* and *S. mors-uvae*. Bessey and Hitchcock report it on species of *Ribes* but *S. mors-uvae* was undoubtedly the species intended. *S. humuli* occurs on the leaves of roses. *S. pannosa* in its conidial stage often attacks the entire end of the growing shoot of Crimson Rambler roses and thus does much damage to this variety as it is very common here in Decatur County. I have not observed it as destructive to other varieties. I have found the colored mycelium and perithecia only on the stems.

4. *Sphaerotheca mors-uvae* (Schwein), Berk and Curt.

See Plate II.

Sphaerotheca pannosa Lev. Bessey, Prel. List, Ames Flora; Hitchcock, Partial List Iowa Powdery Mildews.

Sphaerotheca mors-uvae (Schwein), Berk and Curt. Bessey, The Erysiphei, Fink, Blight, etc., of Fayette.

Mycelium abundant, at first white, becoming dark brown; forming dense patches on the fruit, stem and leaves. Perithecia mostly on the stem and fruit, gregarious, immersed in the persistent mycelium, 76-100 micra in diameter, cells 10-25 micra wide. Appendages few, pale brown, short and tortuous, rarely more numerous and longer. Ascus, 70-92x50-62 micra, rarely longer. Spores 20-25x12-15 micra.

On *Ribes cynosbati* L. Ames, July 3, 1876 (Bessey); Fayette, June 23 and 29, 1894 (Fink).

On *Ribes gracile* Michx. Ames, July 2, 1896 (Carver).

On *Ribes rotundifolium* Michx. *Ames, July, 1886 (Hitchcock); *Fayette (Fink).

On *Ribes* sp. Ames *(Bessey), 1894 (Carver); Decatur Co., June, 1904 and 1905 (Anderson).

This species is easily distinguished from all others by the dense, dark brown, felted mycelium. It attacks both wild and cultivated species of *Ribes* and is frequently quite injurious, especially to some cultivated varieties.

5. *Sphaerotheca phytoptophila*, Kellerm & Swingle.

Mycelium evanescent or subpersistent, perithecia gregarious, 60-78 micra in diameter, cells small, about 10 micra wide, often indistinguishable; appendages short, more or less tortuous; pale to dark brown, sometimes obsolete or long, rarely branched; ascus 60-75x42-50 micra; spores 8, 20-25x12-15 micra.

Erysiphe martii Lev. Bessey, the Erysiphei, and Prel. List Ames Flora. Hitchcock, Partial List Iowa Powdery Mildews.

Erysiphe tortilis (Wallr.), Fr. Bessey, Prel. List Ames Flora. Hitchcock, Partial List Iowa Powdery Mildews.

Amphigenous; mycelium variable, thin, effused or abundant, persistent or evanescent; perithecia gregarious or scattered, 5-180 micra, usually about 90 micra in diameter, cells 10-15 micra wide; appendages very variable in number and length, $\frac{1}{2}$ -20 times the diameter of the perithecium, usually interwoven with the mycelium, colored at the base or throughout or rarely hyaline or white; asci 2-8, rarely mayn. 46-72x30-45 micra; spores 3-8, 19-25x9-14 micra. On *Anemone canadensis* L. Iowa City, X (X).

On *Anemone* sp. Ames, 1894 (Carver).

On *Anemone virginiana* L. Ames, July 12, 1876 (Bessey).

On *Astragalus carolinianus* L. Ames, Sept. 9, 1894 (Combs); *Belle Plaine, Sept., 1886 (Hitchcock); Decatur Co., Sept., 1904, and Aug. and Sept., 1905 (Anderson); Decorah, Aug. 2, 1886 (Holway); Fayette, Sept., 1893 (Fink).

On *Brassica nigra* (L.) Koch. Fremont Co., Aug. 8, 1905 (Anderson).

On *Clematis virginiana* L. Ames, Oct., 1882 (Bessey), *Aug., 1886 (Hitchcock); Decatur Co., Sept., 1904 (Anderson); Iowa City, Oct. 10, 1886 (Macbride), Oct. 7, 1900 (Bloom). Oct., 1900 (Stromsten).

On *Falcata pitcheri* (T. & G.), Kunze, Decatur Co., Oct., 1905 (Anderson).

On *Geranium maculatum* L. Iowa City, Oct. 2 (Bloom).

On *Onagra biennis* (L.) Scop. Fayette, 1893 (Fink); Decorah, Sept. 17, 1879 (Holway).

On *Pisum sativum* L. Ames X (X); Decatur Co., June, 1905 (Anderson); Iowa City, May, 1886 (Macbride).

On *Polygonum aviculare* L. Ames, June 29, 1905 (Anderson); Decatur Co., July, 1904 and 1905 (Anderson).

On *Polygonum erectum* L. Decatur Co., July 12, 1905 (Anderson); Ringgold Co., Oct. 7, 1905 (Anderson).

On *Polygonum ramosissimum*, Michx. Fremont Co., Aug. 8, 1905 (Anderson).

On *Ranunculus abortivus* L. Ames, X (Rofls); Decatur Co., July, 1904 and 1905 (Anderson); Iowa City, July, 1886 (Macbride).

On *Syndesmon thalictroides* (L.), Hoffman, Iowa City, May, 1889 (Linder).

On *Thalictrum purpurascens* L. Decatur Co., July 12, 1905 (Anderson).

This is the most variable of our species of Erysiphaceae. Were it not that the character of the various extreme types intergrade into each other we would be inclined to consider various types as specifically distinct. Our specimens on *Polygonum* have appendages only $\frac{1}{2}$ -1 $\frac{1}{2}$ times the diameter of the perithecium while on *Clematis* they sometimes reach a length of 15-20 times the diameter of the perithecium. Other Ranunculaceae show forms with appendages of intermediate length. Other characters also vary widely. In Decatur County *Onagra biennis* and *Syndesmon thalictroides* are

affected with the conidial stage but I have been unable to find perithecia.

The cultivated pea (*Pisum sativum*) is often seriously injured by this species. The other Iowa hosts are of but little importance economically with the exception of *Clematis* which is sometimes cultivated for ornament. During the seasons of 1904 and 1905 one could scarcely find a plant of *Polygonum erectum* but what was more or less affected and thus this weed was largely kept in check by the mildew.

Erysiphe cichoracearum, DC.

See Plate I.

Erysiphe cichoracearum, DC. Fink, Blights, etc., of Fayette.

Erysiphe horridula, Lev. Bessey, The Erysiphei.

Erysiphe lamprocarpa, Lev. Bessey, The Erysiphei and Prel. List Ames Flora; Hitchcock, Partial List Iowa Powdery Mildews; Halsted, in E. & E., N. A. Fungi (424).

Erysiphe linkii Lev. Halsted, in E. & E., N. A. Fungi (1904).

Erysiphe montagnei Lev. Bessey, The Erysiphei.

Erysiphe spadacea, Berk & Curt. Bessey, The Erysiphei.

Amphigenous; mycelium persistent or evanescent, haustoria not lobed; perithecia gregarious or scattered, 80-140 micra in diameter, very rarely larger, cells variable, 10-20 micra wide; appendages variable, generally colored and densely interwoven with the mycelium; asci 4-25 or more, more or less stalked, 58-90x30-50 micra; spores quite uniformly 2, rarely more, 20x28x12-20 micra.

On *Ambrosia artemisiaefolia*, L. Ames, Sept. 1, 1894 (Combs); Decatur Co., Aug. 13, 1905 (Anderson); *Fayette, 1894 (Fink); Iowa City, Sept. 30, 1886 (Macbride); Oct. 6, 1893 (Bloom).

On *Ambrosia trifida*, L. Ames, Aug. 25, 1894 (Combs); Sept. 5, 1873 (Bessey); *Aug., 1886 (Hitchcock); Decatur Co., Aug., 1904 and 1905 (Anderson); Fremont Co., Aug. 8, 1905 (Anderson); *Fayette, 1894 (Fink); Iowa City, Sept. 9, 1885 (Macbride); Oct. 7, 1893 (Bloom); Ringgold Co., Oct. 7, 1905 (Anderson).

On *Ambrosia trifida integrifolia* (Muhl.), T. & G. Ames, Sept. 22, 1894 (Combs); Decatur Co., Sept., 1905 (Anderson); Ringgold Co., Oct. 7, 1905 (Anderson).

On *Ambrosia psilostachya*, DC. *Fayette, 1893 (Fink).

On *Artemisia biennis*, Willd. Ames, Sept. 22, 1894 (Combs).

On *Artemisia gnaphaloides*, Nutt. Decorah, Sept., 1879 (Holway).

On *Artemisia serrata*, Nutt. Ames, Sept., 1887 (Halsted).

On *Aster cordifolius*, L., Iowa City, Oct. 11, 1893 (Bloom).

On *Aster laevis* L. Armstrong, Sept., 1895 (Shimek); Decatur Co., Sept., 1904 and 1905 (Anderson); Fremont Co., Aug. 7, 1905 (Anderson); Fayette, 1893 (Fink).

On *Aster sagittifolius*, Willd. Ames, Fall 1889 (X); Fayette, 1893 (Fink); Muscatine, Oct. 21, 1893 (Bloom).

- On *Aster salicifolius* Lam. Ames, Oct. 15, 1877 (Bessey).
 On *Aster* sp. Ames, Aug. 25, 1894, and Sept. 17, 1894 (Combs), *Fayette, 1893 (Fink).
 On *Carduus altissimus*, L. Ames, Oct. 9, 1894 (Combs); Fayette, Sept., 1893 (Fink); Johnson Co., Sept. 28, 1886 (Macbride).
 On *Carduus discolor* (Muhl.), Nutt. Ames, Sept. 12, 1894 (Combs), Oct. 19, 1892 (Carver); Sept. 9, X (Rolfs); Decatur Co., Oct., 1905 (Anderson); Ringgold Co., Oct. 7, 1905 (Anderson).
 On *Cosmos bipinnatus*. Ames, Nov., 1893 (Carver), in greenhouse.
 On *Eupatorium perfoliatum*, L. Ames, Sept. 19, 1892 (Carver).
 On *Eupatorium purpureum* L. Ames, Sept. 17, 1892 (Carver).
 On *Galium circaezans* Michx. Decatur Co., Sept., 1904 and 1905 (Anderson).
 On *Helenium autumnale*, L. Ames, Aug. 25, 1894 (Combs); Decatur Co., Oct., 1904 (Anderson); Johnson Co., Oct. 7, 1893 (Linder).
 On *Helianthus annuus*, L. Ames, Sept. 8, 1892 (Carver); *Fayette, 1893 (Fink).
 On *Helianthus doronicoides* Lam. Ames, Oct. 7, 1877 (Bessey).
 On *Helianthus grosse-serratus* Martens. Ames, Sept. 15, 1894 (Combs); Decatur Co., Sept., 1904 (Anderson).
 On *Helianthus* sp. Johnson Co., X (X).
 On *Helianthus tuberosus*, L. Ames, Sept. 22, 1894 (Combs); Oct. 5, 1891 (Rolfs); Decatur Co., Aug., 1904 and Sept., 1905 (Anderson).
 On *Hydrophyllum virginicum*. Ames, Aug. 7, 1899 (Hume); Johnson Co., May 25, 1894 (Glass).
 On *Lappula virginica* (L) Greene. Johnson Co., X (X).
 On *Leptilon canadense* (L) Britt. Ames, Sept. 22, 1894 (Combs).
 On *Parietaria pennsylvanica*, Muhl. Ames, Aug. 19, 1899 (Hume & Hodson).
 On *Phlox divaricata* L. Decatur Co., July 12, 1905 (Anderson).
 On *Phlox drummondii*, Hook. Ames, Oct., 1892 (Bettinger); 1892 (Wright); Fayette, Sept., 1893 (Fink).
 On *Phlox procumbens*. Johnson Co., May, 1889 (Linder).
 On *Plantago major*, L. Ames, Oct., 1901 (Lummis); Decatur Co., Oct., 1904 and 1905 (Anderson).
 On *Plantago rugelii* Dec. Decatur Co., Oct., 1904 (Anderson).
 On *Rudbeckia hirta* L. Johnson Co., X (Macbride).
 On *Solidago canadensis*, L. Ames, Sept. 22, 1894 (Combs); *Fayette, 1893 (Fink).
 On *Solidago rigida*, L. *Fayette, 1893 (Fink).
 On *Solidago serotina* Ait. Iowa City, Oct. 3, 1893 (Bloom).
 On *Solidago serotina gigantea* (Ait.), A. Gray. *Fayette, 1893 (Fink).
 On *Verbena bracteosa*, Michx. Ames, 1894 (Carver); *Fayette, 1893 (Fink).
 On *Verbena hastata*, L. Ames, Aug. 25, 1894 (Combs); Sept., 1896 (Carver); Decatur Co., Aug. 3, 1905 (Anderson); *Fayette, 1893 (Fink); Fremont Co., Aug. 8, 1905 (Anderson); Des Moines, 1895 (Carver); Iowa City, Oct., 1895 (Macbride); Aug. 25, 1893 (Bloom).
 On *Verbena stricta*, Vent. Ames, Sept. 8, 1877 (Bessey); Aug. 25, 1893 (Stewart); Sept. 4, 1894 (Combs); Oct. 7, 1901 (Paddock); June 28, 1905 (Anderson); Fremont Co., Aug. 8, 1905 (Anderson); Greenfield, Sept. 18, 1893 (Stewart); Johnson Co. X (X).

- On *Verbena urticifolia*, L. Ames, Aug. 30, 1894 (Combs); Oct., 1890 (Blaine); Oct. 19, 1877 (Bessey); 1894 (Carver); Decatur Co., Sept. 3, 1905 (Anderson); *Fayette, 1893 (Fink); Decorah, Oct., 1879 (Holway); Iowa City, Oct. 3, 1893 (Bloom).
- On *Verbesina alternifolia* (L.), Britt. Decatur Co., Sept., 1904 and 1905 (Anderson).
- On *Vernonia fasciculata*, Michx. Ames, Sept. 1, 1894 (Combs); Sept. 12, 1894 (Stewart); Iowa City, Oct. 7, 1893 (Linder).
- On *Vernonia noveboracensis* (L.), Willd. Polk City, Aug. 29, 1902 (Pammel); Johnson Co., 1889 (Linder).

This is our most common species of mildew, and behaves somewhat differently on the different host plants. On *Plantago major* the mycelium is more abundant and the perithecia more numerous than on the similar but thinner-leaved *P. rugelii*. On *Aster laevis* I found asci with 2-4 spores although the species is generally easily recognized by its numerous 2-spored asci. During 1904 I looked in vain for perithecia on *Verbena hastata* and *V. urticifolia*, but found none although the conidial stage was very abundant. In 1905 I found an abundance of perithecia on both hosts. I have failed to find perithecia on a number of hosts supposed to be affected with this species and which showed conidia in abundance. Of the host plants here reported under this species I have found the conidial stage on the following in Decatur County but they are not included in the preceding data because no perithecia were found. *Aster salicifolius*, *A. cordifolius*, *Carduus altissimus*, *Hydrophyllum virginicum*, *Lappula virginica*, *Solidago canadensis*, *Verbena bracteosa*, *Vernonia fasciculata*, *V. noveboracensis*. Although so common this species is not important economically. Most of the hosts attacked are weeds.

3. *Erysiphe galeopsidis* DC.

Erysiphe galeopsidis, DC. Fink, Blights, etc., of Fayette.

Closely approaches *E. cichoracearum*, but is distinguished by its lobed haustoria and the absence of spores on the living host plant.

On *Mint*, St. Francis river, July 14, 1897 (X).

On *Scutellaria lateriflora*, L. Ames, Oct. 12, 1878 (Bessey); Fayette, 1893 (Fink); Iowa City, Oct. 28, 1893 (Bloom).

On *Scutellaria galericulata* Ames, 1899 (Pammel).

On *Stachys palustris*, L. Ames, Oct. 5, 1898 (Ball).

On *Stachys* sp. Johnson Co., X (X).

On *Teucrium canadense* L. Johnson Co., X (X).

It is very doubtful if this form is entitled to rank as a distinct species. It has been ascertained that certain forms of *E. cichoracearum* do not form spores on the living host plant and that the

same species on certain hosts shows a tendency to form lobed haustoria.

4. *Erysiphe graminis* DC.

Erysiphe graminis DC. Bessey, Prel. List Ames Flora; Hitchcock; partial list Iowa Powdery Mildews; Fink, Blights, etc., of Fayette.

Usually epiphyllous; mycelium more or less persistent; perithecia large, 135-280 micra in diameter, scattered or gregarious, more or less immersed in the persistent mycelium, cells obscure; appendages rudimentary, very short, pale brown; asci 9-30, pedicellate, 70-108x24-40 micra; spores 8 (rarely 4); 20-23x 10-13 micra, seldom produced on the living host plant.

On *Cinna arundinacea*, L. Fayette, 1893 (Fink).

On *Poa pratensis*, L. *Ames, Aug., 1886 (Hitchcock); Decatur Co., Oct. 4, 1904 (Anderson); *Fayette, 1893 (Fink); Johnson Co., May 3, 1894 (X).

This species is quite common on *Poa pratensis*, but the perithecia are seldom found. They appear to be formed early.

Erysiphe taurica Lev.

Mycelium often covering the whole plant, usually persistent, effused, densely compacted, tomentose, membranaceous or crustaceous; perithecia usually immersed in the persistent mycelium, large, 135-240 micra in diameter, soon becoming concave; cells obscure; appendages usually numerous, densely interwoven, rather short and vaguely branched, sometimes very short or even obsolete; asci 7-38, pedicellate, large, 75-110x28-40 micra; spores 2, large, 28-40x14-22 micra.

On *Heliopsis scabra* Dunal. Decatur Co., Aug.-Oct., 1904 and 1905 (Anderson); Ringgold Co., Oct. 10, 1905 (Anderson).

Heretofore this has been considered as an old world species. Salmon, in his monograph of the Erysiphaceae, gives the distribution of this species as the continent of Europe (France, Spain, Italy, Greece, Germany, Austria-Hungary, Russia), Algeria in Africa, and Turkey, Syria, Persia, Turkestan, and India in Asia. It seems somewhat strange that this species should now be found in the middle of the United States, but I can refer the form under consideration to no other species as it agrees in every important detail with the description given for *E. taurica*.

In August, 1904, I first collected this species but on examination I found that the perithecia had not developed asci. I collected at intervals during the fall but not until very late in the season could I find traces of asci. In 1905 I found asci somewhat earlier but have been unable to find spores without soaking in water for 24-48 hours.

During the autumns of 1904 and 1905 nearly every plant of *Heliopsis scabra* seen by the writer in Decatur and Ringgold counties, Iowa, and Harrison County, Missouri, presented a white

or hoary appearance, from the presence of this mildew. It had not been observed previously and the *Heliopsis scabra* seen in Fremont County and eastern Nebraska in 1905 was not affected.

E. M. Freeman in Minnesota Botanical Studies XXIV, reports *Erysiphe cichoracearum* on *Heliopsis scabra*. It is quite probable that this was the species under consideration.

MICROSPHAERA Lev.

Perithecia globose to globose depressed; asci several, 2-8 spored; appendages free from the mycelium; more or less dichotomously branched at the apex.

Key to Iowa Species of *Microsphaera*.

- Tips of appendages recurved when mature.
- Appendages short, $\frac{1}{3}$ -2 $\frac{1}{2}$ times the diameter of the perithecium....1. *M.alni*
- Appendages long, 2 $\frac{1}{2}$ -8 times the diameter of the perithecium.
- Apex much branched, ornate, spores 22-26x12-15 micra....3. *M.alni extensa*
- Apex less branched, spores 18-23x9-13 micra.....2. *M.alni vaccinii*
- Tips of appendages not recurved when mature.
- Appendages colored.....6. *M.russellii*
- Appendages hyaline or nearly so:
- Appendages long, 2-7 times the diameter of the perithecium, contorted and angularly bent, branching irregular and lax.....7. *M.euphorbiae*
- Appendages, 2-4 times the diameter of the perithecium, branching lax.....
-5. *M.diffusa*
- Appendages, 1-2 times the diameter of the perithecium, branching close and regular4. *M.grossulariae*

Microsphaeraalni (Wallr.) Wint.

- Microsphaeraalni* (Wallr.), Wint. Fink, Blights, etc., of Fayette.
- Microsphaeraabbreviata* Peck. Bessey, The Erysiphei.
- Microsphaera densissima* (Schwein.), C. & P., Bessey, The Erysiphei.
- Microsphaerafriessi* Lev. Bessey, Prel. List Ames Flora; Hitchcock, Partial List Iowa Powdery Mildews.
- Microsphaerahedwigii* Lev. Bessey, The Erysiphei; Hitchcock, Partial List Iowa Powdery Mildews.
- Microsphaeramenispermii* E. C. Howe. Bessey, The Erysiphei.
- Microsphaeraplatani* E. C. Howe. Bessey, The Erysiphei.
- Microsphaerapulchra* Cook & Peck. Bessey, The Erysiphei.
- Microsphaeraravenellii* Berk. Bessey, The Erysiphei.
- Microsphaerasemitosta* Berk & Curt. Bessey, The Erysiphei.
- Microsphaeraquercina* (Schwein.), Burr, in part. Fink, Blights, etc., of Fayette.

Amphigenous; mycelium variable, evanescent or persistent, sometimes forming definite patches; perithecia scattered or gregarious, 66-110 micra in diameter, sometimes larger; cells 10-15 micra wide; appendages 4-26, $\frac{1}{3}$ -2 $\frac{1}{2}$ times the diameter of the perithecium, rigid, sometimes colored at the base; apex variously but closely, 3-6 times, dichotomously branched; tips recurved; asci 3-8, 42-70x32-50 micra; spores, 4-8, 18-23x10-12 micra.

- On *Alnus rugosa* (Du Roi), K. Koch, Jones Co., Aug., 1895 (Macbride).
 On *Carpinus caroliniana* Walt., *Fayette, 1893 (Fink).
 On *Ceanothus americanus* L. Johnson Co. X (X).
 On *Cornus candidissima* Marsh. Muscatine, Oct. 21, 1893 (Bloom).
 On *Corylus americana* L. Ames, Sept. 2 and 14, 1878 (Bessey); Sept. 8, 1894 (Stewart & Stewart); Decatur Co., Oct., 1904 (Anderson); *Fayette, 1893 (Fink); Johnson Co., Sept. 29, 1886 (Macbride).
 On *Euonymus autopurpurens* Jacq. Fayette, Sept., 1893 (Fink).
 On *Flowering pea*. Johnson Co., Sept., 1889 (Bloom).
 On *Juglans regia*. Iowa City, Sept., 1888 (Macbride).
 On *Lathyrus odoratus* L. Ames, Oct., 1902 (Fawcett); Johnson Co., Aug., 1892 (Macbride); Corydon, Nov. 6, 1900 (Stromsten).
 On *Lathyrus palustris*, L. Johnson Co., X (X).
 On *Louicera sullivantii* A. Gray. Decorah, Aug., 1879 (Holway); *Fayette, 1893 (Fink); Fremont Co., Aug. 7, 1905 (Anderson).
 On *Lonicera* sp. Ames, Oct. 9, 1892 (Carver); Forest City, X (X); Decatur Co., Oct., 1905 (Anderson).
 On *Menispermum canadense* L. *Holway in E. & E. N. A. Pyrenomycetes.
 On *Ostrya virginiana* (Mill.), Willd., Decatur Co., Oct. 28, 1905 (Anderson).
 On *Quercus macrocarpa* Michx. Ames, Oct. 9, 1894 (Combs).
 On *Quercus robur*. Ames, Oct., 1893 (Carver).
 On *Quercus rubra* L. Ames, Sept. 14, 1878 (Bessey); Oct. 20, 1882 (Osborn); Boone Co., Aug. 19, 1903 (Pammel & Buchanan); Decatur Co., Nov., 1904 (Anderson); Iowa City, Sept. 9, 1900 (Shinnek); Oct. 7, 1898 (Bloom); Muscatine, Oct. 20, 1900 (X).
 On *Quercus velutina* Lam. Johnson Co., Oct., 1886 (Macbride).
 On *Syringa vulgaris* L. Ames, 1878 (Bessey); 1891 (Raymond); Oct. 9, 1892 (Carver); Sept. 4, 1894 (Coombs); Sept. 10, 1894 (Stewart & Stewart); July 22, 1898 (Carver); Oct. 14, 1901 (Lummis); Decatur Co., Nov. 7, 1905 (Anderson); Fayette, Sept., 1893 (Fink); Iowa City, Oct. 12, 1886 (Macbride); Jordan, July 30, 1903 (Buchanan).
 On *Ulmus americana* L. *Fayette, 1893 (Fink).
 On *Viburnum lentago* L. Decorah, Sept. 9, 1879 (Holway); *Fayette, 1893 (Fink); Johnson Co., X (X).
 On *Vicia* sp. Johnson Co., Aug. 12, 1884 (Macbride).

This is a common and very variable species attacking a great variety of host plants. In the State University herbarium is a specimen on *Platanus occidentalis* collected in October, 1901, in Illinois opposite Muscatine. This species does not appear to be as destructive as some others but injures the host to some extent, often quite seriously.

2. *Microsphaeraalni vaccinii* (Schwein.) Salmon.

Microsphaera elevata, Burr. Bessey, The Erysiphei; Hitchcock, Partial List Iowa Powdery Mildews.

Generally epiphyllous; mycelium persistent or sometimes evanescent; perithecia variable in size, 70-145 micra in diameter, cells 10-20 micra wide; ap-

pendages 4-22, 2½-8 times the diameter of the perithecium, delicate, hyaline or occasionally brown at the base, apex 2-4 times dichotomously branched, branches variable; tips recurved; asci 2-16, 45-72x28-38 micra, spores 4-6, 18-22x10-13 micra.

On *Catalpa catalpa* (L.), Karst, Johnson Co., Sept. 25, 1886 (Macbride).

On *Catalpa speciosa* Warder. Decatur Co., 1904 and 1905 (Anderson); *Iowa City, Oct., 1886 (Hitchcock); Scott Co., Sept. 1, 1897 (Macbride).

This species is occasionally quite destructive, causing a dying and premature dropping of the leaves, thereby greatly weakening the tree.

3. *Microsphaera alni extensa* (Cooke & Peck) Salmon.

Microsphaera extensa Cooke & Peck. Bessey, The Erysiphei, and Prel. List Ames Flora; Hitchcock, Partial List Iowa Powdery Mildews.

Microsphaera quercina (Schwein.), Burr, in part. Fink, Blights, etc., of Fayette.

Epiphyllous; mycelium persistent; perithecia gregarious, 90-140 micra in diameter, cells 10-20 micra wide; appendages 8-19, 2½-6 times the diameter of the perithecium, apex 3-5 times dichotomously forked; tips regularly recurved; asci 3-8, short pedicellate, 58-72x34-45 micra; spores, 4-8, 22-26x12-15 micra.

On *Quercus alba* L. *Fayette, 1893 (Fink).

On *Quercus prinoides* Willd. Decatur Co., Oct., 1904 (Anderson).

On *Quercus rubra* L. *Fayette, 1893 (Fink).

This variety seems to intergrade with the type of the species and it is difficult to draw the line between them. Some of the specimens on *Quercus* referred to under *M. alni* may belong here and the two specimens from Fayette referred to here may belong under *M. alni*. Forms on *Q. rubra* from Decatur County are clearly *M. alni* while specimens on *Q. prinoides* gathered about the same time are typical of the variety *extensa*. It is not very destructive.

4. *Microsphaera grossulariae* (Wallr.) Lev.

Microsphaera grossulariae (Wallr.), Lev. Bessey, The Erysiphei; Fink, Blights, etc., of Fayette.

Microsphaera van bruntae Ger. Bessey, The Erysiphei.

Epiphyllous or amphigenous; mycelium evanescent or subsistent, perithecia scattered to densely gregarious, 65-130 micra in diameter, cells 14-20 micra wide; appendages 5-22, 1-1¼ times the diameter of the perithecium, colorless, apex 4-5 times closely dichotomously branched, ultimate branches forming a narrow fork, tips not recurved; asci 4-10, very short stalked, 46-62x 28-38 micra; spores 4-6; very rarely only 3, 20-28x2-16 micra.

On *Sambucus canadensis* L. Fayette, Oct., 1893 (Fink); Johnson Co., Oct., 1889 (Linder).

In Europe this species attacks the cultivated gooseberry and is sometimes quite troublesome. In America it sometimes attacks

other species of *Ribes* and *Sambucus*. The American gooseberry mildew is *Sphaerotheca mors-uvae*. *M. grossulariae* is seemingly quite rare in Iowa.

5. *Microsphaera diffusa*, Cooke & Peck.

Microsphaera diffusa Cooke & Peck. Bessey, The Erysiphei.

Microsphaera symphoricarpi E. C. Howe. Bessey, The Erysiphei, and Prel. List, Ames Flora; Hitchcock; Partial List Iowa Powdery Mildews.

Amphigenous; mycelium persistent or somewhat evanescent; perithecia scattered or gregarious, variable, 55-126 micra in diameter, cells 10-20 micra wide; appendages 4-30 or rarely more, 1½-7 times the diameter of the perithecium, colorless or pale brown toward the base apex, 3-5 times dichotomously branched, tips not recurved, branches of the higher orders often appearing lateral; asci 4-9, 46-60x28-30 micra, short pedicellate; spores 3-6, 18-22x9-11 micra.

On *Meibomia canadensis* (L.) Kuntze. Decatur Co., Oct., 1904 and 1905 (Anderson); Fremont Co., Aug. 8, 1905 (Anderson); Ringgold Co., Oct. 7, 1905 (Anderson).

On *Meibomia sessilifolia* (Torr.), Kuntze, Ames, Sept. 14, 1898.

On *Symphoricarpos symphoricarpos* (L.) MacM. Ames, Sept. 7, 1882 (Bessey); Oct. 4, 1882 (Bessey); Aug., 1886 (Hitchcock); Decatur Co., Sept., 1904 and 1905 (Anderson); Corydon, Nov. 5, 1900 (Stromsten); Fremont Co., Aug. 7, 1905 (Anderson); Johnson Co., Oct., 1882 (Hitchcock).

The form on *Meibomia* has generally been considered distinct from that on *Symphoricarpos* but there does not appear to be sufficient difference to justify such separation.

In the southern part of the state this species is very common both on *Meibomia canadensis* and *Symphoricarpos vulgaris*. In summer *Symphoricarpos* sometimes presents a whitish appearance from the abundance of the conidial stage of this species.

6. *Microsphaera russellii* Clinton.

Microsphaera russellii Clinton. Bessey, The Erysiphei and Prel. List Ames Flora; Hitchcock, Partial List Iowa Powdery Mildews; Fink, Blights, etc., of Fayette.

Amphigenous; mycelium inconspicuous; perithecia scattered, 70-118 micra in diameter, cells 6-14 micra wide; appendages 5-14, 3-7 times the diameter of the perithecium, flaccid, colored nearly to the apex, septate, apex 2-4 times dichotomously branched, branching irregular and lax, tips not recurved; asci 4-9, short pedicellate, 42-56x24-32 micra; spores 3-5, 18-22x10-12 micra.

On *Oxalis stricta*, L. Ames, Oct. 17, 1878 (Bessey); Decorah, Oct. 19, 1878 (Holway); Decatur Co., Oct., 1905 (Anderson); Fayette, Oct., 1892 (Fink); Iowa City, Oct., 1886 (Hitchcock).

In this species the appendages are very slow in arriving at maturity.

Microsphaera euphorbiae (Peck), Berk & Curt.

Erysiphe euphorbiae Peck. Bessey, The Erysiphei.

Microsphaera euphorbia (Peck), Berk & Curt. Fink, Blights, etc., of Fayette.

Amphigenous; mycelium subpersistent or sometimes evanescent; perithecia 85-145 micra in diameter, rarely larger, cells 10-15 micra wide, appendages 7-28, 2½-8 times the diameter of the perithecium, flexuose, often angularly bent, colorless, aseptate, apex 3-4 times dichotomously branched, branching irregular and lax, tips straight or recurved; asci 4-13, rarely more; short pedicellate, 48-66x26-33 micra; spores usually 4 (3-6), 19-21x10-12 micra.

On *Euphorbia corollata*, L. Decatur Co., Oct., 1904 and 1905 (Anderson); Decorah, Sept., 1879 (Holway); *Fayette, 1893 (Fink); Ringgold Co., Oct. 7, 1905 (Anderson).

On *Euphorbia marginata* Pursh. Johnson Co., 1888 (Macbride).

As in some other species of *Microsphaera* the appendages are very slow in arriving at maturity, hence it is often collected with the appendages not yet branched.

In August, 1905, I found this species in abundance on *Euphorbia marginata* in Cass County, Nebraska, but could find none on the east side of the Missouri River in Fremont County although the host was very abundant.

Uncinula Lev.

Perithecium containing several asci, asci 2-8 spored; appendages free from the mycelium, uncinuate or coiled at the apex.

Key to Iowa Species of *Uncinula*.

- Appendages colored2. *U. necator*
- Appendages hyaline or nearly so.
- Asci 2 spored.....5. *U. macrospora*
- Asci 4-8 spored.
- Appendages delicate, narrow, 3-4 micra wide, asci 4-7 spored.
- Appendages 50-160, ½-¾ times the diameter of the perithecium.....4. *U. parvula*
- Appendages 24-46, 1¼-2 times the diameter of the perithecium.....7. *U. geniculata*
- Appendages stouter.
- Appendages thick walled, refractive at base.....6. *U. clintoni*
- Appendages thin walled.
- Asci 4-6 spored.....1. *U. salicis*
- Asci 7-8 spored.....3. *U. circinata*

1. *Uncinula salicis* (DC.) Wint.

Uncinula adunca, Lev. Bessey, The Erysiphei, and Prel. List, Ames Flora; Hitchcock, Partial List Iowa Powdery Mildews.

Uncinula heliciiformis E. C. Howe. Hitchcock, Partial List Iowa Powdery Mildews.

Uncinula salicis (DC.), Wint. Fink, Blights, etc., of Fayette.

Amphigenous; mycelium evanescent or persistent; perithecia 90-175 micra in diameter, cells 10-15 micra wide; appendages usually numerous or crowded, 100-

150, sometimes less, $\frac{3}{4}$ -2½ times the diameter of the perithecium, simple, hyaline, slightly enlarged upward; asci 8-14, rarely less, 55-80x30-40 micra; spores 4-6, 20-26x10-15 micra.

On *Populus deltoides*, Marsh. Johnson Co., X (X).

On *Populus grandidentata* Michx. Columbus Jc., Aug., 1899 (Pammel); Johnson Co., X (Macbride).

On *Populus tremuloides*, Michx. *Iowa City, Oct., 1886 (Macbride).

On *Salix amygdaloides* Anders., Ames, Aug. 30, 1894 (Combs).

On *Salix discolor*, Muhl. Ames, Aug. 15, 1898 (Ball); Greenfield, Sept. 18, 1893 (Stewart); Johnson Co., Oct. 21, 1893 (Shimek).

On *Salix humilis*, Marsh. Ames, Sept., 1899 (Pammel).

On *Salix* sp. Ames, Oct. 12, 1878 (Bessey); *July, 1886 (Hitchcock); Decorah, Sept., 1879 (Holway); Fayette, Sept., 1893 (Fink); Johnson Co., Aug., 1886 (Hitchcock); Mason City, Sept., 1900 (Shimek); Rock Rapids, Aug. 5, 1896 (Shimek).

This is a very variable and widely distributed species. The forms on *Populus* and *Salix* differ somewhat but not enough to justify separation.

Uncinula necator (Schwein.) Burr.

Uncinula americana, E. C. Howe. Bessey, Prel. List Ames Flora.

Uncinula ampelopsidis. Peck. Bessey, Prel. List Ames Flora, Hitchcock, Partial List Iowa Powdery Mildews.

Uncinula necator (Schwein.), Burr. Fink, Blights, etc., of Fayette.

Amphigenous, with perithecia usually epiphyllous, sometimes occurring on the inflorescence; mycellium evanescent to subpersistent; perithecia more or less scattered, 70-128 micra in diameter, cells rather irregular in shape, 10-20 micra wide, appendages 7-32, 1-4 times the diameter of the perithecium, septate, the lower half colored; apex more or less helicoid when mature; asci 4-6, rarely more, 50-60x30-40 micra; spores 4-7, 18-25x10-12 micra.

On *Parthenocissus quinquefolia* (L), Planch. Ames, Sept. 11, 1882 (Bessey); Aug. 17, 1899 (Hume); Decatur Co., Sept. and Oct., 1904 and 1905 (Anderson); Decorah, Sept., 1879 (Holway); Johnson Co., Oct. 23, 1886 (Macbride); Ringgold Co., Oct. 7, 1905 (Anderson).

On *Vitis cordifolia* Michx. *Fayette, 1893 (Fink).

On *Vitis labrusca*, L. Ames, Aug., 1891 (Pammel); Oct. 30, 1891 (Rolf); Oct., 1892 (Bettinger); Decatur Co., Oct., 1905 (Anderson).

On *Vitis* sp. Ames, Sept., 1889 (X); Sept., 1890 (Pammel); Sept. 12, 1894 (Combs); Fayette, Oct., 1893 (Fink).

This is the powdery mildew of the grape and is to be distinguished from the downy mildew, *Peronospora viticola*. In Iowa it does not appear to be as destructive on the grape as it is on the Virginia creeper (*Parthenocissus quinquefolia*). On the latter host it is frequently quite destructive, as it also appears to be on the grape in some regions. In Iowa so far as the writer's observation indicates, the *Peronospora* is more destructive than the *Uncinula*.

Sulphur and Bordeaux mixture are used as remedies against the present species.

Uncinula circinata Cooke & Peck.

See Plate II.

Uncinula circinata, Cooke & Peck. Bessey, Prel. List, Ames Flora; Hitchcock, Partial List Iowa Powdery Mildews; Fink, Blights, etc., of Fayette.

Hypophyllous; mycelium usually evanescent; perithecia usually scattered, 160-225 micra in diameter, rarely smaller; cells irregular, 10-14 micra wide; appendages very numerous, usually crowded, their length rather less than the diameter of the perithecium, simple, hyaline, apex simply uncinata; asci 9-26, 68-86x29-40 micra; spores 8, sometimes only 7, 18-22x10-14 micra.

On *Acer saccharinum*, L. Ames, Oct., 1894 (Carver); *Belle Plaine, Sept., 1886 (Hitchcock); Decatur Co., Oct. 28, 1905 (Anderson); Decorah, Oct., 1879 (Holway); Iowa City, Oct. 7, 1893 (Bloom).

On *Acer saccharum*, Marsh. *Fayette, Sept., 1893 (Fink).

A very beautiful species under the microscope. A specimen labeled *U. circinata* on *Acer saccharum* in Prof. Fink's herbarium proved to be *Phyllactinia corylea*.

Uncinula parvula Cooke & Peck.

Amphigenous; mycelium evanescent; perithecia usually hypophyllous, scattered, 86-122 micra in diameter, cells about 10 micra wide; appendages numerous 50-160, $\frac{1}{2}$ - $\frac{3}{4}$ times the diameter of the perithecium, simple, hyaline, apex simply uncinata; asci, 5-8, 50-64x34-38 micra; spores 4-7, usually 6, 20-24x10-12 micra. On *Celtis occidentalis* L. Ames, Sept. 15, 1878 (Bessey).

Uncinula macrospora Peck.

Uncinula intermedia Berk. & Curt. Bessey, The Erysiphei.

Uncinula macrospora Peck. Bessey, The Erysiphei; Hitchcock, Partial List Iowa Powdery Mildews; Fink, Blights, etc., of Fayette.

Amphigenous; mycelium evanescent or subsistent, often forming circumscribed patches on the upper surface of the leaf; perithecia gregarious or scattered, 95-165 micra in diameter; cells about 10 micra wide; appendages 50-130 or more, $\frac{1}{3}$ -1 times the diameter of the perithecium; colorless; aseptate; apex simply uncinata, rarely subhelicoid; asci 8-14 or more; often curved, 54-65x 29-35 micra; spores 2, 30x15-18 micra.

On *Ulmus americana* L. *Cedar Rapids, Sept., 1886 (Hitchcock); Decatur Co., Oct., 1905 (Anderson); Decorah, Sept., 1879 (Holway); Fayette, Sept., 1894 (Fink); Johnson Co., Sept., 1885 (Macbride).

On *Ulmus racemosa* Thomas. Decatur Co., Oct. 28, 1905 (Anderson).

On *Ulmus americana* I have found the perithecia evenly distributed over the under surface of the leaf with the mycelium completely evanescent and I have also found it with mycelium subsistent in circumscribed patches on the upper surface of the leaf.

On *Ulmus racemosa* all I have found has been in circumscribed patches on the upper surface of the leaf. These patches are often very conspicuous.

Uncinula clintoni Peck.

Uncinula clintoni Peck. Hitchcock, Partial List Iowa Powdery Mildews; Fink, Blights, etc., of Fayette.

Hypophyllous or amphigenous, mycelium usually more or less evanescent; perithecia gregarious or scattered, 80-130 micra in diameter, cells irregular in shape, 10-20 micra wide; appendages 10-35, 1-2½ times the diameter of the perithecium, hyaline or somewhat colored at base; apex clavate uncinata; asci 4-10, very short stalked, 40-62x34-40 micra; spores 3-7, 20-27x10-13 micra.

On *Tilia americana* L. Ames, Sept. 22, 1878 (Bessey); 1878 (Thomas); Sept., 1892 (Bettinger); *Cedar Rapids, Sept., 1886 (Hitchcock); Decorah, Aug., 1879 (Holway); *Fayette, 1893 (Fink); Johnson Co., Sept. 14, 1886 (Macbride); Jones Co., Aug., 1895 (Macbride); Muscatine, Oct. 20, 1900 (Stromsten).

Uncinula geniculata Gerard.

Epiphyllous; mycelium thin; forming definite patches or more or less effused, sometimes evanescent; perithecia subgregarious or scattered, 90-120 micra in diameter, cells rather irregular, 10-15 micra wide; appendages 24-46, 1¼-2 times the diameter of the perithecium, some usually abruptly bent or geniculate, hyaline, aseptate, apex simply uncinata; asci 5-8; very short pedicellate, 48-56x34-38 micra; spores 4-6, 22x12 micra.

On *Morus rubra* L. Decatur Co., Oct. 28, 1905 (Anderson).

This species is very inconspicuous and may be much more common than would be indicated by the fact that it is not often collected.

PHYLLACTINIA Lev.

Perithecia large; asci many; 2, rarely 3-spored, appendages hyaline, free from the mycelium, acicular or rarely flexuously bent, acute at tip with a bulbous base; apex of perithecium provided with outgrowths from the epidermal cells. This genus is often separated from the others as a subfamily (Phyllactiniae). This distinction is based on the fact that the mycelium does not form haustoria in the ordinary manner, but sends special branches into the stomata of the host, each of these branches giving rise to an haustorium which penetrates the surrounding tissue.

Key to Iowa Species of *Phyllactinia*.

Appendages undivided1. *P. corylea*
Appendages divided2. *P. corylea tomentosa*

Phyllactinia corylea (Pers.) Karst.

Phyllactinia condollei Lev. Bessey, The Erysiphei.

Phyllactinia guttata (Wallr.), Lev. Bessey, The Erysiphei.

Phyllactinia suffulta (Rebent.), Sacc. Bessey, Prel. List. Ames Flora; Hitchcock, Partial List Iowa Powdery Mildews; Fink, Blights, etc., of Fayette.

Usually hypophyllous; mycelium persistent or scant and evanescent; perithecia usually scattered, 140-270 micra in diameter or larger, cells obscure, 15-20 micra wide; appendages 5-18 or more, 1-3 times the diameter of the perithecium, acicular, rigid, hyaline, aseptate, swollen at the base into a hollow bulb, asci 5-45, 60-105x20-40 micra, rarely larger, pedicellate, spores generally 2, rarely 3, 30-42x16-25 micra, when 3 smaller.

- On *Acer saccharum* Marsh. Fayette (Fink).
- On *Betula papyrifera* Marsh. *Fayette, 1893 (Fink).
- On *Cornus florida* L. *Fayette, 1893 (Fink).
- On *Cornus stolonifera* Michx. Fayette, Sept., 1893 (Fink).
- On *Corylus americana*, L. *Fayette, 1893 (Fink); Johnson Co., Sept. 25, 1886 (Macbride); Sept. 19, 1899 (Shimek); *Oct., 1886 (Hitchcock).
- On *Crataegus coccinea* L. Johnson Co., Oct., 1894 (X).
- On *Crataegus* sp. *Fayette, 1893 (Fink).
- On *Crataegus tomentosa* L. Ames, Oct. 14, 1901.
- On *Celastrus scandens* L. Johnson Co., X (X).
- On *Fraxinus lanceolata* Berk. Story City, Aug. 27, 1903 (Buchanan).
- On *Fraxinus* sp. *Fayette, 1893 (Fink).
- On *Meibomia canadense* (L.), Kuntze. Johnson Co., X (X).
- On *Meibomia grandiflora* (Walt.), Kuntze. *Fayette, 1893 (Fink).
- On *Ostrya virginiana* (Mill.) Willd. Ames, 1877 (Bessey); Decatur Co., Oct. 28, 1905 (Anderson); Iowa City, Oct. 6, 1900 (Stromsten); Muscatine, Oct. 20, 1900 (Stromsten).
- On *Quercus palustris* DuRoi. Johnson Co., Nov., 1886 (Macbride).
- On *Quercus rubra* L. Johnson Co., Oct. 12, 1886 (X).
- On *Quercus velutina* Lam. Johnson Co., 1886 (Macbride).
- On *Ulmus americana* L. *Fayette, 1893 (Fink).
- On *Ulmus racemosa* Thomas. Decatur Co., Oct. 28, 1905 (Anderson).
- On *Xanthoxylum americanum* Mill. Ames, Sept. 15, 1878 (Bessey); Fayette, Sept., 1894 (Fink).

This species seems to be very common in the eastern part of the state but is not so plentiful in the southwestern part. I have found it rarely in Decatur County. It probably does not grow on herbaceous plants but perithecia are often found there. The apical outgrowths serve to attach the perithecium to the substratum and by this means stray perithecia may seem to be firmly attached where they did not originate.

Phyllactinia corylea tomentosa, Macbride & Peck, Var., Nov.

See Plate I.

Hypophyllous; mycelium persistent; perithecia as in *P. corylea*; appendages 2-3 times the diameter of the perithecium; divided down to the bulbous base, the divisions flexuously bent in graceful curves, hyaline, aseptate.

On *Quercus velutina*, Lam. Johnson Co., 1886 (Macbride).

In the herbarium of the State University were a few specimens labeled *Phyllactinia suffulta* var. *tomentosa*. On inquiry Prof.

Macbride informed the writer that he collected the same during the fall of 1886 at which time there was an abundance. It covered the entire north side of a tree 40 feet high. A quantity was collected but most of it was afterward found missing. No special effort has since been made to collect it.

The variety is based on the appendages which are markedly different from those of the type. Profs. Macbride and Peck agreed upon the name *Phyllactinia suffulta tomentosa* for the variety. It seems that *corylea* rather than *suffulta* is the name that should be applied to the species and is so published here.

The occurrence of this variety and the circumstances under which it was found are rather remarkable. Its taxonomic position is a puzzle. The appendages are so different from those of the typical *P. corylea* that it might be considered a distinct species if it could be shown that these differences were constant. On the other hand it may simply be a sport due to some peculiarities of host plant and season. Several facts seem to lend color to the latter view.

HOST INDEX.

Abbreviations used: E., Erysiphe; M., Microsphaera; Ph., Phyllactinia; Po., Podosphaera; S., Sphaerotheca; U., Uncinula.

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<i>Salix amygdaloides</i> Anders.....	<i>U. salicis</i>
<i>Salix discolor</i> Muhl.....	<i>U. salicis</i>
<i>Salix humilis</i> Marsh.....	<i>U. salicis</i>
<i>Salix</i> sp.....	<i>U. salicis</i>
<i>Sambucus canadensis</i> L.....	<i>M. grossulariae</i>
<i>Sanguisorba canadensis</i> L.....	<i>Po. oxycantheae</i>
<i>Scutellaria lateriflora</i> L.....	<i>E. galeopsidis</i>
<i>Scutellaria galericulata</i>	<i>E. galeopsidis</i>
<i>Sisymbrium officinale</i> Scop.....	?
<i>Solanum carolinense</i> L.....	?
<i>Solidago canadensis</i> L.....	<i>E. cichoracearum</i>
<i>Solidago rigida</i> L.....	<i>E. cichoracearum</i>
<i>Solidago serotina</i> Ait.....	<i>E. cichoracearum</i>
<i>Solidago serotina gigantea</i> (Ait.) A. Gray.....	<i>E. cichoracearum</i>
<i>Solidago ulmifolia</i>	?
<i>Sonchus oleraceus</i> L.....	<i>S. humuli fuliginea</i>
<i>Stachys palustris</i> L.....	<i>E. galeopsidis</i>
<i>Stachys</i> sp.....	<i>E. galeopsidis</i>
<i>Symphoricarpos symphoricarpos</i> (L.) MacM.....	<i>M. diffusa</i>
<i>Symphoricarpos vulgaris</i> Michx. See <i>S. symphoricarpos</i> .	
<i>Syndesmon thalictroides</i> (L.) Hoffing.....	<i>E. polygoni</i>
<i>Syringa vulgaris</i> L.....	<i>M. alni</i>
<i>Taraxacum officinale</i> Weber. See <i>F. taraxacum</i> .	
<i>Taraxacum taraxacum</i> (L.) Karst.....	<i>S. humuli fuliginea</i>
<i>Taraxacum canadense</i> L.....	<i>E. galeopsidis</i>
<i>Thalictrum purpurascens</i> L.....	<i>E. polygoni</i>
<i>Tilia americana</i> L.....	<i>U. clintoni</i>
<i>Ulmus americana</i> L.....	<i>M. alni</i> — <i>U. macrospora</i> — <i>Ph. corylea</i>
<i>Ulmus racemosa</i> Thomas.....	<i>U. macrospora</i> — <i>Ph. corylea</i>
<i>Verbena bracteosa</i> Michx.....	<i>E. cichoracearum</i>
<i>Verbena hastata</i> L.....	<i>E. cichoracearum</i>
<i>Verbena stricta</i> Vent.....	<i>E. cichoracearum</i>
<i>Verbena urticifolia</i> L.....	<i>E. cichoracearum</i>
<i>Verbesina alternifolia</i> (L.) Britton.....	<i>E. cichoracearum</i>
<i>Veronica virginica</i> L. See <i>Leptandra virginica</i> .	
<i>Vernonia fasciculata</i> Michx.....	<i>E. cichoracearum</i>
<i>Vernonia noveboracensis</i> (L.) Willd.....	<i>E. cichoracearum</i>
<i>Viburnum lentago</i> L.....	<i>M. alni</i>
<i>Vicia</i> sp.....	<i>M. alni</i>
<i>Vitis cordifolia</i> Michx.....	<i>U. necator</i>
<i>Vitis labrusca</i> L.....	<i>U. necator</i>
<i>Vitis</i> sp.....	<i>U. necator</i>
<i>Xanthium canadense</i> Mill.....	?
<i>Xanthoxylum americanum</i> Mill.....	<i>Ph. corylea</i>

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EXPLANATION OF PLATES.

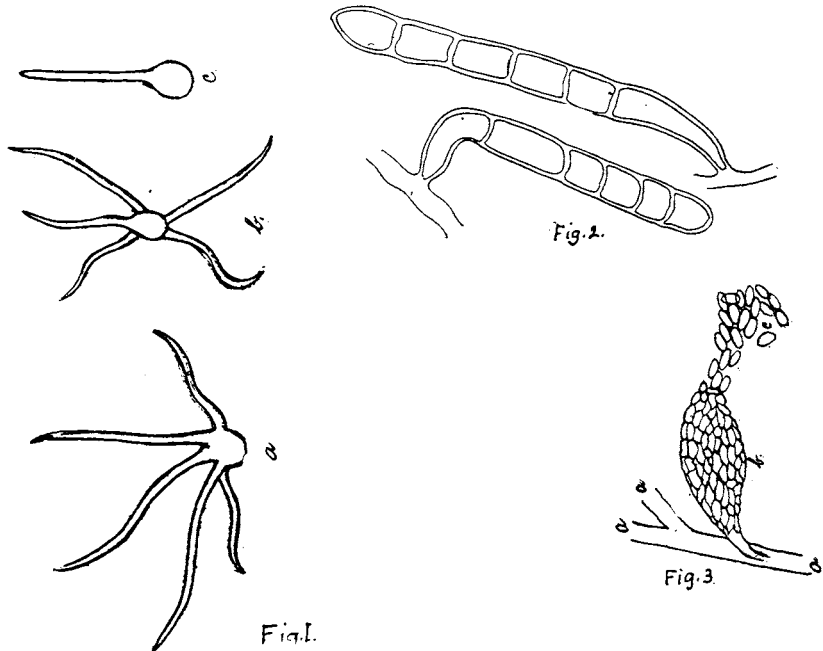


PLATE I.

Fig. 1. *Phyllactinia corylea tomentosa*. a and b, two appendages; c, an appendage of the typical *P. corylea* from same leaf as a and b. (Author's illustration.)

Fig. 2. Hyphae and conidia of *Erysiphe cichoracearum*, from leaf of *Hydrophyllum virginicum*. (Drawn by Miss King.)

Fig. 3. A fruit of *Ampelomyces quisqualis*. a. A mycelium of *Erysiphe* with the fruit of *Ampelomyces*; b, arising out of it; c, spores escaping from the ruptured end of fruit. (Author's illustration.)

PLATE II.

(Drawn by Miss King.)

(See page 46.)

Fig. 1. A perithecium of *Uncinula circinata* from a leaf of *Acer saccharinum* showing very numerous appendages uniformly coiled at apex.

Fig. 2. Perithecia of *Sphaerotheca mors-uvae* from the cultivated gooseberry, showing few or obsolete appendages and the persistent mycelium in which they are immersed.

PLATE III.

(See page 46.)

Showing Variations in *Erysiphe polygoni*. (Drawn by Miss King.)

Fig. 1. From a leaf of *Clematis virginiana*, showing few, but long flexuose appendages.

Fig. 2. From a leaf of *Astragalus carolinianus*, showing more numerous but short appendages. b. Tips of appendages.

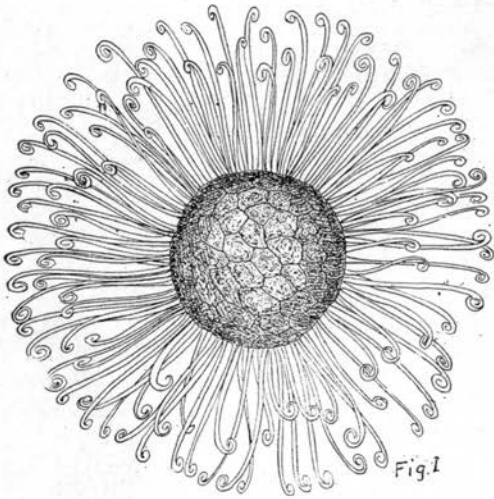


Fig. 1

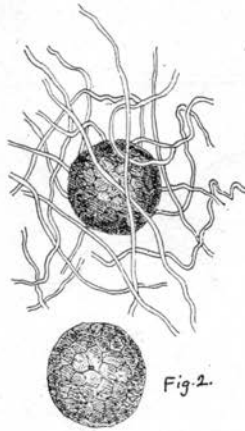


Fig. 2.

PLATE II.

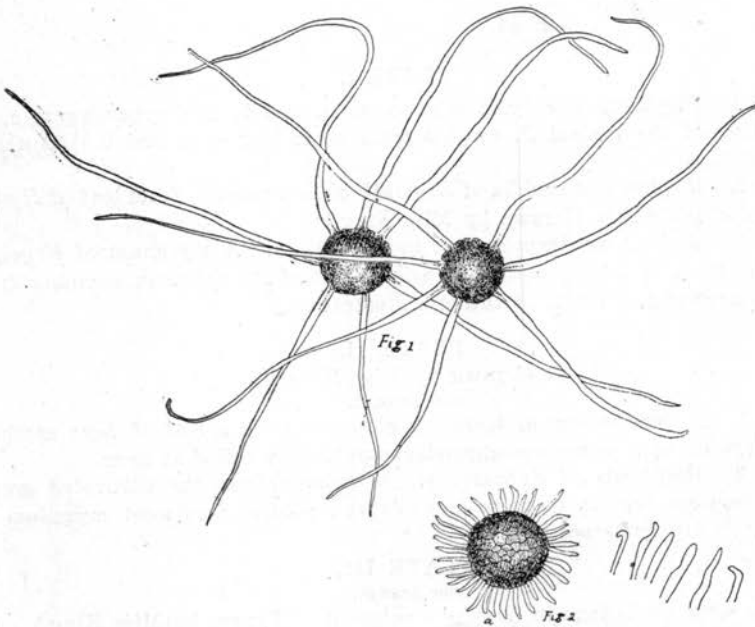


Fig. 1

Fig. 2

PLATE III.