

THE ERYSIPHACEAE OF KANSAS

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by

GARY MACK LONG

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Major Professor

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INTRODUCTION

The Erysiphaceae are pyrenomycetes of the order Erysiphales. Obligate parasites of Angiosperms, they exhibit a wide host range of approximately 1300 species, the majority being cultivated vascular plants.

Classification of the Erysiphaceae began with Linnaeus (1753). In "Species Plantarum" he made note of Mucor Erysiphe, listing several species on which it had been observed. Many species were subsequently noted and described. The descriptions were superficial and were named for the plant on which they were found to occur.

This method of classification was used until Wallroth (1819) introduced the concept that one species could occur on more than a single host species. He contended that classification should be made on the basis of the various shapes of the appendages and the modes of branching of the appendages.

A paper by Schlechtendahl (1819) published immediately following Wallroth's noted that division of the group could be made on the basis of the asci; some cleistothecia containing a single 8-spored ascus, and others containing several asci.

The observations made by Wallroth (1819) and Schlechtendahl (1819) established the method for subsequent classification based on structural characteristics.

A host oriented key to the Erysiphaceae is presented in this work. In addition to the host species that have been observed as infected, it includes cultivated and natural species capable of growing in this climatic range that are known to be parasitized by members of the Erysiphaceae.

LITERATURE REVIEW

Several regional reports on Erysiphaceae were written in the years following the papers of Wallroth (1819) and Schlechtendahl (1819). They were based on the concepts in these papers and introduced no new criteria for classification.

Schweinitz (1834) published an account of the North American forms in which he described 16 new species. Later study determined that many of these were the same species on different hosts.

Leveille (1851) published a monograph "Organisation et Disposition methodique des especes que composent le genre Erysiphe". He divided the Erysiphaceae into two groups: Sporangium unicum, in which he placed the genera Podosphaera, and Sphaerotheca as having single asci, and Sporangium plurima with the genera Phyllactinia, Uncinula, Calocladia, and Erysiphe as having multiple asci. The genera within the two groups were established on the basis of the structure of the appendages.

The Tulasne brothers described and illustrated 16 species in the first volume of the "Selecta Fungorum Carpologia" (1861). The recognition of only 16 species and one genus, Erysiphe, was a step backward for classification, but the work is notable for the excellent illustrations of both conidial and cleistothecial forms.

In 1870 De Bary published "Beitrag zur Morphologie und Physiologie der Pilze". It was the first published work on the life history of the Erysiphaceae, and the development of the cleistothecia was described in detail. In classifying the group he established two genera, Podosphaera and Erysiphe, on the basis of single and multiple asci.

Cooke and Peck published two papers on the Erysiphaceae of the United States in 1872. In these papers they named several new species, 7 of which were later retained by Salmon (1900).

Burrill and Earle (1887) published "Parasitic Fungi of Illinois, Part 2, Erysiphaceae". They listed 28 species, employing a broad deliniation for each of the species and a notation of the hosts for each of the species.

Palla (1899) noted that Phyllactinia produces haustoria from hyphae which extrude through the stomata of the host plant. This provided the basis for the sub-family divisions of the group into Erysipheae and Phyllactineae.

The first major work on the Erysiphaceae was published by Salmon in 1900. The system of classification used by Salmon was based on hyphal and cleistothecial characteristics. While noting the character of the conidial stage of the group, he did not consider conidial characteristics reliable enough to be used as criteria in establishing species.

Under his method of classification he retained the two sub-families Erysipheae and Phyllactineae. Erysiphe, Sphaerotheca, Podosphaera, Uncinula, Microsphaera, and Phyllactinia were recognized as genera under which he listed a total of 60 species and varieties.

In 1905, Salmon observed that Erysiphe taurica was endophytic in its conidial stage. He renamed it Oidiopsis taurica and placed it in a new sub-family, Oidiopsidae.

Arnaud (1921) transferred the species Oidiopsis taurica in the sub-family Oidiopsidae to the species Leveillula taurica in the sub-family Leveilluleae.

Regional works followed by Klika (1924), Jorstad (1925), Skoric (1927), and Sawada (1927), all of which utilized the classification system of

Salmon (1900).

Blumer published his first monograph of Erysiphaceae in 1933. In this work he listed 8 genera: Sphaerotheca, Erysiphe, Microsphaera, Uncinula, Phyllactinia, Leveillula, Podosphaera, and Typhulochaeta. Within these genera he recognized 122 species. Although he used the general criteria established by Salmon, he considered conidial characteristics to be valid for species differentiation, and in addition he placed greater emphasis on host specificity than did Salmon.

Brunzda (1933) followed Blumer with a monograph in which he used the classification criteria of Blumer. In his work, however, he recognized two types of conidial development. He gave the name Euoidium to those formed in chains, and Pseudoidium to conidia produced singly.

In 1937 Homma published a study of the Erysiphaceae in which he recognized 11 genera and 74 species. The 11 genera were the 8 established by Blumer and in addition 3 that were based on types of conidial development. He used the two types described by Brunzda (1933) and added Ovulariopsis, with clavate conidia.

On the basis of these three types of conidial development Homma (1937) differentiated Sawadaea from Uncinula, Cystotheca from Sphaerotheca, and Uncinulopsis from Phyllactinia. The three genera are not retained by most investigators but the importance of the types of conidia was recognized and are incorporated into the monograph by Blumer published in 1967.

In the new monograph Blumer (1967) retained the classical criteria established first by Salmon (1900), some of the basic considerations of his first monograph, and incorporated some of the conidial characteristics that had proved valid. The number of genera was reduced to 7 and the

species to 88 from the original 133. The new monograph with its broader concept of species seems to be more acceptable, and the characteristics for differentiation of species, while sometimes rather ambiguous, are generally discernible and reliable.

The problems of identification of Erysiphaceae which exhibit no perfect stage are as yet unsolved. Sawada (1914) devised a key for imperfect stages, but knowledge of its usefulness is scanty due largely to its publication in Japanese.

Attempts by investigators have established some valid criteria. The reliability of conidial dimensions and type of development was demonstrated by Brunzda (1933), Blumer (1933), and Homma (1937).

Hirata (1955) in a study of germ tubes described four morphological types: forked, unbranched with appressoria unlobed; branched or unbranched with apical or lateral lobed appressoria; and, germ tube with an appressorium type structure at the base.

Using these characteristics in addition to mycelial characteristics it is possible to reliably identify only 6 species.

PROCEDURE

Specimens from the KSU mycological herbarium were examined. Gross features of the mycelium, cleistothecia and appendages were noted with the use of a dissection microscope. Removal of the cleistothecia from the host material was done with the aid of the dissection microscope.

Maintaining the appendages intact during removal from the host is an individual problem with each species. Some were more easily removed while the material was dry, while with others it was necessary to saturate

the material with aerosol before removal.

Microscopic observations were made with the material mounted in distilled water.

MORPHOLOGY

The Erysiphaceae are an easily recognized, morphologically-distinct group. Most conspicuous is the hyaline to white superficial mycelium, composed of septate hyphae. The hyphal cells are thin walled, typically uninucleate, with lateral swellings called appressoria. The nuclei frequently have protruding nucleoli.

The appressoria initiate production of haustoria which generally extend through the stomata of the host. They aid in anchoring the fungus and are the means by which the fungus feeds.

Phyllactinia and Leveillula are exceptions to this form of haustorial development. Phyllactinia produces extensions of the hyphae which enter the stomata and the haustoria are developed in the mesophyll. Leveillula produces an even more extensive system of intercellular mycelium from which the haustoria are produced.

Three types of haustorial development have been noted. Globular haustoria are the most common, the other types being digitate, and multiple in which several haustoria are initiated by a single appressorium.

Asexual reproduction is accomplished by means of specialized hyphae called conidiophores. They are typically unbranched, and develop at right angles to the host surface. Composed of a stipe and a generative cell, they produce conidia at their tips. Conidiophores have been shown to exhibit extreme variability in size and shape when on different hosts or when subjected

to different environmental conditions.

The conidia are smooth, one celled, uninucleate structures that exhibit various shapes. Ovate, cylindrical, clavate, barrel-shaped, and intermediate forms throughout have been observed.

The perfect stage of Erysiphaceae is a cleistothecium. It is approximately spherical, colorless when young, yellowish when immature, and brown to black when mature. The wall of the cleistothecium is composed of two layers, the outer layer being thick walled, non-nucleated cells of somewhat typical size and the inner layer, composed of thin walled binucleate cells.

Within the cleistothecia are club-shaped asci containing spores. The asci are short, stout structures some with a foot cell that attaches it to the cleistothecium. Ascospores are similar to the conidia, being generally slightly larger and thicker walled.

Externally the cleistothecia bear typical appendages. They are generally thicker and darker than the mycelium with less frequent septa and fewer branches than the hyphae.

TAXONOMIC TREATMENT

The key is basically an adaptation of the key by Salmon (1900). The nomenclature is that of Salmon's (1900) except for changes made in response to the rules of nomenclature, these being established after publication of the monograph.

Some differentiations within the key utilize criteria that is more easily recognizable than that of Salmon (1900) and has been established as reliable by the work of Blumer (1967).

Order ERYSIPHALES

The Erysiphales are obligate parasites with cleistothecial type ascocarps containing large, globose or ovoid, often stalked asci which, at maturity, form a single basal layer within the cleistothecium. The cleistothecial wall is pseudoparenchymatous and dark. The cleistothecia are formed on a superficial mycelium without the development of a stroma.

The order Erysiphales contains the single family, Erysiphaceae.

KEY TO THE GENERA OF ERYSIPHALES

Sub-family Erysipheae

1. Mycelium generally ectoparasitic with haustoria in the epidermal cells; imperfect stage of the oidium type, conidia ellipsoid, barrel shaped or cylindrical; cleistothecia usually less than 150 μ m in diameter (exception: Erysiphe graminis).
2. Cleistothecia contain only one ascus 3
 3. Cleistothecial appendages mycelial-like, irregularly curved, occasional irregular branching I. Sphaerotheca
 3. Appendages rigid, straight or curved ascending, ends generally dichotomously branched. II. Podosphaera
2. Cleistothecia contain more than one ascus. 4
 4. Appendages mycelial-like, irregularly curved, occasional irregular branching. III. Erysiphe
 4. Appendages usually dichotomously branched, hook-shaped, curved, or spirally recurved at the tips 5
 5. Appendages with one or more dichotomous branches at the tip. IV. Microsphaera

5. Appendages simple or branched, tips hooked or spirally recurved V. Uncinula
1. Mycelium at least in part endophytic, with haustoria in the mesophyll cells; conidia often acuminate on one side; cleistothecia usually over 150 um in diameter 6
- Sub-family PHYLLACTINIEAE
6. Appendages straight, rigid, with a spherical swelling at the base; brush-like cell at the apex of the cleistothecium; imperfect stage of the oidiopsis type. VI. Phyllactinia
- Sub-family LEVEILLULAEAE
6. Appendages mycelial-like and crooked, occasional irregular branching; imperfect stage of the oidiopsis type. VII. Leveillula

I. SPHAEROTHECA Lev. Ann. Sci. Nat. III. 15:138. 1851.

Cleistothecia subglobose, ascus solitary, 8-spored, appendages floccose, spreading horizontally and often interwoven with the mycelium, simple or vaguely branched, frequently obsolete.

Key to the Species

1. Segments of the cleistothecial wall small (10-20 um) 2
2. Secondary mycelium singular in form, little branching, thick walled hyphae present 3
3. Secondary mycelium tightly compact, yellowish
. I. Sphaerotheca pannosa
3. Secondary mycelium brown, cleistothecia numerous 4
4. Conidia ellipsoid, length usually less than twice the width, inner wall of the cleistothecia does not separate from the outer wall

II. Sphaerotheca mors-uvae

4. Conidia ellipsoid, usually more than twice as long as wide; inner wall of cleistothecia separates from the outer. III. Sphaerotheca lanestris
2. Secondary mycelium not fully developed 5
5. Cleistothecia 80-120 um in diameter; appendages up to 9 times as long as the diameter of the cleistothecia IV. Sphaerotheca humili
5. Cleistothecia 60-80 um in diameter; appendages approximately as long as the diameter of the cleistothecia V. Sphaerotheca phytoptophila
1. Segments of the cleistothecial wall large (30-40 um); secondary mycelium missing; diameter of the cleistothecia 66-98 um, usually less than 85 um VI. Sphaerotheca humili var. fuliginea
- I. Sphaerotheca pannosa (Wallroth ex Fries) Leveille
- Mycelium persistent, secondary mycelium tightly compact, yellowish; cleistothecia immersed in the mycelium, 85-120 um in diameter, cells average 10 um wide; appendages few, short, tortuous; ascus 8-spored. Host genera: Lycium, Prunus, Rosa.
- Specimens examined: McPherson Co.: on Rosa sp. in Canton, J. Ritz, June 5, 1922.
- II. Sphaerotheca mors-uvae (Schweinitz) Berk. and Curt.
- Mycelium persistent, little branching, hyphae thick walled; cleistothecia gregarious, 76-110 um in diameter, inner wall does not separate from the outer wall; appendages few, generally less than twice the diameter of the cleistothecia; conidia ellipsoid, usually less than twice as long as wide.

Host genera: Ribes

III. Sphaerotheca lanestris Harkn.

Mycelium persistent; cleistothecia gregarious, imbedded in the mycelium, 80-120 μ m in diameter, inner wall of the cleistothecia separates from the outer; appendages short or obsolete.

Host genera: Quercus

IV. Sphaerotheca humilí (de Candolle) Burrill

Mycelium evanescent; cleistothecia gregarious, 80-120 μ m in diameter, cells 10-21 μ m wide; appendages up to 9 times the diameter of the cleistothecia, number of appendages variable; asci 8-spored.

Host genera: Agastache, Agrimonia, Bidens, Celtis, Cosmos, Crepis, Epilobium, Erigeron, Filipendula, Fragaria, Franseria, Geranium, Geum, Gilia, Heuchera, Hieracium, Humulus, Hydrophyllum, Lactuca, Madia, Matricaria, Mentha, Phlox, Prenanthus, Prunella, Ranunculus, Rhus, Ribes, Rosa, Rubus, Sambucus, Sanguisorba, Saxifraga, Senecio, Spiraea, Stachys, Tamarix, Verbena, Veronica, Vicia, Viola.

Specimens examined: Riley Co.: on Humulus lupulus east of Manhattan, C. T. Rogerson, Oct. 22, 1950.

V. Sphaerotheca phytoptophila Kellerm, and Swingle

Mycelium sparase; cleistothecia globular, 60-80 μ m in diameter; appendages few, approximately as long as the diameter of the cleistothecia; conidia oval, hyaline, granular.

Host genera: Celtis

Specimens examined: Riley Co.: on Celtis occidentalis, Manhattan, Kellerman and Swingle, Dec. 1888; on Celtis occidentalis, Manhattan, C. T. Rogerson, July 22, 1957.

VI. Sphaerotheca humili (DC.) Burr. var. fuliginea Salm.

Mycelium evanescent; cleistothecia gregarious, 66-98 um in diameter, cells 20-40 um wide; appendages approximately as long as the diameter of the cleistothecia, tortuous and interwoven.

Host genera: Agastache, Agoseus, Astragalus, Castilleja, Delphinium, Fragaria, Hydrophyllum, Kalanchoe, Saxifraga, Spiraea, Taraxacum, Vernonia, Veronicastrum, Viola.

Specimens examined: Franklin Co.: on Taraxacum officinale on the campus of Ottawa Univ., Ottawa, C. T. Rogerson, June 11, 1956. Nemaha Co.: on Taraxacum officinale in Sabetha, C. L. Lefebvre, Sept. 30, 1935. Riley Co.: on Taraxacum officinale on the campus of K.S.U., Manhattan, C. T. Rogerson, Oct. 16, 1950.

II. PODOSPHAERA Kunze. Myk. Heft. 2-111, 1823.

Cleistothecia globose or globose depressed; ascus solitary; 8 spores; appendages equatorial or apical, dichotomously branched, branches simple and straight or swollen and knob-shaped.

Key to the Species

1. Appendages equatorially attached, radially spreading or curved ascending, up to 3 times as long as the diameter of the cleistothecia, 5-12 in number I. Podosphaera clandestina
1. Appendages attached at the top, usually in a cluster 2
2. Appendages rarely dichotomously branched II. Podosphaera leucotricha
2. Appendages always dichotomously branched III. Podosphaera clandestina var. tridactyla

I. Podosphaera clandestina Lev. ex Fries

Syn: Podosphaera oxycanthae (DC.) de Bary

Mycelium variable; cleistothecia more or less gregarious, 64-90 um in diameter, cells 10-18 um wide; appendages equatorially attached, radially spreading, 5-12 in number, variable in length up to 6 times the diameter of the cleistothecia, apex 2-4 times dichotomously branched, ultimate branch swollen; asci contain 8 spores.

Host genera: Amelanchier, Crataegus, Malus, Prunus, Pyrus, Spiraea.

Specimens examined: Brown Co.: on Prunus virginiana along Lous

Creek northeast of Hiawatha, C. T. Rogerson, June 25, 1957.

Clay Co.: on Prunus demissa, Clay Center, W. O. Lyon, Sept.,

1893. Franklin Co.: on Prunus virginiana, Ottawa, C. T. Rogerson,

June 4, 1954. Riley Co.: on Prunus demissa, Manhattan, C. H.

Thompson, July 13, 1891; on Prunus cerasus, Manhattan, J. B. S.

Norton, June 17, 1896; on Prunus avium, Manhattan, G. F. Freeman,

July 11, 1908; on Prunus virginiana by the Ashland agronomy dam,

Manhattan, C. T. Rogerson, June 15, 1955. Rooks Co.: on Prunus

demissa, Rockport, E. Bartholomew, Sept. 19, 1892. Wabaunsee

Co.: on Prunus virginiana 3 miles south of Alva, C. T. Rogerson,

May 30, 1952.

II. Podosphaera leucotricha (Ellis and Everhart) Salmon

Mycelium persistent, thin; cleistothecia densely gregarious, 75-96 um in diameter, cells 10-16 um wide; appendages both basally and apically inserted, 4-7 times as long as the diameter of the cleistothecia.

Host genera: Malus, Prunus, Pyrus, Spiraea

Specimens examined: Morris Co.: on Pyrus malus south of Neosho, C. T.

Rogerson, August 26, 1945.

III. Podosphaera clandestina Lev. ex Fries var. tridactyla (Wallr.)

Mycelium evanescent; cleistothecia 70-105 um in diameter, cells 10-15 um wide; appendages 2-8, usually 4, in number, apical insertion, generally clustered, dichotomously branched, ascus contains 8 spores.

Host genera: Prunus, Sorbus, Spiraea

Specimens examined: Riley Co.: on Prunus virginiana, Manhattan, Kellerman and Swingle, July 29, 1887.

III. ERYSIPHE Hedw. f.; DC (emend. Lev.). Ann. Sci. Nat. III. 15:161. 1851.

Cleistothecia globose or globose depressed, sometimes becoming concave; asci several, 2-8 spored; appendages floccose, simple, or irregularly branched, mycelial-like and interwoven with the mycelium.

Key to the Species

1. Secondary mycelium thick walled; digital, lobed haustoria; conidiophores usually swollen at the base; cleistothecia usually over 150 um in diameter I. Erysiphe graminis
1. Secondary mycelium not fully developed, haustoria globose to pear-shaped, conidiophores without basal swelling; cleistothecia usually under 150 um in diameter 2
2. Conidia borne in chains; appendages mycelial-like, curved; asci 2-3 spored 3
3. Appendages longer than the diameter of the fruiting body; appressoria never lobed.
- II. Erysiphe cichoracearum
3. Appendages approximately as long as the diameter of the cleistothecia; appressoria lobed
- III. Erysiphe galeopsidis

2. Conidia borne singly on conidiophores; asci 3-8 spored . . . 4
4. Appendages twice as long as the diameter of the cleistothecia;
 asci 3-spored IV. Erysiphe polygona
4. Appendages 2-4 times as long as the diameter of the cleistothecia; asci 8-spored V. Erysiphe aggregata

I. Erysiphe graminis DC.

Mycelium persistent, thick walled; cleistothecia 135-280 um in diameter, immersed in the mycelium, cells obscure; appendages rudimentary, short; digital, lobed haustoria; asci 9-30; spores 8.

Host genera: Agropyron, Agrostis, Avena, Beckmannia, Bromus, Calamagrostis, Cinna, Cynodon, Dactylis, Digitaria, Elymus, Festuca, Hordeum, Koeleria, Melica, Oenothera, Phalaris, Phleum, Poa, Polypogon, Puccinellia, Secale, Sitanion, Sphenopholis, Sporobolus, Triticum.

Specimens examined: Bourbon Co.: on Oenothera laciniata north of Ft.

Scott, C. T. Rogerson and S. M. Pady, June 12, 1956. Dickinson Co.: on Hordeum vulgare east of Elmo, C. T. Rogerson, May 29, 1957; on Poa pratensis, Abilene, K. E. Urban, summer, 1955.

Douglas Co.: on Hordeum vulgare south of Lawrence, C. T. Rogerson and S. M. Pady, June 11, 1956. Franklin Co.: on Poa pratensis on the Ottawa Univ. campus, Ottawa, S. M. Pady, Nov. 11, 1944.

Geary Co.: on heads of wheat, C. M. Slagg, June 4, 1952. Greenwood Co.: on Hordeum vulgare, Eureka, C. Q. Hollingsworth, May, 1954. Jackson Co.: on Triticum aestivum 2 miles east of Holton,

C. T. Rogerson and S. M. Pady, June 2, 1955. Leavenworth Co.: on Hordeum vulgare east of Eaton, S. M. Pady and C. T. Rogerson,

June 10, 1957. Miami Co.: on Hordeum vulgare, Paola, B. E.
 McLaury, May 19, 1955. Osborne Co.: on Hordeum pusillum, Natoma,
 B. Brown, June 10, 1891; on Poa pratensis, Natoma, B. Brown, June
 10, 1891. Ottawa Co.: on Triticum sp., Bennington, C. T. Rogerson,
 June 3, 1953. Pottawatomie Co.: on Triticum aestivum 2 miles east
 of Belvue, S. M. Pady, May 1, 1945; on Triticum aestivum east of
 Manhattan, C. T. Rogerson and S. M. Pady, June 2, 1955. Riley
 Co.: on volunteer wheat along Wildcat Creek west of Manhattan,
 C. T. Rogerson, June 3, 1952; on Agropyron repens along Sunset
 Lane, Manhattan, C. T. Rogerson, June 17, 1953. Saline Co.: on
Hordeum vulgare north of Salina, C. T. Rogerson, June 8, 1956.

II. Erysiphe cichoracearum DC.

Mycelium evanescent; cleistothecia 80-140 um in diameter, cells
 10-20 um wide; appendages 2-4 times the diameter of the cleistothecia,
 usually numerous and densely interwoven; 10-15 asci containing 2 spores.

Host genera: Acalypha, Achillea, Actinomeris, Ageratum, Althaea,
Ambrosia, Applopappus, Arcticum, Arnica, Artemisia, Begonia,
Bidens, Boltonia, Calendula, Callistephus, Campanula, Carica,
Centaurea, Chrysanthemum, Chrysopsis, Chrysothamnus, Cichorium,
Cirsium, Citrullus, Cordia, Coreopsis, Cosmos, Crepis, Cryptantha,
Cucumis, Curcubita, Cynara, Cynoglossum, Dahlia, Doronicum,
Echinocystis, Erechtites, Erigeron, Eriogonum, Eupatorium,
Franseria, Galium, Gerbera, Geum, Grindelia, Gutierrezia, Hedera,
Helenium, Helianthus, Heliopsis, Heuchera, Hieracium, Humulus,
Hydrophyllum, Hypericum, Inula, Iva, Lactuca, Lagenaria, Lamium,
Lappula, Layia, Liatris, Linaria, Linum, Lithospermium, Luffa,
Madia, Malva, Matricaria, Mentha, Mertensia, Mimulus, Momordica,

Nicotiniana, Parietaria, Penstemon, Phacelia, Phlox, Pilea,
Piquera, Plantago, Polemonium, Populus, Prenanthes, Prunella,
Ratibida, Rudbeckia, Salvia, Senecio, Sesbania, Scutellaria,
Sicyos, Silphium, Solanum, Sonchus, Stachys, Tanacetum, Taraxacum,
Teucrium, Tragopogon, Verbascum, Verbesina, Vernonia, Veronicastrum,
Viguera, Wisteria, Xanthium, Zinnia.

Specimens examined: Anderson Co.: on Cirsium altissimum 2 miles north
of Garnett, C. T. Rogerson, Oct. 6, 1950. Brown Co.: on Hydrophyllum
virginianum along Lous Creek northeast of Hiawatha, C. T. Rogerson,
June 25, 1957. Chase Co.: on Solanum nigrum, C. T. Rogerson, Sept.
28, 1957. Leavenworth Co.: on Ambrosia trifida 2 miles east of
Leavenworth, C. L. Kramer, Sept. 20, 1958; on Ambrosia psilostachya
DC. var. coronopifolia 2 miles west of Leavenworth, C. L. Kramer,
Sept. 20, 1958; on Plantago major at 12th and Ottawa St. in
Leavenworth, C. L. Kramer, Sept. 20, 1958; on Verbesina alternifolia
at the Soldiers Home, E. Bartholomew, Oct. 9, 1909; on Helianthus
strumosus at the Soldiers Home, E. Bartholomew, Oct. 15, 1909.
Osborne Co.: on Ambrosia trifida, Natoma, B. Brown, Sept., 1890;
on Verbena stricta, Natoma, B. Brown, Sept., 1890. Riley Co.:
on Lactuca sp. along Wildcat Creek west of Manhattan, C. T. Rogerson,
June 17, 1953; on Helianthus rigidus in flood area along Wildcat Creek
west of Manhattan, C. T. Rogerson, Oct. 15, 1954; on Verbena stricta
2 miles west of Tuttle Creek Dam, C. L. Kramer and P. C. Duffield,
Sept. 24, 1958; on Verbena stricta in Hackberry Glen south of Man-
hattan, C. T. Rogerson, Oct. 2, 1950; on Plantago major on the KSU
campus, C. T. Rogerson, Oct. 16, 1950; on Ambrosia trifida north

of the KSU campus, C. T. Rogerson, Oct. 8, 1950; on Salvia agureum on the KSU campus, C. T. Rogerson, Oct. 29, 1950; on Verbena urticifolia, Manhattan, C. T. Rogerson, Oct, 1950; on Ambrosia trifida, Manhattan, M. A. Carleton, Sept. 24, 1884; on Parietaria pennsylvanica, Manhattan, Kellerman and Swingle, March 4, 1889; on Solidago missouriensis, Manhattan, B. Norton, Nov. 17, 1892; on Lamium amplexicaule on the KSU campus, C. T. Rogerson, June 4, 1951; on Phlox paniculata, Manhattan, C. O. Johnston, July 24, 1951; on Lactuca floridana west side of Manhattan Country Club, C. T. Rogerson, Sept. 22, 1951; on Acalypha rhomboidea, Manhattan, C. M. Slagg, Oct. 3, 1951; on Helianthus annuus, Manhattan, R. P. White, Dec. 5, 1921; on Acalypha gracileus, Manhattan, C. T. Rogerson, Oct. 29, 1952.

Rooks Co.: on Ambrosia trifida, Rockport, E. Bartholomew, Sept. 16, 1893; on Helianthus fornicoides, Rockport, E. Bartholomew, Sept. 15, 1893; on Parietaria pennsylvanica, Rockport. E. Bartholomew, Aug. 15, 1892; on Verbena stricta, Rockport, E. Bartholomew, Aug. 6, 1894; on Verbena hastata, Rockport, E. Bartholomew, Sept. 14, 1893.

III. Erysiphe galeopsidis DC.

Mycelium evanescent; cleistothecia 80-140 um in diameter, cells 10-20 um wide; appendages 2-4 times the diameter of the cleistothecia, usually numerous and densely interwoven; haustoria lobed; asci 10-15; 2 spores, produced only on non-living plant material.

Host genera: Scutellaria, Stachys, Teucrium

Specimens examined: Riley Co.: on Scutellaria lateriflora, Manhattan, R. F. White.

IV. Erysiphe polygoni DC.

Mycelium variable from dense and lichenoid to thin and persistent

to evanescent; cleistothecia gregarius, 65-180 um in diameter, cells 10-15 um wide, variable in length up to 10 times as long as the diameter of the cleistothecia, asci 2-8; spores vary from 2-8, usually 3-6.

Host genera: Acacia, Althaea, Amorpha, Amphicarpa, Anemone, Anemonella, Apios, Aquilegia, Arenaria, Armoracia, Astragalus, Astilbe, Beta, Brassica, Cassia, Castilleja, Clematis, Colutae, Crotalaria, Dahlia, Delphinium, Desmanthus, Epilobium, Erechtites, Erysimum, Eschscholtzia, Fagopyron, Falcata, Galium, Gardenia, Gaura, Geranium, Glycyrrhiza, Hydrangea, Iberus, Lathyrus, Lespedeza, Liriodendron, Lobularia, Lonicera, Lotus, Lupinus, Lycium, Lycopersicon, Medicago, Oxytropis, Oenothera, Paeonia, Phaseolus, Pisum, Polygonum, Psorales, Ranunculus, Rapphanus, Robinia, Strophostyles, Thalictrum, Trifolium, Vicia, Vigna, Zizia.

Specimens examined: Leavenworth Co.: on Polygonum aviculare at 12th and Ottawa St., Leavenworth, C. L. Kramer, Sept. 20, 1958; on Falcata comosa at the Soldiers Home, Leavenworth, E. Bartholomew, Oct. 15, 1909. Riley Co.: on Polygonum aviculare 5 miles east of the junction of K-13 and US 40 5 miles south of Manhattan, C. L. Kramer, Sept. 19, 1958; on Polygonum aviculare on the KSU campus, C. T. Rogerson, Sept. 17, 1952.

V. Erysiphe aggregata (Peck) Farl.

Mycelium evanescent; cleistothecia densely gregarius, sometimes forming crust-like covering, 130-230 um in diameter, cells generally 10 um wide; appendages densely interwoven, 2-4 times as long as the diameter of the cleistothecia; 20 asci; 8 spores.

Host genera: Alnus

IV. MICROSPHAERA Lev. Ann. Sci. Nat. III. 15:154. 1851.

Cleistothecia globose to globose depressed, asci several, 2-8 spored; appendages mycelial-like, branched in a definite manner at the apex, usually several times dichotomously branched.

Key to the Species

1. Appendages numerous, as long as the diameter of the cleistothecia, equatorial of apical insertion, often occur tufted in one direction 2
2. Ends of the branches straight, appendages tufted to one side, 1-3 fold dichotomously branched . I. Microsphaera astragali
2. Ends of the branches reflexed 3
3. Appendages straight or arched upward; asci with 4-6, generally 5 spores II. Microsphaera diffusa
3. Appendages wavy or geniculate; asci with 2-6, generally 4 spores III. Microsphaera euphorbiae
1. Appendages equatorially attached and radially spreading, rigid, numerous dichotomous branches at the tip 4
4. End of the final branch not reflexed, often parallel forks; branches in a compact group, often becoming fan-shaped IV. Microsphaera grossularia
4. End of the final branch reflexed 5
5. Usually fewer than 8 appendages, generally shorter than the diameter of the perithecia. V. Microsphaeraalni
5. Numerous appendages (8-15, occasionally 20 or more). VI. Microsphaeraalni var. vaccinii

I. Microsphaera astragali (DC.) Trev.

Mycelium evanescent; cleistothecia densely gregarious, 95-146 um in diameter; appendages 5-18, 4-10 times as long as the diameter of the cleistothecia, tufted to one side, tips of branches straight; 5-12 asci; 3-6 spores.

Host genera: Astragalus

II. Microsphaera diffusa Cooke and Peck

Mycelium varies from thin and effused to evanescent; cleistothecia scattered or gregarious, 90-100 um in diameter, cells 10-20 um wide; appendages 4-30 in number, 1-7 times as long as the diameter of the cleistothecia, branching diffuse and irregular, tips of the ultimate branches not recurved; 4-9 asci; 3-6 spores (usually 4).

Host genera: Apios, Crotalaria, Desmodium, Lespeza, Lycium, Phaseolus, Robinia, Symphoricarpos, Vicia.

Specimens examined: Anderson Co.: on Symphoricarpos orbiculatus southwest of Garnett, C. T. Rogerson, Oct. 13, 1955. Osage Co.: on Symphoricarpos orbiculatus 9 miles north of Lyndon, C. L. Kramer and P. C. Duffield, Aug. 14, 1958. Riley Co.: on Symphoricarpos orbiculatus, 10 miles west of Manhattan, C. L. Kramer and P. C. Duffield, Aug. 12, 1958; on Symphoricarpos orbiculatus 5 miles east of the junction of K-13 and US 40, C. L. Kramer and P. C. Duffield, Sept. 19, 1958. Wabaunsee Co.: on Symphoricarpos orbiculatus 12 miles east of the junction of K-13 and US 40, C. L. Kramer and P. C. Duffield, Sept. 19, 1958.

III. Microsphaera euphorbiae (Peck) Berk. and Curt.

Mycelium persistent; cleistothecia gregarious, 85-145 um in diameter,

cells 10-15 um wide; appendages 7-28 in number, 2-8 times as long as the diameter of the cleistothecia, flexuose contorted or angularly bent, apex 3-4 times dichotomously branched; 4-13 asci; generally 4 spores.

Host genera: Astragalus, Euphorbia, Phaseolus.

Specimens examined: Riley co.: on Euphorbia sp. on the KSU campus, C. T. Rogerson, Oct. 29, 1950; on Euphorbia corollata, Manhattan, M. A. Carleton, Oct. 15, 1884; on Euphorbia marginata north of the KSU campus, C. T. Rogerson, Oct. 8, 1950; on Euphorbia marginata, Manhattan, M. C. Carleton, Oct. 15, 1884.

IV. Microsphaera grossularia (Wallr.) Lev.

Mycelium evanescent, thin on the upper surface of the leaf; cleistothecia densely gregarious, 65-130 um in diameter; appendages 5-22 in number, 1-2 times as long as the diameter of the cleistothecia, apex 4-5 times dichotomously branched, ultimate branches form forks (not recurved); 4-10 asci; 4-6 spores.

Host genera: Ribes, Sambucus.

Specimens examined: Riley Co.: on Sambucus canadensis in Hackberry Glen south of Manhattan, C. T. Rogerson, Oct. 15, 1951.

V. Microsphaeraalni (Wallr.)

Mycelium evanescent, thin on the upper surface of the leaf; cleistothecia 66-110 um in diameter, cells 10-15 um wide; 4-26 appendages, up to 3 times as long as the diameter of the cleistothecia, apex 3-6 times dichotomously branched, tips of the ultimate branches recurved; 3-8 asci; 4-8 spores.

Host genera: Alnus, Betula, Campis, Carpinus, Cephalanthus, Cornus, Corylus, Desmodium, Diervella, Euonymus, Forestiera, Fraxinus,

Gaultheria, Gleditsia, Ilex, Lappula, Lathyrus, Ligustrum, Lonicera,
Magnolia, Menispermum, Nemopanthus, Ostrya, Platanus, Quercus, Rho-
dodendron, Sambucus, Sophora, Syringa, Trifolium, Ulmus, Viburnum,
Vicia, Vigna.

Specimens examined: Leavenworth Co.: on Quercus macrocarpa 2 miles north
of Leavenworth, C. L. Kramer, Sept. 20, 1958. Pottawatomie Co.: on
Quercus sp. 5 miles east of Manhattan, C. T. Rogerson, Oct. 22, 1951.
Riley Co.: on Euonymus atropurpureus 4 miles west of Manhattan,
C. L. Kramer and P. C. Duffield, Sept. 24, 1958; on Quercus macro-
carpa in Hackberry Glen south of Manhattan, C. T. Rogerson, Oct. 15,
1951; on Euonymus atropurpureus north of Manhattan, C. T. Rogerson,
Sept. 17, 1950; on Quercus macrocarpa on the KSU campus, C. T.
Rogerson; on Ligustrum vulgare, Manhattan, C. T. Rogerson, Oct. 16,
1950; on Quercus acuminata, Manhattan, L. Swingle, Oct. 23, 1910.

VI. Microsphaera alni (Wallr.) var. vaccinii (Schwein.)

Mycelium persistent, sometimes evanescent; cleistothecia scattered,
70-145 um in diameter, cells 10-20 um wide; 4-22 appendages, 2-8 times
as long as the diameter of the cleistothecia, flexuose or angularly
bent, apex 2-4 times dichotomously branched, tips of the ultimate
branches recurved; 2-16 asci; 4-6 spores.

Host genera: Catalpa, Gaylussacia, Oxycoccus

V. UNCINULA Lev. Ann. Sci. Nat. III. 15:151. 1851.

Cleistothecia globose to globose depressed; asci several, 2-8
spored; appendages simple, or rarely once or twice dichotomously
branched, uncinatc at the apex.

Key to the Species

1. Appendages colored for at least half their length, 1-4 times as long as the diameter of the cleistothecia; cleistothecia 70-120 um in diameter I. Uncinula necator
1. Appendages colorless 2
 2. Spores 2-4; cleistothecia 85-165 um in diameter; asci 8-20; appendages numerous, 1/3 equal in length to the diameter of the cleistothecia. II. Uncinula macrospora
 2. Spores 4-8 3
 3. Spores 7-8 4
 4. Diameter of the cleistothecia 85-156 um; appendages flexuose, equal in length to the diameter of the cleistothecia; asci 4-11 . . III. Uncinula flexuosa
 4. Diameter of the cleistothecia 160-225 um; appendages simple, shorter than the diameter of the cleistothecia; asci 9-26. IV. Uncinula circinata
 3. Spores 4-6 5
 5. Cleistothecia 90-125 um in diameter. 6
 6. Appendages shorter than the diameter of the cleistothecia, 50-160 um in number VI. Uncinula parvula
 6. Appendages 1-2 times as long as the diameter of the cleistothecia, 24-46 in number . . . VII. Uncinula geniculata

I. Uncinula necator (Schwein.) Burr.

Mycelium usually thin and effused; cleistothecia scattered, 70-128 um in diameter, cells distinct and regular, 10-20 um wide;

appendages variable, 1-4 times as long as the diameter of the cleistothecia, brown in the lower half; 4-6 asci; 4-6 spores.

Host genera: Parthenocissus, Vitis.

Specimens examined: Leavenworth Co.: on Vitis lambruscam in garden at 12th and Ottawa St., Leavenworth, C. L. Kramer, Sept. 20, 1958. Riley Co.: on Parthenocissus quinquefolia, Manhattan, S. M. Pady, Oct., 1950.

II. Uncinula macrospora Peck

Mycelium evanescent; cleistothecia gregarious in small patches, 95-165 um in diameter; appendages numerous (50-125), length equal to or less than the diameter of the cleistothecia; 8-14 asci; 2 spores.

Host genera: Ostrya, Ulmus.

Specimens examined: Anderson Co.: on Ulmus americana 2 miles north of Garnett, C. T. Rogerson, Oct. 6, 1950. Pottawatomie Co.: on Ulmus fulva at Pottawatomie Res., M. A. Carleton, Oct. 21, 1892. Riley Co.: on Ulmus rubra, Manhattan, Kellerman and Swingle, Nov. 3, 1889.

III. Uncinula flexuosa Peck

Mycelium evanescent; cleistothecia scattered, 85-156 um in diameter; appendages equal in length to the diameter of the cleistothecia, abruptly flexuose; 4-11 asci; 8 spores.

Host genera: Aesculus

Specimens examined: Johnson Co.: on Aesculus glabra 5 miles north of Olatha along road K-7, C. L. Kramer and P. C. Duffield, July 28, 1958. Riley Co.: on Aesculus glabra along Wildcat Creek, Manhattan, C. T. Rogerson, Aug. 9, 1952.

IV. Uncinula circinata Cooke and Peck

Mycelium evanescent; cleistothecia scattered 160-225 um in diameter;

appendages numerous, densely crowded, slightly shorter than the diameter of the cleistothecia; 9-26 asci; 8 spores.

Host genera: Acer, Fraxinus.

Specimens examined: Riley Co.: on Acer saccharinum, Manhattan, Leon Swingle, Nov. 2, 1910.

V. Uncinula salicis (DC.) Winter

Mycelium evanescent; cleistothecia densely gregarious 125-175 um in diameter, appendages numerous, densely crowded 1-3 times as long as the diameter of the cleistothecia; 8-14 asci; 4-6 spores.

Host genera: Salix

Specimens examined: Riley Co.: on Salix amygdaloides, Manhattan, M. A. Carleton, Oct. 18, 1893.

VI. Uncinula parvula Cooke and Peck

Mycelium evanescent; cleistothecia scattered, 90-125 um in diameter; appendages numerous (50-160), shorter than the diameter of the cleistothecia; 5-8 asci; 4-7 spores.

Host genera: Celtis

Specimens examined: Riley Co.: on Celtis occidentalis, M. A. Carleton, Oct. 19, 1893; on Celtis occidentalis, on the KSU campus, Manhattan, C. T. Rogerson, Oct. 7, 1951.

VII. Uncinula geniculata Gerard

Mycelium thin, forming definite patches; cleistothecia more or less scattered, 90-120 um in diameter; 24-46 appendages, 1-2 times as long as the diameter of the cleistothecia; 5-8 asci; 4-6 spores.

Host genera: Morus

Specimens examined: Anderson Co.: on Morus rubra 2 miles north of Garnett, C. T. Rogerson, Oct. 6, 1950.

VI. PHYLLACTINIA Lev. Ann. Sci. Nat. III. 15:144. 1851.

Mycelium evanescent; cleistothecia scattered, 140-270 um in diameter (rarely up to 350 um), cells 15-20 um wide; apex of cleistothecium with densely crowded specialized outgrowth terminating in a fascicled head; appendages equatorially attached, 5-18 in number, 1-3 times as long as the diameter of the cleistothecia, rigid, straight or slightly flexuose, swollen at the base; 5-45 asci; 2 spores.

Single species Phyllactinia guttata

I. Phyllactinia guttata (Wallroth ex Fries) Leveille

Host genera: Acer, Aralia, Berberis, Betula, Carpinus, Carya, Cephalanthus, Cirsium, Cladastris, Cornus, Corylus, Cratageus, Desmodium, Dipsacus, Fragaria, Fraxinus, Hamamelis, Ilex, Liriodendron, Magnolia, Morus, Ostrya, Philadelphus, Platanus, Prunus, Quercus, Rhus, Ribes, Robinia, Rosa, Rubus, Rumex, Salix, Sambucus, Sassafras, Scabiosa, Smilax, Tilia, Triosteum, Ulmus, Vaccinium, Zanthophyllum.

Specimens examined: Riley Co.: on Fraxinus viridis, Manhattan, W. A. Kellerman, Oct. 20, 1884; on Celastrus scandens, Manhattan, J. B. S. Norton, Sept. 11, 1893; on Celastrus scandens, Manhattan, L. Swingle, Oct. 23, 1910; on Celastrus scandens on the KSU campus, Manhattan, C. O. Johnston, Oct. 10, 1929; on Fraxinus lanceolata on the KSU campus, Manhattan, C. T. Rogerson, Sept. 30, 1951; on Celastrus scandens in Hackberry Glen south of Manhattan, Haard and Kramer, Oct. 4, 1962.

VII. LEVEILLULA Arnaud. Comp. Rend. Acad. Sci. 178:1394-1396. 1921.

Amphigenous, often covering the entire plant; mycelium persistent, densely compacted, endophytic in the conidial stage; cleistothecia gregarious, generally immersed in the mycelium, 135-240 um in diameter, cells obscure; appendages numerous, mycelial-like, occasional irregular branching; 7-38 asci; 2 spores.

Single species Leveillula taurica

I. Leveillula taurica (Lev.) Arnaud

Host genera: Prosopis.

HOST KEY TO SPECIES OF ERYSIPIHALES

The key is arranged alphabetically by families. Genera within each family are listed alphabetically. Species of Erysiphales known to occur on the respective host genera are listed on the right.

ACERACEAE

Acer Phyllactinia guttata
 Uncinula circinata

ANACARDIACEAE

Rhus Sphaerotheca humili

ARALIACEAE

Aralia Phyllactinia guttata
Hedera Erysiphe cichoracearum

BEGONIACEAE

Begonia. Erysiphe cichoracearum

BERBERIDACEAE

Berberis Phyllactinia guttata

BETULACEAE

<u>Alnus</u>		<u>Erysiphe aggregata</u>
		<u>Microsphaera alni</u>
<u>Betula</u>		<u>Phyllactinia guttata</u>
		<u>Microsphaera alni</u>
<u>Carpinus</u>		<u>Phyllactinia guttata</u>
		<u>Microsphaera alni</u>
<u>Corylus</u>		<u>Phyllactinia guttata</u>
		<u>Microsphaera alni</u>
<u>Ostrya</u>		<u>Phyllactinia guttata</u>
		<u>Microsphaera alni</u>
		<u>Uncinula macrospora</u>

BIGNONIACEAE

<u>Campis</u>		<u>Microsphaera alni</u>
<u>Catalpa</u>		<u>Microsphaera alni</u>

BORAGINACEAE

<u>Cryptantha</u>		<u>Erysiphe cichoracearum</u>
<u>Cynoglossum</u>		<u>Erysiphe cichoracearum</u>
<u>Lappula</u>		<u>Erysiphe cichoracearum</u>
		<u>Microsphaera alni</u>
<u>Lithospermium</u>		<u>Erysiphe cichoracearum</u>
<u>Mertensia</u>		<u>Erysiphe cichoracearum</u>

CAMPANULACEAE

<u>Campanula</u>		<u>Erysiphe cichoracearum</u>
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CAPRIFOLIACEAE

<u>Lonicera</u>		<u>Microsphaera alni</u>
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Sambucus Phyllactinia guttata

. Sphaerotheca humili

. Microsphaera grossularia

. Microsphaera alni

Symphoricarpos Microsphaera diffusa

Triosteum Phyllactinia guttata

Viburnum Microsphaera alni

CAROPHYLLACEAE

Arenaria Erysiphe polygoni

CELASTRACEAE

Elionymus Microsphaera alni

CHENOPODIACEAE

Beta Erysiphe polygoni

COMPOSITAE

Achillea Erysiphe cichoracearum

Actinomeris

Ageratum

Ambrosia

Applopappus

Arctium

Arnica Sphaerotheca humili

. Erysiphe cichoracearum

Artemisia Erysiphe cichoracearum

Bidens Sphaerotheca humili

. Erysiphe cichoracearum

Boltonia

Calendula

<u>Callistephus</u>	<u>Erysiphe cichoracearum</u>
<u>Centaurea</u>	
<u>Chrysanthemum</u>	
<u>Chrysopsis</u>	
<u>Chrysothamnus</u>	
<u>Cichorium</u>	
<u>Cirsium</u>	
<u>Coreopsis</u>	
<u>Cosmos</u>	
<u>Crepis</u>	<u>Sphaerotheca humili</u>
.	<u>Erysiphe cichoracearum</u>
<u>Dahlia</u>	
1. Conidia borne in chains; ascus 2-spored;	
.	<u>Erysiphe cichoracearum</u>
1. Conidia borne singly; ascus 3-spored;	
.	<u>Erysiphe polygoni</u>
<u>Doronicum</u>	<u>Erysiphe cichoracearum</u>
<u>Erechtites</u>	<u>Sphaerotheca humili</u>
1. Conidia borne in chains; ascus 2-spored;	
.	<u>Erysiphe cichoracearum</u>
1. Conidia borne singly; ascus 3-spored;	
.	<u>Erysiphe polygoni</u>
<u>Erigeron</u>	<u>Sphaerotheca humili</u>
.	<u>Erysiphe cichoracearum</u>
<u>Eupatorium</u>	<u>Erysiphe cichoracearum</u>
<u>Franseria</u>	<u>Sphaerotheca humili</u>
.	<u>Erysiphe cichoracearum</u>

<u>Gerbera</u>		<u>Erysiphe cichoracearum</u>
<u>Grindella</u>		
<u>Gutierrezia</u>		
1. Conidia borne in chains; ascus 2-spored;		
.		<u>Erysiphe cichoracearum</u>
1. Conidia borne singly; ascus 3-spored;		
.		<u>Erysiphe polygoni</u>
<u>Helenium</u>		<u>Erysiphe cichoracearum</u>
<u>Helianthus</u>		
<u>Heliopsis</u>		
<u>Hieracium</u>		<u>Sphaerotheca humili</u> var. <u>fuliginea</u>
.		<u>Erysiphe cichoracearum</u>
<u>Iva</u>		<u>Erysiphe cichoracearum</u>
<u>Lactuca</u>		<u>Sphaerotheca humili</u>
.		<u>Erysiphe cichoracearum</u>
<u>Liatris</u>		<u>Erysiphe cichoracearum</u>
<u>Matricaria</u>		<u>Sphaerotheca humili</u>
.		<u>Erysiphe cichoracearum</u>
<u>Piquera</u>		
<u>Ratibida</u>		
<u>Rudbeckia</u>		
<u>Senecio</u>		
<u>Silphium</u>		
<u>Sonchus</u>		<u>Sphaerotheca humili</u> var. <u>fuliginea</u>
.		<u>Erysiphe cichoracearum</u>
<u>Tanacetum</u>		

Taraxacum Sphaerotheca humili var. fuliginea

. Erysiphe cichoracearum

Trapogon

Verbesina Sphaerotheca humili var. fuliginea

. Erysiphe cichoracearum

Zinnia Erysiphe cichoracearum

CORNACEAE

Cornus Phyllactinia guttata

. Microsphaera alni

CRASSULACEAE

Kalanchoe Sphaerotheca humili var. fuliginea

CRUCIFEREAE

Armoracia Erysiphe polygoni

Brassica

Erysimum

Iberus

Lobularia

Raphanus

CURCUBITACEAE

Citrullus Erysiphe cichoracearum

Cucumis

Curcubita

Echinocystis

Lagenaria

Luffa

Momordica

Sicyos

DISPACEAE

Dipsacus Phyllactinia guttata

Scabiosa

ERICACEAE

Gaultheria Microsphaeraalni

Gaylussacia Microsphaeraalni var vaccini

Rhododendron

1. Appendages regularly branched . . . Erysiphe polygoni

1. Appendages dichotomously branched

2. Appendages fewer than 8 Microsphaeraalni

2. Appendages numerous (12-15)

. Microsphaeraalni var vaccini

Vaccinium Microsphaeraalni var vaccini

. Phyllactinia guttata

EUPHORBIACEAE

Acalypha Erysiphe cichoracearum

Euphorbia Microsphaera euphordiae

FAGACEAE

Quercus Phyllactinia guttata

. Sphaerotheca lanestris

. Microsphaeraalni

GERANIACEAE

Geranium Erysiphe polygoni

. Sphaerotheca humili

GRAMINEAE

Agropyron Erysiphe graminis

Agrostis

<u>Avena</u>	<u>Erysiphe graminis</u>
<u>Beckmannia</u>	
<u>Bromus</u>	
<u>Calamagrostis</u>	
<u>Cinna</u>	
<u>Cynodon</u>	
<u>Dactylis</u>	
<u>Digitaria</u>	
<u>Elymus</u>	
<u>Festuca</u>	
<u>Hordeum</u>	
<u>Koeleria</u>	
<u>Melica</u>	
<u>Phalaris</u>	
<u>Phleum</u>	
<u>Poa</u>	
<u>Polypogon</u>	
<u>Puccinellia</u>	
<u>Secale</u>	
<u>Sitanion</u>	
<u>Sphenopholis</u>	
<u>Sporobolus</u>	
<u>Triticum</u>	

HAMAMELIDACEAE

<u>Hamamelis</u>	<u>Phyllactinia guttata</u>
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HIPPOCASTANACEAE

<u>Aesculus</u>	<u>Phyllactinia guttata</u>
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Aesculus Uncinula flexuosa

HYDROPHYLLACEAE

Hydrophyllum

1. Cleistothecia contain one ascus
 2. Cleistothecial wall segments small (10-20 um) .
 Sphaerotheca humili
 2. Cleistothecial wall segments large (30-40 um) .
 Sphaerotheca humili var. fuliginea
1. Cleistothecia contain more than one ascus
 3. Conidia borne in chains; ascus 2-spored
 Erysiphe cichoracearum
 3. Conidia borne singly; ascus 3-spored
 Erysiphe polygoni

Phacelia Erysiphe cichoracearum

HYPERICACEAE

Hypericum Erysiphe cichoracearum

JUGLANDACEAE

Carya Phyllactinia guttata

. Microsphaera alni

LABIATAE

Agastache Sphaerotheca humili var. fuliginea

Lamium Erysiphe cichoracearum

Mentha Erysiphe cichoracearum

. Sphaerotheca humili

Prunella Erysiphe cichoracearum

1. Perithecial wall segments small (10-20 um)
 Sphaerotheca humili

1. Perithecial wall segments large (30-40 um)
 Sphaerotheca humili var. fuliginea
Salvia Erysiphe cichoracearum
Scutellaria

1. Appendages longer than the diameter of the cleistothecia;
 appressoria never lobed Erysiphe cichoracearum

1. Appendages approximately as long as the diameter of the
 cleistothecia; appressoria lobed. Erysiphe galeopsidis
Stachys Sphaerotheca humili

1. Appendages longer than the diameter of the cleistothecia;
 appressoria never lobed Erysiphe cichoracearum

1. Appendages approximately as long as the diameter of
 the cleistothecia; appressoria lobed
 Erysiphe galeopsidis

Teucrium

1. Appendages longer than the diameter of the cleistothecium;
 appressoria never lobed Erysiphe cichoracearum

1. Appendages approximately as long as the diameter of the
 cleistothecium; appressoria lobed. Erysiphe galeopsidis

LAURACEAE

Sassafras Phyllactinia guttata

LEGUMINOSAE

Acacia Erysiphe cichoracearum

Amorpha

Apios Erysiphe cichoracearum

1. Appendages with apical or equatorial insertion; tufted
 in one direction Microsphaera fusca

1. Appendage equatorially attached, radially spread .
. Microsphaeraalni
Astragalus Sphaerotheca humili var. fuliginea
. Erysiphe cichoracearum
1. Appendages tufted in one direction; ends of the branches
straight Microsphaera astragali
1. Appendages wavy or geniculate; ends of the branches
reflexed Microsphaera euphorbiae
Cassia Erysiphe cichoracearum
Cladrastis Phyllactinia corylea
Colutae Erysiphe cichoracearum
Crotalaria Microsphaera diffusa
. Erysiphe cichoracearum
Desmanthus
Desmodium Phyllactinia guttata
. Erysiphe cichoracearum
1. Appendages apically and equatorially attached, tufted
in one direction Microsphaera diffusa
1. Appendages equatorially attached, radially spread .
. Microsphaeraalni
Gleditsia Microsphaeraalni
Glycyrrhiza Erysiphe cichoracearum
Lathyrus Microsphaeraalni
. Erysiphe cichoracearum
Lespedeza Microsphaera diffusa
. Erysiphe cichoracearum

<u>Lotus</u>		<u>Erysiphe cichoracearum</u>
<u>Lupinus</u>		
<u>Medicago</u>		
<u>Oxytropis</u>		
<u>Phaseolus</u>		<u>Erysiphe cichoracearum</u>
1. Appendages straight or arched upward		
		<u>Microsphaera diffusa</u>
1. Appendages wavy or geniculate		
		<u>Microsphaera euphorbias</u>
<u>Pisum</u>		<u>Erysiphe cichoracearum</u>
<u>Prosopis</u>		<u>Leveillula taurica</u>
<u>Psoralea</u>		<u>Erysiphe cichoracearum</u>
<u>Robinia</u>		<u>Phyllactinia guttata</u>
		<u>Erysiphe cichoracearum</u>
		<u>Microsphaera diffusa</u>
<u>Sesbania</u>		<u>Erysiphe polygoni</u>
<u>Sophora</u>		<u>Microsphaera alni</u>
<u>Strophostyles</u>		<u>Erysiphe cichoracearum</u>
<u>Trifolium</u>		<u>Microsphaera alni</u>
		<u>Erysiphe cichoracearum</u>
<u>Vicia</u>		<u>Sphaerotheca humili</u>
		<u>Erysiphe cichoracearum</u>
1. Appendages apically or equatorially attached, tufted in one direction		<u>Microsphaera diffusa</u>
1. Appendages equatorially attached, radially spreading		<u>Microsphaera alni</u>

Vigna Erysiphe cichoracearum

. Microsphaera alni

Wisteria Erysiphe polygoni

LILLIACEAE

Smilax Phyllactinia guttata

LINACEAE

Linum Erysiphe cichoracearum

LYTHRACEAE

Cuphea Erysiphe polygoni

MAGNOLIACEAE

Liriodendron Erysiphe polygoni

Magnolia Microsphaera alni

. Phyllactinia guttata

MALVACEAE

Althaea

1. Conidia borne in chains; ascus 2-spored

. Erysiphe cichoracearum

1. Conidia borne singly; ascus 3-spored

. Erysiphe polygoni

Malva Erysiphe cichoracearum

MENISPERMACEAE

Menispermum Microsphaera alni

MORACEAE

Humulus Sphaerotheca humili

. Erysiphe cichoracearum

Morus Phyllactinia guttata

. Uncinula geniculata

OLEACEAE

<u>Forestiera</u>		<u>Microsphaera alni</u>
<u>Fraxinus</u>		<u>Phyllactinia guttata</u>
		<u>Microsphaera alni</u>
		<u>Uncinula circinata</u>

ONAGRACEAE

<u>Epilobium</u>		<u>Sphaerotheca humili</u>
		<u>Erysiphe polygoni</u>
<u>Gaura</u>		
<u>Oenothera</u>		

PAPAVERACEAE

<u>Eschscholtzia</u>		<u>Erysiphe polygoni</u>
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PLANTAGINACEAE

<u>Plantago</u>		<u>Erysiphe cichoracearum</u>
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PLATANACEAE

<u>Platanus</u>		<u>Microsphaera alni</u>
		<u>Phyllactinia guttata</u>

POLEMONIACEAE

<u>Gilia</u>		<u>Sphaerotheca humili</u>
<u>Phlox</u>		<u>Erysiphe cichoracearum</u>
		<u>Sphaerotheca humili</u>
<u>Polemonium</u>		<u>Erysiphe cichoracearum</u>

POLYGONACEAE

<u>Eriogonum</u>		<u>Erysiphe cichoracearum</u>
<u>Fagopyrum</u>		<u>Erysiphe polygoni</u>
<u>Polygonum</u>		
<u>Rumex</u>		<u>Phyllactinia guttata</u>

RANUNCULACEAE

- Anemone Erysiphe polygoni
- Anemonella
- Aquilegia
- Clematis
- Delphinium Sphaerotheca humili var. fuliginea
1. Conidia borne in chains; ascus 2-spored
- Erysiphe cichoracearum
1. Conidia borne singly; ascus 3-spored
- Erysiphe polygoni
- Paeonia Erysiphe polygoni
- Ranunculus Sphaerotheca humili
- Erysiphe polygoni
- Thalictrum

RHAMNACEAE

- Rhamnus Microsphaera alni

ROSACEAE

- Agrimonia Sphaerotheca humili
- Amelanchier Podosphaera clandestina
- Crataegus
- Filipendula Sphaerotheca humili
- Fragaria Phyllactinia guttata
1. Cleistothecial wall segments small (10-20 μ m) . . .
- Sphaerotheca humili
1. Cleistothecial wall segments large (30-40 μ m) . . .
- Sphaerotheca humili var. fuliginea

Geum Erysiphe polygoni
 Sphaerotheca humili

Malus

1. Appendages equatorially attached, radially spreading
 Podosphaera clandestina

1. Appendages apically attached, usually in a cluster
 Podosphaera leucotricha

Physocarpus Sphaerotheca humili

Prunus Phyllactinia guttata
 Sphaerotheca pannosa

1. Appendages equatorially attached, radially spreading
 Podosphaera clandestina

1. Appendages apically attached, usually in a cluster
 2. Appendages rarely dichotomously branched . . .
 Podosphaera leucotricha

2. Appendages dichotomously branched
 Podosphaera tridactyla

Rosa Phyllactinia guttata

1. Secondary mycelium tightly compact, yellowish . . .
 Sphaerotheca pannosa

1. Secondary mycelium not fully developed
 Sphaerotheca humili

Rubus Phyllactinia guttata
 Sphaerotheca humili

Sanguisorba

Sorbus Podosphaera tridactyla

Spiraea

1. Appendages mycelial-like
 2. Perithecial wall segments small (10-20 um) . .
 Sphaerotheca humili
 2. Perithecial wall segments large (30-40 um) . .
 Sphaerotheca humili var. fuliginea
1. Appendages rigid, straight
 3. Appendages equatorially attached, radially spreading
 Podosphaera clandestina
 3. Appendages apically attached, usually in a cluster
 4. Appendages rarely dichotomously branched .
 Podosphaera leucotricha
 4. Appendages dichotomously branched
 Podosphaera tridactyla

RUBIACEAE

- Cephalanthus Phyllactinia guttata
 Microsphaeraalni

Galium

1. Conidia borne in chains; ascus 2-spored
 Erysiphe cichoracearum
1. Conidia borne singly; ascus 3-spored
 Erysiphe polygoni

- Gardenia Erysiphe polygoni

RUTACEAE

- Zanthoxylum Erysiphe polygoni

SALICACEAE

- Populus Erysiphe cichoracearum

Salix Phyllactinia guttata
 Uncinula salicis

SAXIFRAGACEAE

Astilbe Erysiphe polygoni
Heuchera Phyllactinia guttata
 Erysiphe cichoracearum
 Sphaerotheca humili
Hydrangea Erysiphe polygoni
Philadelphus Phyllactinia guttata
Ribes Phyllactinia guttata
 Microsphaera grossularia
 1. Secondary mycelium brown . . . Sphaerotheca mors-uvae
 1. Secondary mycelium not fully developed
 Sphaerotheca humili

Saxifraga

1. Cleistothecial wall segments small (10-20 um) . . .
 Sphaerotheca humili
 1. Cleistothecial wall segments large (30-40 um) . . .
 Sphaerotheca humili var. fuliginea

SCROPHULARIACEAE

Antirrhinum Sphaerotheca humili
Castilleja Sphaerotheca humili var. fuliginea
 Erysiphe cichoracearum
Linaria
Mimulus
Penstemon

<u>Verbascum</u>		<u>Sphaerotheca humili</u>
		<u>Erysiphe cichoracearum</u>
<u>Veronica</u>		<u>Sphaerotheca humili</u>
<u>Veronicastrum</u>		<u>Sphaerotheca humili</u> var. <u>fuliginea</u>
		<u>Erysiphe cichoracearum</u>

SOLANACEAE

<u>Lycium</u>		<u>Sphaerotheca pannosa</u>
<u>Lycopersicon</u>		<u>Erysiphe polygoni</u>
<u>Nicotiana</u>		<u>Erysiphe cichoracearum</u>
<u>Solanum</u>		

TAMARICACEAE

<u>Tamarix</u>		<u>Sphaerotheca humili</u>
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TILIACEAE

<u>Tilia</u>		<u>Phyllactinia guttata</u>
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ULMACEAE

<u>Celtis</u>		<u>Uncinula parvula</u>
1. Cleistothecia 80-120 um in diameter		
		<u>Sphaerotheca humili</u>
1. Cleistothecia 60-80 um in diameter		
		<u>Sphaerotheca phytoptophila</u>
<u>Ulmus</u>		<u>Phyllactinia guttata</u>
		<u>Microsphaera alni</u>

UMBELLIFERAE

<u>Zizia</u>		<u>Erysiphe polygoni</u>
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URTICACEAE

<u>Parietaria</u>		<u>Erysiphe cichoracearum</u>
<u>Pilea</u>		

VERBENACEAE

Verbena Sphaerotheca humili
 Erysiphe cichoracearum

VIOLACEAE

Cucullata Sphaerotheca humili
Viola Sphaerotheca humili var. fuliginea

VITACEAE

Parthenocissus Uncinula necator
Vitis

SUMMARY

The number of reported hosts for the state of Kansas is relatively small. However, many reported hosts do occur in surrounding states and may reasonably be expected to be parasitized in Kansas.

There are 273 naturally occurring species of plants in Kansas that are known hosts for the Erysiphaceae. In addition, 100 cultivated species that are reported hosts are capable of growing in Kansas. There are also 40 naturally occurring species that are climatically capable of growing in Kansas, but are not known to do so.

Of these 413 known and possibly occurring Erysiphaceae in Kansas, the following numbers are hosts for the respective genera of Erysiphaceae:

<u>Sphaerotheca</u>	73	<u>Uncinula</u>	7
<u>Podosphaera</u>	17	<u>Phyllactinia</u>	75
<u>Erysiphe</u>	297	<u>Leveillula</u>	1
<u>Microsphaera</u>	103		

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THE ERYSIPHACEAE OF KANSAS

by

GARY MACK LONG

B.A., Southwestern College, 1968

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ABSTRACT

Keys and descriptions of 29 species of Erysiphaceae are provided. A host key with host genera listed in alphabetical order is given. The keys include species expected to occur in Kansas that have not been collected. Known Kansas collections are cited.