The Uredinales of Delaware.[1]

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The following account of the Uredinales of Delaware is the result of a study of the rust flora of that State begun in 1906, during the time when the writer was connected with the Delaware College and Experiment Station. A preliminary manuscript was prepared at that time and has since been revised and amplified at various times and finally rewritten in the present form in the winter of 1916-1917. A few changes and additions have since been made to bring the notes up to date.

The records include all the material in the Herbarium of the Delaware College Agricultural Experiment Station, together with the collections made by the writer during a period of three years, and most of the collections made by the late Mr. A. Commons of Wilmington, Delaware.

Mr. Commons made a very extensive collection of the Phanerogams and Fungi of the State, largely during the period from 1885 to 1895. Most of the fungi were determined by Mr. J. B. Ellis and duplicates of the specimens are now in the herbarium of the New York Botanical Garden. A manuscript list of the fungi was prepared by Mr. Commons, but never published.

The writer enjoyed the privilege of a conference with Mr. Commons in 1907 and was permitted to make a record of the rusts from his manuscript list. His collection was not available for consultation at the time, having been stored in boxes in a garret in Wilmington. Duplicates of most of the specimens, however, have been found and examined in the Ellis herbarium at the New York Botanical Garden. Only those specimens which the writer has seen are included in the present account.

A total of 129 species are recorded from the State, including the unconnected species of Aecidium and one uncertain Uredo. These are recorded on 232 different hosts. A total of about 450 collections are included, the greater number of which were made by the writer.

In recording the collections, the nearest postoffice is given, together

[1] Contribution from the Botanical Department of the Purdue University Agricultural Experiment Station.

with the date and name of the collector if made by another person than the writer. The numbers in parentheses following the date are the writer's accession numbers. Collections made at Seaford, July 9, 1907, at Clayton, July 24, 1907, and at Lewes, August 14, 1907, were made in company with Dr. M. T. Cook. In the case of collections made by Mr. Commons the numbers given are those of his manuscript list.

An attempt has been made to include in the notes a review of all the American culture work, together with some reference to similar work conducted by European workers.

A number of field observations which were made at the time of collecting the specimens have since been used by Dr. J. C. Arthur as the basis for successful culture work and have been recorded elsewhere. A considerable number of collections of material for culture work were supplied him, a number of special trips having been made primarily for this purpose, the expenses for which he provided from the funds of the Purdue University Agricultural Experiment Station. Many of the specimens collected, especially those on grasses and sedges, were identified by Dr. Arthur or his associates in rust work. Many others, originally determined by the writer, were sent him from Delaware for confirmation. Throughout the period of time when the collections were being made, a continuous correspondence was carried on with Dr. Arthur which proved very stimulating and the writer is under special obligations to him for this assistance. Acknowledgment is also gratefully made to any others who have in any way aided in the work.

COLEOSPORIACEAE

1. Coleosporium carneum (Bosc.) comb. nov.

Tubercularia carnea Bosc. Ges. Nat. Freunde Berlin Mag. 5:88. 1811.

Coleosporium Vernoniae B. & C. Grevillea 3:57. 1874.

Peridermium carneum Seymour & Earle, Econ. Fungi 550. 1899.

On Carduaceae: II, III.

Vernonia noveboracensis (L.) Willd., Lewes, Aug. 14, 1907, (1680); Collins Beach, Oct. 1, 1907, (1912); Newark, Oct. 25, 1907 (1978.)

Arthur (Mycol. 4:29. 1912), in 1910 proved that *Peridermium carneum* is genetically connected with *Coleosporium Vernoniae*. Success-

ful infection, resulting in the formation of uredinia and telia was obtained by sowing aeciospores from *Pinus taeda* on *Vernonia crinita*, from Florida. These results were confirmed in 1911 by the same author (Mycol. 4:57. 1912), who obtained successful infection on *V. gigantea*, using aecial material from Mississippi; and again in 1913 and 1914 (Mycol. 7:80, 84. 1915), when infection of *V. fasciculata* was obtained from aecial material on *P. taeda* and *P. palustris* collected in Florida.

The type of *Tuberculariа carnea* has not been seen, and presumably is not in existence. It seems desirable, if this name is to be retained at all, to restrict its use to the Vernonia combination or, in case it should later be found desirable to unite this species with *C. Elephantopodis*, for the combined species. Hedgcock & Long (Phytopath. 7:66-67. 1917) record culture work indicating that the two species may be identical. See also Phytopathology 8:321, 325. 1918.

2. Coleosporium delicatulum (Arth. & Kern) Hedgcock & Long, Phytopath. 3:250. 1913.

Peridermium delicatulum Arth. & Kern, Bull. Torrey Club 33:412. 1906.

On Carduaceae: II, III.

Euthamia graminifolia (L.) Nutt., Newark, September 1888, F. D. Chester; Clayton, July 24, 1907, (1706); Felton, Sept. 5, 1907, (1746); Selbyville, Oct. 4, 1907, (1990).

This species until recently has been included with *C. Solidaginis*. The first suggestion leading to a true understanding of its relationship was made by Clinton in 1912 (Conn. Agr. Exp. Station Report 1912:352. 1913) who observed *P. delicatulum* on *Pinus rigida* in Connecticut associated in the field with Coleosporium on *Solidago graminifolia*. He pointed out a morphological correlation between the spore wall markings of the aeciospores and the urediniospores of the two forms but no cultures were attempted.

Hedgcock and Long in 1913 (l. c.) showed by infection experiments that this form is distinct and is connected genetically with *Peridermium delicatulum*. Uredinia developed on Euthamia when inoculated with aeciospores of *P. delicatulum* on *Pinus rigida*.

For a record of additional culture work see Phytopathology 8:321. 1918.

3. Coleosporium Elephantopodis (Schw.) Thüm. Myc. Univ. 953. 1878.

Uredo Elephantopodis Schw. Schr. Nat. Ges. Leipzig 1:70. 1822.

On Carduaceae: II, III.

Elephantopus caroliniana Willd., Greenbank, Aug. 24, 1886, A. Commons (318); Selbyville, Oct. 4, 1907, (1753).

Hedgcock & Long (Phytopath. 7:66-67. 1917) record culture work which indicates that this species is identical with *C. Vernoniae*. Further information regarding this situation is to be found in Phytopathology 8:321, 325. 1918.

4. Coleosporium Ipomoeae (Schw.) Burr. Bull. Ill. Lab. Nat. Hist. 2:217. 1885.

Uredo Ipomoeae Schw. Schr. Nat. Ges. Leipzig 1:70. 1822. *Peridermium Ipomoeae* Hedgc. & Hunt, Mycologia 9:239. 1917.

On Convolvulaceae: II, III.

Ipomoea hederacea (L.) Jacq., Lewes, Aug. 14, 1907, (1683); Selbyville, Oct. 4, 1907, (1982).

Ipomoea pandurata (L.) Meyer,—Faulkland, Sept. 18, 1885, A. Commons (219).

Ipomoea purpurea (L.) Roth.—Lewes, Aug. 14, 1907 (1694). Newark, Sept. 15, 1905 (1539).

Hedgcock & Hunt (Phytopath. 7:67. 1917) have shown that a previously undescribed foliicolous species of Peridermium, to which they give the name *P. Ipomoeae*, is the aecial stage of this species.

5. Coleosporium Pini Gall. Jour. Myc. 7:44. 1891.

Gallowaya Pini Arth. Result. Sci. Congr. Bot. Vienne 336. 1906.

On Pinaceae: III.

Pinus virginiana Mill.—Seaford, June 4, 1908, (2095).

This species represents the type of the genus Gallowaya Arth. which up to the present time remains monotypic. It is in its life history a short cycle Coleosporium bearing the same relation to that genus that Necium Arth. does to Melampsora Cast. and Chrysomyxa Ung. to Melampsoropsis (Schröt.) Arth., etc., as proposed in the revised classification of Arthur (l. c.).

Galloway (Bot. Gaz. 22:433-452. 1896) has made a very thorough investigation of the life history, pathological histology and the effect of this fungus on this host. A large series of inoculations were carried out

proving conclusively that the fungus is autoecious and that telia only are included in the life cycle.

6. Coleosporium Solidaginis (Schw.) Thüm. Bull. Torrey Club 6:216. 1878.

Uredo Solidaginis Schw. Schr. Nat. Ges. Leipzig 1:70. 1822.

Peridermium acicolum Und. & Earle, Bull. Torrey Club 23:400. 1896.

Peridermium montanum Arthur & Kern, Bull. Torrey Club 33:413. 1906.

On Pinaceae: I.

Pinus rigida Mill.—Seaford, June 5, 1908, (2066, 2094); Harrington, June 5, 1908 (2257).

On Carduaceae: II, III.

Solidago canadensis L.—Newark, September, 1888, F. D. Chester; Seaford, July 9, 1907, (1644); Clayton, July 24, 1907, (1704); Lewes, Aug. 14, 1907, (1697, 1701).

Solidago rugosa Mill., Lewes, Aug. 14, 1907, (1698).

Aster paniculatus Lam. Newark, October, 1907, (2265, 2248).

The life history of this species was first worked out by Clinton (Science N. S. 25:289. 1907. Ann. Rep. Conn. Exp. Sta. 1906:320. 1907; 1907:375. 1908). He successfully infected *Solidago rugosa* with aeciospores of *Peridermium acicolum* on *Pinus rigida*. The aecial material used was collected in three localities in Connecticut and three trials were made, all of which resulted in the development of uredinia. Telia followed in two cases.

More recently Hedgcock (Phytopath. 6:65. 1916) and Wier and Hubert (Phytopath. 6:68. 1916) working independently, have shown that, in Montana, the species under discussion has for its aecial stage a Peridermium common in the west on the needles of various pines, known as *P. montanum* Arth. & Kern. Hedgcock sowed aeciospores collected on *Pinus contorta* in Montana on various hosts and obtained the development of aecia and telia on *Aster conspicuous*. Wier & Hubert also sowed aeciospores from the same host and State on a number of local hosts for Coleosporium and obtained infection resulting in aecia on *Solidago canadensis, S. missouriensis* and *Aster laevis geyeri*.

A review of the present knowledge with reference to this species can be found in Phytopathology 8:324. 1918.

7. Cronartium cerebrum (Peck) Hedgcock & Long, Jour. Agr. Res. 2:247. 1914.

Peridermium cerebrum Pk. Bull. Buff. Soc. Nat. Sci. 1:68. 1873.

Aecidium giganteum Mahr. Wald. Nordam. 120. 1890.

Cronartium Quercuum Miyabe; Shirai, Bot. Mag. Tokyo 13:74. 1899.

Peridermium fusiforme Arth & Kern, Bull. Torrey Club 33:421. 1906.

On Pinaceae: I.

Pinus virginiana Mills., Seaford, April 1908, (2250).

On Fagaceae: II, III.

Quercus coccinea Wang., Seaford, July 9, 1907, (1645).

Quercus digitata (Marsh.) Sudw., Seaford, July 9, 1907, (1641, 1642) (Barth. Fungi Columb. 2720); Lewes, Aug. 14, 1907, (2249).

Quercus marylandica Moench., Seaford, July 9, 1907, (1646, 1647, 1652), (Barth. Fungi Columb. 2719); Lewes, Aug. 14, 1907.

Quercus nigra L., Seaford, July 9, 1907, (1643).

The first record of culture work with this species was made by Shirai (Bot. Mag. 13:74. 1899). He successfully inoculated *Quercus serrata*, *Q. variabilis* and *Q. glandulosa* in Japan, with aeciospores of *Peridermium giganteum* (Mahr.) Tubeuf from native Pinus sp.

Shear (Jour. Myc. 12:89. 1906) was the first in America to report successful inoculation indicating the connection of *Peridermium cerebrum* with the American Cronartium on Quercus sp. He conducted out-of-door inoculation experiments in the vicinity of Washington, D. C., using aeciospores of *Peridermium cerebrum* on *Pinus virginiana* to infect *Q. coccinea*. The experiments resulted in the formation of uredinia followed by telia. He also records convincing field observations confirming the above mentioned culture work.

Arthur in the same year (Jour. Myc. 13:194. 1907) confirmed Shear's results under greenhouse control by obtaining successful infection on *Q. velutina* which resulted in the formation of uredinia and telia following sowings with aecial material furnished by Dr. Shear, on *Pinus virginiana*. These results were confirmed by the same author in 1910 (Mycol. 4:26. 1912) when infection was obtained on *Q. rubra* using aecia on *P. virginiana* from the same locality.

Hedgcock in 1908 (Phytopath, 1:131. 1911) infected *Q. lobata, Q. rubra* and *Q. densifolia echinoides* by sowing with aeciospores from *Pinus virginiana* and *P. echinata,* resulting in the formation of uredinia and telia on all hosts. He also records further inoculation experiments in 1909 and 1910 in which 14 additional species of Quercus were successfully infected as was also *Castanopsis chrysophylla.* Typical galls were produced on five species of pines by introducing teliospores from the oak into wounds on the limbs. Many cross inoculations are recorded between species of Quercus in which uredospores were used.

Later Hedgcock & Long (Jour. Agr. Res. 2:247. 1914) record further inoculation work extending as well as confirming the above results and also show by carefully conducted inoculation experiments that *Peridermium fusiforme* is a synonym of the species under discussion.

Arthur in 1913 (Mycologia 7:79. 1915) confirms Hedgcock and Long's findings with reference to *Peridermium fusiforme,* obtaining successful infection of *Q. rubra* and *Q. Phellos,* following sowings with aeciospores from typical galls of this species on *Pinus taeda* from Alabama.

A more recent view with reference to the relation of *Peridermium cerebrum* and *P. fusiforme* to the Cronartium on oaks will be found in Phytopathology 8:315-316. 1918.

8. Cronartium pyriforme (Peck) Hedgcock & Long, Alt. Stage Peridermium pyriforme 3, 1914.

Cronartium Comandrae Peck, Bot. Gaz. 4:128. 1879.

Peridermium pyriforme Peck, Bull. Torrey Club 6:13. 1875.

On Santalaceae: II, III.

Comandra umbellata (L.) Nutt., Harrington, June 6, 1908, (2070).

Orton & Adams (Phytopath. 4:25. 1914) record convincing field observations made in Pennsylvania which led to the conclusion that the aecial stage of this species was the much confused *Peridermium pyriforme* Pk. No cultures were attempted.

Hedgcock and Long (l. c.) were the first to conduct cultures. They succeeded in infecting *Comandra umbellata* by sowings with aeciospores from *Pinus ponderosa,* resulting in typical uredinia.

In a later publication (Bull. U. S. Dept. Agr. 247:5. 1915) the same

authors discuss this fungus at considerable length and record in detail the results of infection experiments.

Kirkwood (Phytopath. 5:223-224. 1915) records field infection experiments conducted in 1912 in which *Comandra pallida* was infected by aeciospores from *Pinus ponderosa*. The results were inconclusive. In 1914 teliospores were inserted in incisions in the bark of young pine trees resulting in a development of mycelium in the tissues, which on histological examination resembled the condition found in trees known to be natually infected. Further field infections similar to those conducted in 1912 were carried out in 1914.

9. Hyalopsora Polypodii (DC.) Magn. Ber. Deuts. Bot. Ges. 19:582. 1901.

Uredo Polypodii DC. Fl. Fr. 6:81. 1815.

On Polypodiaceae:

Felix fragilis (L.) Und., Stanton, July 4, 1894, A. Commons (2466); Mt. Cuba, July 1894, A. Commons (Distributed in Ellis & Ev. Fungi Columb. 765).

The evidence at hand at the present time leads to the conclusion that this species and other members of the genus Hyalopsora are heteroecious. Bartholomew (Bull. Torrey Club 43:195. 1916) shows that the mycelium of this species is binucleate in all its forms on the above host. No clues to the alternate host have been suggested.

10. Kuehneola Uredinis (Lk.) Arth. Result. Sci. Congr. Bot. Vienne 342. 1906.

Oidium Uredinis Lk. in Willd. Sp. Pl. 6':123. 1824.

Chrysomyxa albida Kühn, Bot. Centr. 16:154. 1883.

Uredo Muelleri Schröt. Krypt. Fl. Schles. 3':375. 1887.

Coleosporium Rubi Ellis & Holw. Sacc. Syll. Fung. 7:759. 1888.

On Rosaceae:

Rubus nigrobaccus Bailey, Faulkland, Sept. 15, 1885, A. Commons (175), Oct. 1, 1886, A. Commons (175a) (type of *Coleosporium* Rubi Ell. & Holw. issued in Ellis & Ev. N. Am. Fungi 1878); Newark, Sept. 5, 1905 (1629).

Rubus frondosus Bizel. Newark, Sept. 1907 (2012).

11. Melampsora Bigelowii Thüm. Mitth. Forstl. Vers. 2:37. 1879.

Uredo Bigelowii Arth. Result. Sci. Congr. Bot. Vienne 338. 1906.

On Salicaceae: II, III.

Salix nigra Marsh., Wilmington, Oct. 4, 1889, A. Commons (1022); Newark, Oct. 6, 1905 (1634), Sept. 10, 1907 (1729).

Arthur in 1903 (Jour. Myc. 11:60. 1905) was the first to show that this American species, like certain European forms on Salix, develops its aecial stage on Larix. He obtained the development of aecia on *Larix decidua* by using for infection, telial material on *Salix amygdaloides*, from Wisconsin. These results were confirmed in 1906 (Jour. Myc. 13:194. 1907) when similar successful infection was obtained on *L. decidua* following exposure to germinating telia on Salix sp. from Indiana. Wier and Hubert (Phytopath. 6:372. 1916) used telia on *Salix Bebbiana* from Montana to successfully infect *L. occidentalis*, and on *S. cordata mackenzieana* from Idaho to infect *L. Europea*. Pycnia and aecia developed in abundance from both infections. (See also Phytopath 7:109. 1917; 8:326. 1918.)

12. Pucciniastrum Agrimoniae (Schw.) Tranz. Script. Bot. Hort. Univ. Petrop. 4:301. 1895.

Caeoma Agrimoniae Schw. Trans. Am. Phil. Soc. II, 4:291. 1832.

On Rosaceae: II, III.

Agrimonia hirsuta (Mühl.) Bicknell, Newark, Sept. 19, 1905, (1547); Oct. 1907 (2235).

No culture work leading to the detection of the alternate form of the species has been conducted. The aecia, in common with other North American species of Pucciniastrum, doubtless occur on the leaves of Abies or Tsuga.

13. Pucciniastrum minimum (Schw.) Arth. Result. Sci. Congr. Bot. Vienne 337. 1906.

Uredo minima Schw. Schr. Nat. Ges. Leipzig 1:70. 1822.

Peridermium Peckii Thüm. Mitth. Forstl. Vers. Oest. 2:320 (24). 1880.

On Ericaceae: II.

Azalea viscosa L., Collins Beach, Oct. 1, 1907 (1910).

Fraser in 1910 (Mycol. 4:184. 1912) was the first to show that the alternate host for this species is *Tsuga canadensis*. He obtained suc-

cessful infection, resulting in pycnia and aecia on leaves and cones of *Tsuga canadensis* (referred to *Peridermium Peckii*) by sowings with telial material from *Rhodora canadensis*.

A comparison of the morphology of all the spore stages of this species with the following, taken together with the close relationship of the hosts involved, strongly suggests that they should be united under one name.

See also Phytopathology 8:329-330. 1918.

14. Pucciniastrum Myrtilli (Schum.) Arth. Result Sci. Congr. Bot. Vienne 337. 1906.

Aecidium Myrtilli Schum. Enum. Pl. Saell. 2:227. 1803.

On Vacciniaceae: II.

Vaccinium vacillans, Kalm., Newark, Sept. 17, 1907 (2008); Selbyville, Oct. 4, 1907 (1989).

Clinton (Rep. Conn. Agr. Exp. Sta. 1909-1910:719. 1911) was the first to show that the aecial stage of this species occurred on *Tsuga canadensis*. He successfully infected *Gaylussacia baccata* by sowing with aeciospores from Tsuga, resulting in the development of the typical uredinia of this species.

Fraser in 1912 (Mycol. 5:237. 1913) confirms Clinton's work by obtaining the development of aecia on the leaves of *Tsuga canadensis* following sowings from teliosporic material on *Vaccinium canadense*. The same author in 1913 (Mycol. 6:27. 1914) obtained aecia on *Tsuga canadensis* following sowing of teliosporic material from *Galussacia resinosa*. The aecia developed in these experiments are similar to those of *Peridermium Peckii* Thüm. but may represent an undescribed form.

15. Pucciniastrum Pyrolae (Pers.) Dietel, in Engler & Prantl Nat. Pfl. 1,1**:47. 1897.

Aecidium Pyrolae Pers. Gmel. Syst. Nat. 2:1473. 1791.

On Pyrolaceae:

Chimaphila maculata (L.) Parsh., Seaford, June 5, 1908. (2075).

16. Pucciniastrum pustularum (Pers.) Dietel, in E. & P. Nat. Pfl. 1,1**:47. 1897.

Uredo pustulata Pers. Syn. Fung. 219. 1801.

Pucciniastrum Epilobii Otth. Mitth. Nat. Ges. Bern 1861:72. 1861.

Pucciniastrum Abieti-Chamaenerii Kleb. Jahrb. Wiss. Bot. 34:387. 1900.

On Onagraceae: II.

Epilobium coloratum Muhl., Mt. Cuba, Sept. 20, 1893, A. Commons (2262).

Klebahn (Zeits. Pflanzenkr. 9:22-26. 1899) and other European investigators have shown that the aecial stage of the rust on species of Epilobium belonging to the section Chamaenerion occurs in Europe on *Abies pectinata*.

Fraser in 1910 (Mycol. 4:176. 1912) was the first in America to record successful cultural experiments with this species. He showed that the aecia were found on *Abies balsamea* using for infection telia from *Epilobium angustifolium* collected in Nova Scotia. The aeciospores thus produced were used to infect *Epilobium angustifolium* and the typical uredinia of this species resulted. Weir and Hubert (Phytopath. 6:373. 1916) using telial material from the same host collected in Idaho obtained development of pycnia on *Abies lasiocarpa*.

It will be noted that all the cultural work has been conducted with but one American species of Epilobium which belongs in the same group as those successfully cultured in Europe. It is probable that there are at least two distinct biological races involved. Sydow (Monog. Ured. 3:442-444. 1915) recognizes two species.

See also Phytopathology 8:328-329. 1918 for a review of more recent work.

17. Uredinopsis Atkinsonii Magn. Hedwigia 43:123. 1904.

On Polypodiaceae:

Dryopteris Thelypteris (L.) A. Gray, Stanton, July 13, 1894, A. Commons (2471).

Fraser in 1912 (Mycol. 5:236. 1913) proved that this species has its aecial stage on *Abies balsamea* (*Peridermium balsameum* Pk. p. p.) by successfully infecting *Dryopteris Thelypteris* with aeciospores from *Abies balsamea* with production of uredinia.

18. Uredinopsis mirabilis (Pk.) Magn. Hedwigia 43:121. 1904.

Septoria mirabilis Pk. Ann. Rep. N. Y. Mus. 25:87. 1873.

On Polypodiaceae:

Lorinseria areolata (L.) Presl., Selbyville, Oct. 4, 1907, (1755).

Onoclea sensibilis L., Newark, Oct. 1907, (2259).

Fraser in 1910 (Mycol. 4:189. 1912) conducted inconclusive culture experiments indicating that this species on *Onoclea sensibilis* had for its aecial stage a Peridermium on *Abies balsamea*. In 1912 (Mycol. 5:236. 1913), however, the same author demonstrated conclusively that such was the case. Teliosporic material on *Onoclea sensibilis* L. was used to successfully infect the leaves of *Abies balsamea* resulting in pycnia and aecia of *Peridermium balsameum*. In three trials using aeciospores from *Abies balsamea*, uredinia developed on Onoclea. In 1913 (Mycol. 6:25. 1914) the results of 1912 were repeatedly confirmed. The species of the genus Uredinopsis are separated on rather slight morphological characters. Fraser reports the results of experiments, however, that indicate that this species is at least biologically distinct.

PUCCINIACEAE.

19. Gymnoconia interstitialis (Schlecht.) Lag. Tromsö Mus. Aarsh. 16:140. 1894.

Caeoma interstitiale Schlecht. Horae Phys. Berol. 96. 1820.

Aecidium nitens Schw. Schr. Nat. Ges. Leipzig 1:69. 1822.

Puccinia Peckiana Howe; Peck, Ann. Rep. N. Y. State Mus. 23:57. 1872.

Puccinia tripustulata Peck, Ann. Rep. N. Y. State Mus. 24:91. 1872.

Gymnoconia Peckiana Trotter, Fl. Ital. Crypt. 1^{12}:338. 1910.

Kunkelia nitens Arth. Bot. Gaz. 58:504. 1917.

On Rosaceae: I.

Rubus allegheniensis Porter, Newark, May 1889, F. D. Chester.

Rubus villosus Ait., Newark, May 15, 1907, (1620), June 16, 1907, M. T. Cook, (1661).

Tranzschel (Hedwigia 32:257. 1893) was the first to report success in culturing this species. He succeeded in obtaining the development of *Puccinia Peckiana* Howe on *Rubus saxatilis* by sowing spores of *Caeoma nitens* Burrill.

In America Clinton (Bot. Gaz. 19:116. 1895) confirmed Tranzschel's work by successfully infecting *Rubus villosus* with production of telia. He used aecial material from the same host.

Kunkel (Bull. Torrey Club 40:361-366. 1913; Am. Jour. Bot. 1:37-47. 1914) has shown that *Caeoma nitens* on *Rubus frondosus* behaves

like a short cycle telial form comparable to Endophyllum, since the so-called aeciospores germinate like teliospores. In a later study (Bull. Torrey Club 43:559-569. 1916) Kunkel concludes that there are two forms of orange rust of Rubus in North America. He found that in certain collections the spores germinate as aeciospores with germ tube, while in others they germinate as teliospores. Arthur (l. c.) concurs in this view and establishes the genus Kunkelia for the short cycled form. Atkinson (Am. Jour. Bot. 5:79-83. 1918) presents evidence in support of the contention that only one species should be recognized and that it represents a form whose life history is unstable and that the spores may germinate either as aeciospores which on infection develop teliospores of *Puccinia Peckiana*, or as teliospores which, following infection, result in a repetition of the caeomoid aecial form. He considers that the behavior of the spores is dependent on certain conditions, the most important of which is temperature. Until more evidence is available it seems best to continue to list this species under the old name.

20. Gymnosporangium Botryapites (Schw.) Kern, Bull. Torrey Club 35:506. 1908.

Caeoma Botryapites Schw. Trans. Am. Phil. Soc. II. 4:294. 1832.

Gymnosporangium biseptatum Ellis, Bull. Torrey Club 5:46. 1874.

On Juniperaceae: III.

Chamaecyparis thyoides (L.) B.S.P., Seaford, April 14, 1908.

Dr. W. G. Farlow (Anniv. Mem. Bost. Soc. Nat. Hist. 35:1880) was the first to attempt infection experiments with this species. He reports success in obtaining pycnia on *Crataegus tomentosa*. It is noteworthy that later studies have not confirmed the occurrence of the species on Crataegus. Later (Proc. Am. Acad. Nat. Sci. 12:313. 1885) spermogonia were obtained on leaves and stems of *Amelanchier canadensis*. Dr. R. Thaxter (Proc. Am. Acad. Nat. Sci. 14:263. 1887) obtained the development of aecia on *Amelanchier canadensis* which were recognized to be *Roestelia Botryapites* (Schw.) C. & E. These results were later repeatedly confirmed (Conn. Agr. Exp. Sta. Bull. 107:4. 1891).

Dr. J. C. Arthur (Mycol. 1:240. 1909) records successful infection of *Amelanchier intermedia* from telial material collected by the writer at Newfield, N. J., pycnia only resulting.

Dodge (Torreya 15:133-134. 1915; Bull. Torrey Club 42:519-542.

1915) conducted an extensive investigation of this species in comparison with *G. transformans*. In connection with this work he repeatedly obtained infection by using telia from galls on *Chamaecyparis thyoides*, on *A. canadensis*, *A. intermedia* and *A. Amelanchier* which resulted in the development of *Roestelia Botryapites*. (c. f. 27). He failed to obtain any infection on Aronia.

21. Gymnosporangium clavariaeforme (Jacq.) DC. Fl. Fr. 2:217. 1895.

Tremella clavariaeformis Jacq. Coll. 2:174. 1788.

On Malaceae: I.

Amelanchier canadensis (L.) Medic., Felton, June 8, 1893, F. D. Chester.

The alternate host for this species occurs on *Juniperus communis* L. and *J. sibirica* Burgsd.

Oersted (Overs. Vid. Selsk. Forh. 210, 1867; Bot. Zeit. 222, 1867) was the first to carry out infection experiments with this species. He successfully infected *Crataegus oxycantha* following sowings with telial material. This species has since been frequently cultured by European investigators and the results have been fully summarized by Klebahn (Die Wirtswechselden Rostpilze 339-345. 1904).

In America, Thaxter (Proc. Am. Acad. Sci. 22:262. 1887; Bot. Gaz. 14:166. 1889) was the first to conduct definite cultures. He succeeded in obtaining the development of an abundance of pycnia and aecia on *Crataegus tomentosa* and *Amelanchier canadensis*.

Dr. J. C. Arthur (Jour. Myc. 14:19. 1908) in 1907 succeeded in obtaining infection of *Amelanchier intermedia* following sowings of sporidia from *Juniperus sibirica* with development of pycnia only. In 1908 (Mycol. 1:239. 1909) aecia were obtained on *Amelanchier erecta* following sowings of sporidia from *J. sibirica* from Colorado. In 1910, (Mycol. 4:24. 1912) using similar infection material, the same author succeeded in obtaining pycnia and aecia on *Amelanchier erecta* and pycnia on *Crataegus punctata*. In 1911 (Mycol. 4:56. 1912) the same results on *Amelanchier erecta* were obtained as in 1910, using telial material from the same locality. In 1913 (Mycol. 7:79. 1915) pycnia were obtained on *Crataegus cerronus*, following inoculation with telia from Colorado on *Juniperus sibirica*.

22. Gymnosporangium germinale (Schw.) Kern, Bull. Torrey Club 35:506. 1908.

Cacoma germinale Schw. Trans. Am. Phil. Soc. II. 4:294. 1832.

Gymnosporangium clavipes Cooke & Peck; Cooke, Jour. Quek. Club 2:267. 1871.

Roestelia aurantica Pk. Bull. Buffalo Soc. Nat. Sci. 1:68. 1873.

On Malaceae: I.

Cydonia vulgaris (L.) Pers., Smyrna, July 15, 1895, comm. J. C. Stockley; Felton, Aug. 1897, F. D. Chester.

On Juniperaceae: III.

Juniperus virginiana L., Iron Hill, May 1897, F. D. Chester; Seaford, April 14, 1908, (2252).

Dr. W. G. Farlow was the first to conduct culture experiments with this species. In 1883 (Proc. Am. Acad. Sci. 20:313. 1885) using telia from *Juniperus virginiana* he succeeded in obtaining the development of pycnia on leaves of *Malus Malus*, *Aronia arbutifolia* and *Amelanchier canadensis*, but aecia did not develop.

Dr. R. Thaxter (Bot. Gaz. 11:236. 1886; Proc. Am. Acad. Sci. 22:264. 1887) conducted similar cultural work obtaining well developed aecia on *Amelanchier canadensis* and pycnia on *Malus Malus*.

Dr. J. C. Arthur in 1907 (Jour. Myc. 14:18. 1908) using material on *Juniperus sibirica* from Illinois secured infection on leaves of *Amelanchier intermedia* and on fruit of *A. erecta* with development of pycnia only. In 1908 the same author (Mycol. 1:239. 1909) using telial material from *J. virginiana* from Kentucky succeeded in developing pycnia and aecia on Crataegus sp. In 1909 (Mycol. 2:229. 1910) successful infection of *Amelanchier erecta* with development of aecia in abundance and of *Crataegus punctata* with development of pycnia only was obtained. Telial material from *J. sibirica* from Michigan was used in these experiments. In 1910, (Mycol. 4:24. 1912) using telial material from Wisconsin on *J. sibirica*, successful infection of *Amelanchier erecta* and *Crataegus tomentosa* was obtained resulting in abundant aecia in both cases. Aeciospores from the Amelanchier were used in June 1910 to inoculate *J. sibirica* resulting in the development of telia the following spring.

23. Gymnosporangium globosum Farl. Anniv. Mem. Boston Soc. Nat. Hist. 18. 1880.

On Malaceae: I.

Crataegus phaenopyrum (L. f.) Medic., Newark, Oct. 1888, F. D. Chester.

Dr. W. G. Farlow (Anniv. Mem. Boston Soc. Nat. Hist. 34:1880 and Proc. Am. Acad. N. S. 12:312. 1885) was the first to conduct infection experiments with this species. He succeeded in obtaining pycnia only on *Crataegus tomentosa, C. Douglasii, C. oxyacantha,* following sowings with telial material from *J. virginiana.* Dr. R. Thaxter (Proc. Am. Acad. Sci. 22:263. 1887; Bot. Gaz. 14:167. 1889) succeeded in obtaining infection resulting in aecia on *Crataegus coccinea* and *Malus Malus* and spermogonia on *Sorbus americana* and *Cydonia vulgaris.*

In a later report (Conn. Agr. Exp. Sta. Bull. 107:4. 1891) additional work is recorded confirming the previous results on *Malus Malus* and recording successful infection of *Sorbus americana* resulting in the development of aecia.

Dr. J. C. Arthur in 1906 (Jour. Myc. 13:200. 1907) using a telial material from *Juniperus virginiana* from Indiana obtained aecia on *Crataegus Pringlei.* Similar material from West Virginia gave aecia on *Sorbus americana* and pycnia on *Crataegus Pringlei* and *Malus coronaria.* In 1907, (Jour. Myc. 14:18. 1908) infection from telial material from Indiana resulting in aecia, was secured on *Malus Malus.* In 1908 (Mycol. 1:239. 1909) infection resulting in aecia was obtained on *Crataegus Pringlei,* using telial material from Massachusetts. Pycnia were also obtained on Crataegus sp. using telial material from Kentucky. In 1909 (Mycol. 2:229. 1910) successful infection resulting in aecia was obtained on *Crataegus coccinea* using infecting material from North Carolina.

24. Gymnosporangium Juniperi-virginianae Schw. Schr. Nat. Ges. Leipzig 1:74. 1822.

Gymnosporangium macropus Lk. in Willd. Sp. Pl. 6²:128. 1825.

Aecidium pyratum Schw. Trans. Am. Phil. Soc. II. 4:309. 1832.

Roestelia pyrata Thax. Proc. Am. Acad. 22:269. 1887.

On Malaceae: I.

Pyrus coronaria L., Wilmington, Aug. 26, 1886, A. Commons.

Pyrus malus L., Felton, Sept. 5, 1907 (1737).

On Juniperaceae: III.

Juniperus virginiana L., Georgetown, May 18, 1892, F. D. Chester; Lincoln City, May 1906, H. S. Jackson.

The species recorded above is the common cedar-apple rust known throughout the eastern United States and is one of the serious apple diseases often, in epidemic years, causing enormous losses. An account of this disease in Delaware with a list of susceptible and immune varieties has been prepared by Chester (Del. Exp. Sta. Rep. 8:63-69. 1896).

Farlow in 1877 and 1883 (Aniv. Mem. Boston Soc. Nat. Hist. 35:1880; Proc. Am. Acad. 20:313, 314. 1885) was the first to attempt culture work with this species. He obtained incomplete proof of the life history. In 1886 Thaxter (Proc. Am. Acad. 22:257. 1887) first conducted cultures establishing the genetic relation of the common apple rust (*Roestelia pyrata*) and *G. macropus*. He succeeded in obtaining aecia on *Pyrus malus* following sowing of teliospores from *J. virginiana*. The results were repeated and confirmed in 1887 (Bot. Gaz. 14:166. 1889). Halsted in 1886 (Bot. Gaz. 11:190. 1886; Bull. Iowa Agr. Coll. Dept. Bot. 59. 1886) obtained infection on *Pyrus Iowensis* resulting in aecia.

Stewart and Carver in 1896 (Rep. N. Y. (Geneva) Exp. Sta. 14:535. 1896) conducted culture experiments in New York and Iowa and obtained infection of apples in New York using telia collected in Iowa as well as locally, with successful development of aecia on some varieties. In Iowa infection could only be obtained on wild crab when either New York or Iowa telia were used. The results are recorded in considerable detail and are exceedingly interesting and difficult of explanation.

In 1901 Pammel (Bull. Iowa Exp. Sta. 84:24. 1905) conducted cultural experiments and reports infection of *Pyrus Iowensis* and *Crataegus mollis* and *C. pinnatifida* with development of aecia using telial material from both New York and Missouri.

Arthur in 1905 (Jour. Myc. 12:13. 1906) using telial material from Iowa and North Carolina obtained infection resulting in abundant pycnia on the apple from both sources. In 1906 and 1907 and 1910 (Jour. Myc.

13:200. 1907; 14:17. 1908; Mycol. 4:24. 1912) pycnia were again obtained on apple following sowings from telial material from Indiana.

In 1915 Reed and Crabill (Tech. Bull. Va. Exp. Sta. 9:43-45. 1915) report the results of numerous infection experiments on different varieties of cultivated apples. Their experiments bring out strongly the well established fact that some varieties are susceptible and other relatively or totally immune. They also show that only young leaves are susceptible.

25. Gymnosporangium Myricatum (Schw.) Fromme, Mycol. 6:229. 1914.

Cacoma (Accidium) Myricatum Schw. Trans. Am. Phil. Soc. II. 4:294. 1832.

Podisoma Ellisii Berk. Grevillea 3:56. 1844.

Gymnosporangium Ellisii Farl., Ellis N. A. Fungi 271. 1879.

On Myricaceae: I.

Myrica cerifera L., Seaford, July 9, 1907 (1648).

On Juniperaceae: III.

Chamaecyparis thyoides (L.) B. S. P., Seaford, April 14, 1908 (2251).

Fromme (l. c.) has shown by infection experiments and field observations that the well known *Gymnosporangium Ellisii* has for its aecial stage *Accidium Myricatum*. This is especially remarkable since only one other Gymnosporangium *(G. Blasdaleanum)* has been definitely shown by infection experiments to have aecia of the cupulate type, and since no other species of Gymnosporangium is known to have an aecial host in other than the Rosales.

26. Gymnosporangium nidus-avis Thaxter, Bull. Conn. Exp. Sta. 107:6. 1891.

On Juniperaceae: III.

Juniperus virginiana L., Lewes, April 15, 1908 (2243).

This species produces largely "witches' brooms" on the red cedar.

Thaxter conducted culture experiments in 1886 and in 1887 (Proc. Amer. Acad. 22:264. 1887; Bot. Gaz. 14:167. 1889) in which he infected *Amelanchier canadensis* with production of pycnia and aecia in abundance using sporidia of the above species, at that time undescribed, but referred to *G. conicum*. In 1891 Thaxter (l. c.) stated "infections with

this species have been conducted every year since the spring of 1886 . . . and the results in all the cultures were identical."

Arthur in 1907 (Jour. Myc. 14:19. 1908), using sporidia from *J. virginiana* collected in Illinois, obtained successful infection of *Malus Malus* with production of pycnia followed by aecia, but failed to obtain infection of *Amelanchier intermedia*. In 1909 (Mycol. 2:230. 1910) successful infection of *Crataegus Pringlei* with production of pycnia only, and of *Malus Iowensis* with development of aecia was obtained, but without infection on *Amelanchier canadensis*. In 1910 (Mycol. 4:25. 1912) infection of *Cydonia vulgaris* and *Amelanchier vulgaris* with production of pycnia only is recorded. In 1911 (Mycol. 4:56. 1912) using sporidia from New Jersey successful infection of *Amelanchier erecta* resulted in the production of aecia on fruits; using sporidia from Nebraska successful infection of *Malus coronaria* with production of pycnia only is recorded. In 1914 (Mycol. 7:83. 1915) *Amelanchier vulgaris* was inoculated with telial material from Massachusetts and abundant production of pycnia and aecia resulted.

27. Gymnosporangium transformans (Ellis) Kern, Bull. N. Y. Bot. Gard. 7:463. 1911.

Roestelia transformans Ellis; Peck, Bull. Torrey Club 5:3. 1874.

Gymnosporangium fraternum Kern, Bull. N. Y. Bot. Gard. 7:439. 1911.

On Malaceae: I.

Aronia arbutifolia (L. f.) Ell., Seaford, June 1908 (2262).

The above collection is of pycnia only.

Dodge (Torreya 15:133-134. 1915; Bull. Torrey Club 42:519-542. 1915) has studied the foliicolous form occurring on *Chamaecyparis thyoides* which until Kern's monographic study (l. c.) had been considered a form of *G. biseptatum*. His work clearly shows that this leaf form has for its aecia *Roestelia transformans* on Aronia having repeatedly obtained infection followed by development of aecia on *A. arbutifolia* and *A. nigra*. He also claims to have obtained infection with the leaf form on *Amelanchier intermedia, A. canadensis* and *A. Amelanchier*, resulting in the development of aecia having the morphology of *R. Botryapites* which has been repeatedly shown to go to the branch form known commonly as *G. biseptatum*. The young infections of *G. bisep-*

tatum which occur on the young twigs may easily be confused with the leaf form unless microscopically examined, and might have been mixed with the material of *G. fraternum* used in the infection experiments.

28. Phragmidium americanum Diet. Hedwigia 44:124. 1905.

On Rosaceae:

Rosa Carolina L. Collins Beach, Oct. 1, 1907.

Rosa humilis Marsh., Seaford, June 4, 1908 (2050); Lewes, Aug. 14, 1907 (1685).

29. Phragmidium disciflorum (Tode) J. F. James, Cont. U. S. Nat. Herb. 3:276. 1895.

Ascophora disciflora Tode, Fungi Meckl. 1:16. 1790.

On Rosaceae:

Rosa sp. (cultivated), Newark, September 1888, F. D. Chester.

30. Phragmidium Duchesneae (Arth.) Sydow, Monog. Ured. 3:93. 1912.

Kuehneola Duchesneae Arthur, N. A. Flora 7:185. 1912.

Frommea Duchesneae Arthur, Bull. Torrey Club 44:504. 1917.

On Rosaceae:

Duchesnea Indica (Ards.) Focke, II, Newark, May 1908, H. S. Jackson; III, Wilmington, Nov. 1, 1890, A. Commons (1686).

This species and the following possess only uredinia (primary and secondary) and telia in their life cycle differing from the commoner species occurring on Rubus and Rosa in the absence of any Caeoma stage. As suggested by Arthur (Phytopath. 6:100. 1916; Bull. Torrey Club 44:501-511. 1917) their affinities are with Phragmidium rather than with Kuehneola which doubtless belongs in the Uredinaceae. In the classification of the Uredinales based on the length of life cycle, proposed by Arthur (Result. Sci. Congr. Bot. Vienna in 1906) these species would represent a genus in the Phragmidiatae bearing the same relation to Phragmidium and Earlea that Bullaria does to Dicaeoma and Dasyspora in the Dicaeomatae. Frommea Arthur (l. c.) has been proposed as the name of this genus.

31. Phragmidium triarticulatum (B. & C.) Farl., Bull. Bussey Inst. 1:433. 1876.

Aregma triarticulatum Berk. & Curtis; Berk. Grevillea 3:51. 1874.

Kuehneola obtusa Arthur N. A. Flora 7:185. 1912. p. p.

Phragmidium Potentillae-canadensis Diet. Hedw. Beibl. 42:179. 1903.
Frommea obtusa Arth. Bull. Torrey Club 44:503. 1917.

On Rosaceae:

Potentilla canadensis L., Newark, September 1907 (2004).

32. Pileolaria Toxicodendri (Berk. & Rav.) Arth. N. A. Flora 7²:147. 1907.

Uromyces Toxicodendri Berk & Rav. Grevillea 3:56. 1874.

On Sapindaceae:

Rhus radicans L., Stanton, Sept. 10, 1885, A. Commons (184).

33. Polythelis fusca (Pers) Arth. Result Sci. Congr. Bot. Vienne 341. 1906.

Aecidium fuscum Pers. Linn. Syst. Nat. 2²:1873. 1791.
Puccinia fusca Wint. Rabh. Krypt. Fl. 1:199. 1884.

On Ranunculaceae:

Anemone quinquefolia L., Newark, April 13, 1908, (2255).

The mycelium of this species is perennial as first shown by DeBary (Monatsber. K. Akad. d. Wiss. Berlin 1865). Plants affected by this rust are deformed, slightly dwarfed and seldom if ever flower. The leaves are paler and narrower than normal and are considerably thickened.

34. Puccinia Agropyri E. & E. Jour. Myc. 7:131. 1892.

On Poaceae:

Agropyron repens L., Newark, August 23, 1907 (1716).

No successful culture work has been conducted with this sub-epidermal leaf rust on this host. It is indistinguishable from the normal form of *P. tomipara* Trel. on Bromus sp. and with other similar forms on various grasses described under a variety of names including *P. oblitcrata* Arth. on *Agropyron* sp., *P. alternans* Arth. on *Bromus* sp. and *P. cinerea* Arth. on Poa sp. Considerable culture work has been done by Arthur showing that these forms have aecia on Ranunculaceae and are probably identical. It is to be expected that aecia for leaf rust on *Agropyron repens* will also be found to be on Ranunculaceae. The most probable connection is with Clematis.

35. Puccinia Aletridis B. & C. Grevillea 3:52. 1874.

On Liliaceae:

Aletris farinosa L., Newark, April 7, 1892, A. Commons (1924); Townsend, Oct. 9, 1896, A. Commons (2785); Selbyville, Oct. 3, 1907 (1756).

The specimen from Newark collected by Commons which is in the Ellis collection at the New York Botanical Garden is labeled as occuring on Chamalerion. The host is clearly Aletris.

No aecia are known for this rather rare species and its life history is in doubt. Only three other collections have been seen by the writer from Massachusetts, Florida and Mississippi.

36. Puccinia Anemones-Virginianae Schw. Schrift. Nat. Ges. Leipzig 1:72. 1822.

On Ranunculaceae:

Anemone virginiana L., Faulkland, Aug. 13, 1886, A. Commons (293).

The above collection was also issued in Ellis & Ev. N. A. Fungi 1847.

37. Puccinia Andropogonis Schw. Trans. Am. Phil. Soc. II, 4:295. 1834. *Accidium Pentastemonis* Schw. Schr. Nat. Ges. Leipzig 1:68. 1822.

On Scrophulariaceae: I.

Melampyrum lineare Lam. (*M. americanum* Michx.), Seaford, June 4, 1908 (2051).

On Poaceae: II, III.

Schizachyrium scoparium (Michx.) Nash (*Andropogon scoparius* Michx.), Lewes, Nov. 16, 1907.

This species on Andropogon was first cultured by Arthur in 1899 (Bot. Gaz. 29:27. 1900) who succeeded in obtaining infection resulting in aecia on *Pentstemon pubescens* using telia from *A. scoparius* from Indiana. In 1904 and 1906 the same author (Jour. Myc. 10:11. 1904; 13:197. 1907) using telia of *A. scoparius* collected in Nebraska, obtained infection resulting in aecia on *P. hirsutus*. In 1910 (Mycol. 4:17. 1912) telia from *A. virginicus* from W. Virginia were successfully cultured on *P. hirsutus* and from *A. scoparius* from Colorado on *P. alpinus*. In 1903 Kellerman (Jour. Myc. 9:10. 1903) verified the results of Arthur by obtaining successful infection on *P. hirsutus* resulting in pycnia following sowing of telia from *A. scoparius* collected in Indiana.

This aecidium on Melampyrum included here is known on this host otherwise only from Connecticut and Massachusetts. It somewhat resembles *A. Melampyri* Kuntze & Schum., which has been shown by Juel (Obv. K. Vet. Akad. Föch 1894. 503) and Klebahn (Kulturv. VIII 402) to go to *Puccinia nemoralis* Juel on *Molina caerulea*. The American aecia differs however from the European in the larger thick walled aeciospores and in the character of the peridial cells and since no telial form referrable to the European species has yet been found in America it is probable that the Aecidium under discussion goes to some American grass or sedge rust. It is scarcely distinguishable from the aecia of *P. Andropogonis* Schw. which occur on other Scrophulariaceae in the same range and is tentatively referred here till positive cultures are conducted.

38. PUCCINIA ANGUSTATA Pk. Bull. Buff. Soc. Nat. Hist. 1:67. 1873.
Aecidium lycopi Ger.; in Peck Bull. Buff. Soc. Nat. Hist. 1:68. 1873.
ON BORAGINACEAE: I.
Lycopus virginicus L., Newark, May 25, 1908, (2236), Seaford, June 4, 1908, (2068).
ON CYPERACEAE: II, III.
Scirpus atrovirens Muhl. Newark, Oct. 4, 1905, (1635).
Scirpus cyperinus (L.) Kunth., Selbyville, October 4, 1907, (1812).
Scirpus georgianus Harper, Newark, September 1907, (1818, 1820).

This species has for its aecial stage *Aecidium lycopi* Ger. on Lycopus sp. as first shown by Arthur in 1899 (Bot. Gaz. 29:273. 1900), who succeeded in infecting *Scirpus atrovirens* with aeciospores from *Lycopus americanus*. These results were confirmed in 1901, 1903, 1904, 1906 and 1907 (Jour. Myc. 8:53. 1902; 11:58. 1905; 13:196. 1907; 14:14. 1908) by sowing teliospores from *Scirpus atrovirens* on leaves of *Lycopus americanus* resulting in each case in the development of aecia. Kellerman in 1903 (Jour. Myc. 9:226. 1903) confirms Arthur's results using the same hosts, collecting his telial material in Ohio. In 1908 (Mycol. 1:234. 1909) Arthur infected *Lycopus communis* and *L. americanus* by sowing with teliospores from *Scirpus cyperinus*. In 1910 (Mycol. 4:17. 1912) the results of 1901-1907 were confirmed and in 1911 (Mycol. 4:54.

1912) the results of 1908 were confirmed in part. In 1912 (Mycol. 7:70. 1915) infection resulting in the development of aecia was again obtained on *L. americanus* using telial material on *S. atrovirens* from Indiana and Ontario.

39. Puccinia Anthoxanthi Fckl. Symb. Myc. Nåchtr. 2:15. 1873.

On Poaceae:

Anthoxanthum odoratum L., Newark, June 1908, (2244).

40. Puccinia Asparagi DC. Flora Fr. 2:595. 1805.

On Convallariaceae:

Asparagus officinalis L., Hare's Corners, October 1896, F. D. Chester; Smyrna, October 1904, C. O. Smith; Lewes, Aug. 14, 1907, (1681).

A discussion of the economic importance of this rust in Delaware will be found in Delaware Experiment Station bulletins 57 and 63.

Sheldon (Science N. S. 16:235. 1902) shows that this species is autoecious and that the urediniospores may carry the fungus over the winter. He also claims to have successfully infected *Allium cepa*, all three stages having been produced on that host.

41. Puccinia asperifolii (Pers.) Wettst. Verh. Zool.-Bot. Ges. Wein. 35:541. 1885.

Puccinia dispersa Erikss. Zeitsch. f. Pflanzkr. 4:257. 1894.

Aecidium asperifolii Pers. Obs. Myc. 1:97. 1896.

On Poaceae:

Secale cereale L., Newark, May 25, 1908, (2263).

DeBary (Monatsber. K. Akad. d. Wiss. Berlin 211. 1866) was the first to show the connection between the leaf rust of rye and *Aecidium asperifolii* Pers. by sowing sporidia on *Anchusa officinalis* L. and on *Lycopsis arvensis*, pycnia and aecia resulting. Uredinia and telia were obtained on rye following sowing of aeciospores from the above mentioned aecial hosts.

In America, Arthur (Mycol. 1:236. 1909) records successful infection experiments resulting in the production of pycnia on *Lycopsis arvensis* L. following sowings of sporidia from *Secale cereale* L. The Lycopsis plants were grown from seed secured in Europe. These cultures prove that the leaf rust of rye in Europe and America is identical.

42. Puccinia Asteris Duby, Bot. Gall. 2:888. 1830.

On Carduaceae:

Aster paniculatus Lam., Newark, September 1905, (1636); September 10, 1907, (1728).

Aster salicifolius Lam., Newark, September 10, 1907, (1728).

43. Puccinia asterum (Schw.) Kern, Mycol. 9:224. 1917.

Aecidium asterum Schw. Schr. Nat. Ges. Leipzig 1:67. 1822.

Puccinia extensicola Plowr. British Ured. & Ust. 181. 1889.

Puccinia vulpinoidis Diet. & Holw.; Dietel, Bot. Gaz. 19:304. 1894.

Puccinia Caricis-Erigerontis Arth. Jour. Myc. 8:53. 1902.

Puccinia Caricis-Asteris Arth. Jour. Myc. 8:54. 1902.

Puccinia Caricis-Solidaginis Arth. Bot. Gaz. 35:21. 1903.

Puccinia Dulichii Syd. Monog. Ured. 1:684. 1903.

On Carduaceae: I.

Erigeron annuus (L.) Pers., Newark, June 1907, (1669).

Euthamia graminifolia (L.) Nutt., Seaford, June 4, 1908, (2043, 2065).

Solidago altissima L., June 5, 1908, (2076).

Solidago rugosa Mill., Seaford, June 9, 1907, (2013, 2014).

Solidago sempervirens L., Seaford, June 4, 1908, (2086).

On Cyperaceae: II, III.

Carex albolutescens Schw., Selbyville, Oct. 4, 1907, (1808, 1809).

Carex festucacea Willd., Seaford, Nov. 15, 1907, (1759).

Carex Leersii Willd., Seaford, June 4, 1908, (2057a, 2061b).

Carex Muhlenbergii Schk., Lewes, Aug. 14, 1907, (1699).

Carex radiata (Wahl) Small, Newark, Sept. 1907, (1826).

Carex rosea Schk., Seaford, June 4, 1908, (2062a).

Carex stipata Muhl., Newark, Sept. 1907, (1821, 1827).

Carex straminea Willd., Seaford, Nov. 14, 1907, (1770), Nov. 15, 1907, (1859).

Carex vulpinoidea Michx., Lewes, Aug. 16, 1907, (1678); June 7, 1908, (2087); Collins Beach, Oct. 1, 1907, (1783); Newark, Aug. 23, 1907, (1717, 1725), Sept. 1907, (1733), April 5, 1908, April 11, 1908, Felton, Sept. 5, 1907, (1740, 1741); Seaford, April 23, 1908, (2032), June 4, 1908, (2077, 2080, 2081).

Dulichium arundinaceum (L.) Britt., Selbyville, Oct. 4, 1907, (1803, Barth. Fungi Columb. 2662); Seaford, Nov. 14, 1907, (1761).

In 1901 Arthur (Jour. Myc. 8:54. 1902) first began culture work showing that aecia which occur commonly on Aster, Solidago and related hosts are genetically connected with uredinia and telia on various species of Carex. The culture work conducted by Arthur is extensive and extends over a period of years from 1901-1914. In this series of culture work aecia have been produced on various species of Aster, Solidago, Erigeron, Leptilon and Euthamia, using telia from many species of Carex from various parts of North America and from Dulichium. (Jour. Myc. 8:54. 1902; 11:58. 1905; 12:15. 1906; 14:13. 1908; Bot. Gaz. 35:15, 21. 1903; Mycol. 1:233. 1909; 2:224. 1910; 4:15, 16. 1912; 7:70, 81. 1915). Fraser in 1911 (Mycol 4:181. 1912) confirms Arthur's results in part by successfully infecting *Aster acuminatus* using telial material from *Carex trisperma*.

This study has also shown that the species as here considered is a composite form made up of several distinct physiological races.

The species is separable from all other American species of Puccinia on Carex by the presence of two pores in the upper part of the rather small (12-19 by 16-23μ) uredospores, and the medium sized (12-20 by 35-50μ) teliospores.

44. Puccinia Batesiana Arth. Bull. Torrey Club 28:661. 1901.

On Carduaceae:

Heliopsis helianthoides (L.) B. S. P., Newark, Oct. 4, 1905, (1510).

This species has not been recorded otherwise on this host but has been collected in Iowa, Minnesota and Nebraska on *Heliopsis scabra* Dunal.

45. Puccinia Vernoniae Schw. Proc. Am. Phil. Soc. II. 4:296. 1832.

Puccinia bullata Schw. Schrift. Nat. Ges. Leipzig 1:74. 1822.

On Carduaceae:

Vernonia noveboracensis (L.) Willd., Clayton, July 24, 1907, (1707).

This very common species is apparently confined to the United States and is the only one so far recorded north of Mexico. The name

first proposed by Schweinitz was based on collections made at Salem, North Carolina, occurring "erumpent from the dried stems of various plants, e. g. Ambrosia, Chenopodium." In his later publication he cites it as occurring in Pennsylvania on *V. noveboracensis*. An examination of the material in the Schweinitz collection at the Philadelphia Academy of Science, made by Dr. J. C. Arthur, shows that there are three packets, containing in the aggregate 9 pieces, of similar stems bearing large sori up to 3 cm. long. The original packet reads "P bullata LvS. Salem & Beth. in caulibus varies." The stems all appear to be of Vernonia and the rust when examined microscopically does not differ from similar material on Vernonia stems (now interpreted as *V. altissima*) collected by L. M. Underwood at Fern, Putnam Co., Indiana, and distributed in Ellis & Ev. N. A. Fungi 2988 and other exsiccati under the name *P. Vernoniae* Schw. No other rust with which this could possibly be confused is known to occur on the stems of Ambrosia or Chenopodium, or on any other host within the range of this species.

That the rust on the stems is the same as the more common, or at least more frequently collected, form on the leaves has been shown by Dr. Arthur who, in 1916, using telial material from the stems of Vernonia sp. collected by C. H. Crabill at Cliffview, Va., and communicated by Dr. F. D. Fromme, succeeded in obtaining the development of pycnia and uredinia on the leaves of Vernonia sp. This culture also demonstrates that this rust, whose life history has long been in doubt, is a brachy-form referrable to the genus Bullaria. Pycnia have not been observed in any field collections thus far studied.

46. Puccinia canaliculata (Schw.) Lagerh. Tromsö Mus. Aarsh. 17:51. 1894.

Sphaeria canaliculata Schw. Trans. Am. Phil. Soc. II, 4:209. 1832.

Aecidium compositarum Xanthii Burr.; DeToni in Sacc. Syll. Fung. 7:799. 1888.

On Carduaceae: I.

Xanthium echinatum Murr., Seaford, June 4, 1908, (2049).

On Cyperaceae: II, III.

Cyperus esculentus L., Selbyville, Oct. 4, 1907, (1794).

Cyperus filiculmis Vahl., Felton, Sept. 5, 1907, (1742).

Cyperus lancastriensis Porter, Selbyville, Oct. 4, 1907, (1813).

Cyperus ovularis (Michx.) Torr., Felton, Sept. 5, 1907, (1744); Newark, Oct. 20, 1907, (2258).

Cyperus refractus Engelm., Newark, Aug. 23, 1907, (1718).

Cyperus strigosus L., Felton, July 30, 1906, (1618); Lewes, Aug. 14, 1907, (1693).

Cyperus Torreyi Britton (*C. cylindricus* (Ell.) Britton), Selbyville, Oct. 4, 1907, (1810).

Arthur (Jour. Myc. 12:23. 1906) conducted culture experiments in 1905 which showed that an aecidium on *Xanthium canadense* is connected with this species on various species of Cyperus. Following sowings of aeciospores from *X. canadense*, collected in Indiana, urediniospores developed on *C. esculentus*.

47. Puccinia Caricis-strictae Dietel, Hedw. 28:23. 1889.
Uromyces Caricis Pk. Ann. Rep. N. Y. State Mus. 24:90. 1872.
On Cyperaceae: II, III.
Carex stricta Lam., Seaford, Nov. 14, 1907, (1757, 1762, 1763, 1764, 1765, 1766).

48. Puccinia Chrysanthemi Roze, Bull. Soc. Myc. Fr. 17:92. 1900.
On Carduaceae:
Chrysanthemum sinense Sabine, Camden, September 1905, (1536); Wyoming, November 1907.

This rust causes considerable damage to cultivated chrysanthemums. The life history is somewhat in doubt. In America the rust exists only in the uredinial stage.

49. Puccinia Cirsii Lasch. in Rab. Fungi Eur. 89. 1859.
On Carduaceae:
Carduus altissimus L., Faulkland, Oct. 20, 1886, A. Commons, 459; August 1887, A. Commons, 137.

The latter specimen was issued in E. & E. N. A. Fungi 2253 as *P. compositarum* Schlecht, f. *Cnici altissimi*. This is a brachy-Puccinia developing pycnia with the uredinia and occurs most commonly on the under surface of the leaves. It occurs throughout the United States on species of Carduus other than *C. lanceolatus*.

50. Puccinia claytoniata (Schw.) Peck, Bull. N. Y. State Mus. 6:226. 1899.

Caeoma (Accidium) claytoniatum Schw. Tran. Am. Phil. Soc. II. 4:294. 1832.

Puccinia Mariae-Wilsoni G. W. Clinton, Bull. Buff. Soc. Nat. Sci. 1:166. 1873.

Allodus claytoniata Arth. Result. Sci. Congr. Bot. Vienna 345. 1906.

On Portulacaceae:

Claytonia virginica L., Newark, May 2, 1907, I, (1578); May 29, 1907, III, (1658); April 19, 1908, I, (2241).

Orton (Mem. N. Y. Bot. Gard. 6:177. 1916) is the authority for the statement that this species has been cultured by Fromme. He sowed aeciospores from primary aecia on the same host and obtained the development of telia of the scattered type indicating that repeating aecia do not occur in this species. An examination of specimens in the Arthur herbarium has failed to reveal any collection of aecia not accompanied by pycnia.

51. Puccinia Cnici Mart. Fl. Mosq. 226. 1817.

Puccinia Cirsii-lanceolati Schroet. Pilze Schles. 1:317. 1887.

On Carduaceae:

Carduus lanceolatus L., Newark, October 1907, (2009).

This species produces aecia of a peculiar character having a rudimentary aecidium. All stages occur most abundantly on the upper surfaces of the leaves.

Kellerman (Jour. Myc. 9:229. 1903) has shown through carefully conducted culture experiments that this species is an eu-Puccinia and autoecious. In America it is known only on the above host.

52. Puccinia Convolvulvi (Pers.) Cast. Obs. Myc. 1:16. 1842.

Uredo Betae Convolvuli Pers. Syn. Fung. 221. 1801.

On Convolvulaceae:

Convolvulus sepium L., Wilmington, Aug. 17, 1886, III, A. Commons (302); Lewes, April 1908, I, (2260).

The collection by Commons was issued in E. & E. N. Am. Fungi 1857 as on *Ipomoea pandurata* (L.) Meyer. The host is certainly Convolvulus. Arthur (Bot. Gaz. 29:270. 1900) has shown that this species

is autoecious. Teliospores from *C. sepium* were sown in the greenhouse on the same host with subsequent abundant development of pycnia and aecia.

53. Puccinia Cryptotaeniae Pk. Rep. N. Y. State Mus. 25:114. 1873.

On Ammiaceae:

Deringia canadensis (L.) Kuntze, Wilmington, Nov. 14, 1888, A. Commons (909); Newark, May 1907, (1667).

This is a micro-Puccinia correlated with *Puccinia microica* Ellis which is an opsis form. The latter was originally reported as occurring on Sanicula sp., which was an error for *Deringia canadensis*.

54. Puccinia Cyani (Schleich.) Pass. Rabh. Fungi Eur. 1767. 1874.

Uredo Cyani Schleich. Pl. Helv. 95.

On Carduaceae:

Centaurea cyanus L., Newark, May 20, 1913, C. O. Houghton.

55. Puccinia Eatoniae Arth. Jour. Myc. 10:18. 1904.

Accidium Ranunculi Schw. Schr. Nat. Ges. Leipzig 1:67. 1822. (Not *A. Ranunculi* Schum. 1803.)

On Ranunculaceae: I.

Ranunculus abortivus L., Newark, May 1, 1905, C. O. Smith. Issued as *A. Ranunculi* Schw. in E. & E. Fungi Columb. 2107. Newark, May 1, 1908, (2238).

On Poaceae: II, III.

Sphenopholis pallens (Spreng.) Schrib., Newark, May 1, 1908, II, (2237), June 1, 1908, III (2234, 2239).

Sphenopholis nitida (Spreng.) Schrib., Newark, June 1908, (2269).

Arthur in Jour. Myc. 10:18. 1904, shows by culture that *Accidium Ranunculi* Schw. has its telial stage on *Sphenopholis pallens* (*Eatonia pennsylvanica* (DC.) A. Gray), having obtained infection on *E. pennsylvanica* resulting in uredinia by inoculation with aeciospores from *Ranunculus abortivus*. Field observations made by the writer in connection with the collections listed above lend confirming evidence to the cultural results by Dr. Arthur. On May 1 the writer collected *Accidium Ranunculi* Schw. (2238). Almost in contact were found the leaves of grass at that time not yet fruiting, bearing fresh uredinia (2237). The

over-wintering leaves of this grass were found to bear telia. On June 1 at the same place this grass was found in fruiting condition bearing fresh telia (2239). The grass proved to be *Eatonia pallens*. Examination showed the rust to be that described by Arthur on *P. Eatoniae*.

56. Puccinia Eleocharidis Arth. Bull. Iowa Agr. College Nov. 156. 1884.

Aecidium compositarum Eupatorii DeToni in Sacc. Syll. Fung. 7:798. 1888.

On Carduaceae: I.

Eupatorium perfoliatum L., Seaford, June 4, 1908, (2054, 2061a, 2074, 2079).

Eupatorium purpureum L., Seaford, June 4, 1908, (2058b, 2060, 2062b, 2067, 2072).

Eupatorium rotundifolium L., Seaford, June 4, 1908, (2055, 2069).

Arthur conducted culture experiments in 1905 (Jour. Myc. 12:23. 1906) showing that an aecidium resembling in every way the common one on Eupatorium species could be induced by sowings with teliospores from Eleocharis. He used teliospores on *Eleocharis palustris* from Wisconsin to successfully infect *Eupatorium perfoliatum*, with subsequent development of aecia—two trials. These results were confirmed in 1906 and 1908 by the same author (Jour. Myc. 13:197. 1907; Mycol. 1:233. 1909) when typical aecia were produced on *Eupatorium perfoliatum* following infection by teliospores from *E. palustris* collected in Kansas and Indiana.

57. Puccinia Ellisiana Thüm. Bull. Torrey Club 6:215. 1878.

Puccinia americana Lagerh. Tromsö Mus. Aarsh. 17:45. 1895.

On Poaceae: II, III.

Andropogon scoparius Mchx., Newark, Oct. 1907 (1830); March 30, 1908, (2246).

This species has been separated from *P. Andropogonis* by the possession of thick walled verrucose uredospores.

Long (Phytopath. 2:164. 1912) carried on successful experiments with this species in 1910, 1911, and 1912 reporting successful infection of *Viola fimbriatula, V. hirsutula, V. sagittata, V. papilionacea*, with

development of aecia following sowings of teliospores from *A. virginicus*. Uredinia were produced on Andropogon when aecia were used for infection.

Arthur in 1912 (Mycol. 7:71. 1915) using telia from Andropogon sp. from North Dakota obtained the development of aecia on *V. cucullata* and *V. Nuttallii*.

In a later paper Long (Jour. Agr. Res. 2:303-319. 1914) presents the results of an extensive research dealing with this species and *P. Andropogonis* Schw. in which he claims to prove "that the ordinary Pentstemon rust *P. Andropogonis*, can be produced from the Viola rust *P. Ellisiana*, by simply passing the Viola rust through Pentstemon as an aecial host." Numerous culture experiments were conducted in support of the above conclusion.

58. Puccinia emaculata Schw. Trans. Am. Phil. Soc. II, 4:295. 1834.

On Poaceae:

Panicum capillare L., Newark, Sept. 15, 1905, (1615); Felton, Sept. 5, 1907, (1750).

Successful cultures have never been conducted with this common rust though many attempts have been made. Morphologically it is very like *P. Pammelii* (Trel.) Arth. (*P. Panici* Diet.) and perhaps should be united with it. On account of the resemblance to that species the aecia should be looked for on Euphorbiaceous hosts. It is convenient, however, to retain it as a separate form till cultures establishing its relationship have been successfully carried out.

59. Puccinia epiphylla (L.) Wettst. in Verh. Zool.-Bot. Ges. Wien 35:541. 1886.

Lycoperdon epiphyllum L. Sp. Pl. 1653. 1753.

Aecidium Tussilaginis Pers. in Gmel. Syst. Nat. 2:1473. 1791.

Puccinia poarum Nielsen Bot. Tidsskr. III, 2:34. 1877.

On Poaceae: II.

Poa annua L., Newark, June 1908, (2245).

Poa pratensis L., Seaford, June 4, 1908, (2053a, 2042); Newark, June 1908, (2268).

Nielsen was the first to show the relation between this rust and *Aecidium Tussilaginis*. He succeeded in infecting *P. annua*, *P. trivialis*, *P. nemoralis*, *P. fertilis* and *P. pratensis* by sowing aeciospores from

Tussilago farfara. He infected the aecial host by sowing with teliospores from *P. annua.*

Additional observations and culture work have been recorded by various European authors, which has been summarized by Klebahn (Die Wirtw. Rostpilze 290. 1904).

60. Puccinia Fraxinata (Lk.) Arth. Bot. Gaz. 34:6. 1902.

Aecidium Fraxini Schw. Schr. Nat. Ges. Leipzig 1:66. 1822. (Not *A. Fraxini* Korn.)

Caeoma Fraxinatum Lk. in Willd. Sp. Pl. 6²:62. 1825.

Puccinia Sparganioides Ellis & Barth. Erythea 4:2. 1896.

On Oleaceae: I.

Fraxinus lanceolata Borck., Newark, 1897, F. D. Chester, June 17, 1907, (1663); May 1908: (2240).

On Poaceae: III.

Spartina cynosuroides (L.) Roth (*S. polystachya* Ell.), Collins Beach, Oct. 1, 1907, (1784).

Spartina stricta (Ait.) Roth (*S. glabra* Muhl.), Lewes, Nov. 16, 1907, (1772, 1773, 1849, 1850a, 1851); Collins Beach, Oct. 1, 1907, (1785, 1786).

The Aecidium on Fraxinus known as *A. Fraxini* Schw. was first shown by Arthur (Bot. Gaz. 29:275. 1900) to have telia on *Spartina cynosuroides.* He obtained the development of aecia on *F. viridis* following sowings of telial material from Iowa and Nebraska. In 1904, 1905, 1907 and 1909 (Jour. Myc. 11:57. 1905; 12:16. 1906; 14:14. 1908; Mycol. 2:225. 1910) similar results were obtained on *F. lanceolata* using telia from Iowa, Kansas, Nebraska and North Dakota.

In 1908 the writer sent telial material collected at Lewes on *S. cynosuroides* and *S. stricta* to Dr. Arthur for culture work. Successful infection of *F. lanceolata* with development of aecia was obtained from cultures with telia from both hosts.

61. Puccinia Helianthi-mollis (Schw.) Jackson, Brooklyn Bot. Gard. Mem. 1:250. 1918.

Aecidium Helianthi-mollis Schw. Schr. Nat. Ges. Leipzig 1:68. 1822.

Puccinia Helianthi Schw. Schr. Nat. Ges. Leipzig 1:73. 1822.

On Carduaceae:

Helianthus annuus L., Newark, Sept. 1907, (2006).

Helianthus angustifolius L., Selbyville, Oct. 4, 1907, (1993).

Helianthus decapetalus L., Newark, Sept. 7, 1905, (1553, 1624), Aug. 23, 1907, (1724).

Carleton (Science 13:250. 1901) was the first in America to record culture experiments showing that the species is autoecious. These results were confirmed by Arthur (Bot. Gaz. 35:17. 1903) whose work indicates, however, that there may be biological races. Further evidence of this was obtained in 1903 (Jour. Myc. 10:12. 1904) and in 1904 (Jour. Myc. 11:53. 1905), on further evidence, the conclusion is made that "*P. Helianthi* Schw. is a single species having many races, for which *H. annuus* acts as a bridging host." Further cultural results were recorded in Jour. Myc. 12:18. 1906.

62. Puccinia Hibisciatum (Schw.) Kellerm. Jour. Myc. 9:110. 1903.

Cæoma Hibisciatum Schw. Trans. Am. Phil Soc. II, 4:293. 1834.

Aecidium Napaeae Arth. & Holw.; Arthur in Bull. Iowa Agr. Coll. 1884:166. 1885.

Aecidium Callirrhoes Ell. & Kellerm. Jour. Myc. 2:4. 1886.

Puccinia Muhlenbergiae Arth. & Holw. Bull. Lab. Nat. Hist. Univ. Iowa 5:317. 1902.

Puccinia tosta Arth. Bull. Torrey Club 29:228. 1902.

On Poaceae: II, III.

Muhlenbergia sobulifera (Muhl.) Trin.,—Wilmington, Oct. 26, 1891, A. Commons (1867).

Muhlenbergia Schreberi Gmel. (*M. diffusa* Willd.),—Newark, Sept. 1907, (1817, 1828).

Kellerman (Jour. Myc. 9:110, 232. 1903) was the first to conduct successful culture experiments leading to an understanding of the life history of this species. An extensive series of inoculations with telial material on *Muhlenbergia mexicana* from Ohio, in which many Malvaceous hosts were used, resulted in obtaining successful infection of *Hibiscus moscheutos* and *H. militaris* with production of typical aecia of *A. Hibisciatum* Schw.

Arthur in 1908 (Mycol. 1:251. 1909) first showed that this species also has for its aecial stage, *A. Napaeae* A. & H. Infection of *Callirrhoe involucrata*, resulting in aecia, was obtained following sowings of teliospores from *M. mexicana* from Kansas. These results were confirmed

in 1909 (Mycol. 2:226. 1910) using telial material on *M. glomerata* from Kansas and in 1910 (Mycol. 4:18. 1912) successful infection followed sowings with teliospores from *M. racemosa* collected in North Dakota.

In 1914 (Mycol. 7:80. 1915) Arthur also showed that *Puccinia tosta* on *Sporobolus asperifolius* has for its aecial stage, *Aecidium Sphaeralceae*. Successful infection of *Sphaeralcea incana* was obtained following sowings of telial material from New Mexico. Infection of *S. lobata* was also obtained when telial material from Texas was used. A comparison of the aecia and of the telia showed *P. tosta* to be inseparable from the form of Muhlenbergia.

63. Puccinia Hieracii (Schum.) Mart. Flora Mosq. 226. 1817.
Uredo Hieracii Schum. Enum. Plant. Saell. 2:232. 1803.
On Cichoriaceae:
Hieracium scabrum Michx., Newark, Sept. 5, 1905, (1623); Lewes, April 25, 1908, (2035).

64. Puccinia Impatientis (Schw.) Arth. Bot. Gaz. 35:19. 1903.
Aecidium Impatientis Schw. Schr. Nat. Ges. Leipzig 1:67. 1822.
Puccinia perminuta Arth. Bull. Torrey Club 34:584. 1907.
On Balsaminaceae: I.
Impatiens aurea Muhl., Newark, June 17, 1907, (1664).
On Poaceae: II, III.
Agrostis hyemalis (Walt.) B. S. P., Seaford, June 4, 1908, (2045).
Agrostis perrenans (Walt.) Tuckerm. Woodland Beach, Aug. 1890, J. H. Holmes (Phan. spec. 312).
Elymus canadensis L., Newark, Aug. 23, 1907, II, (1722).

Arthur has shown that *Aecidium Impatientis* Schw. is connected with a telial form on *Elymus virginicus* L. which previously had been called *P. rubigo-vera* (Bot. Gaz. 35:18. 1903). He obtained the development of aecia on *Impatiens aurea* following inoculation with germinating teliospores on *Elymus virginicus* from Indiana. Further cultures made in 1903 and 1904 (Jour. Myc. 10:11. 1904; 11:57. 1905) gave identical results when telial material from Indiana and Wisconsin were used for inoculation. In 1909 (Mycol. 2:226. 1910) teliospores from *Elymus striatus* were used by Arthur to successfully inoculate *Impatiens*

aurea. Uredinia were also obtained on *E. virginicus*, *E. canadensis*, and *E. striatus* following infection with aeciospores from *Impatiens aurea*.

65. Puccinia Iridis (DC.) Wallr. Rabh. Krypt. Fl. Ed. 1, 1:23. 1844.
Uredo Iridis DC. Encycl. 8:224. 1808.

On Iridaceae:

Iris versicolor L., Newark, July 24, 1906, (1565).

The life history of this common rust is still in doubt, only uredinia and telia are known.

66. Puccinia Lobeliae Ger. Bull. Buffalo Soc. Nat. Sci. 1:68. 1873.

On Campanulaceae:

Lobelia puberula Michx., Wilmington, Sept. 1893, A. Commons, (issued also in E. & E. Fungi Columb. 261); Newark, Sept. 8, 1893, A. Commons, (2213).

Lobelia syphilitica L., Lewes, Aug. 14, 1907, (1696), August, 1907, (2242).

67. Puccinia lysimachiata (Link) Kern, Mycol. 9:215. 1917.
Aecidium Lysimachiae Schw. Schr. Nat. Ges. Leipzig 1:67. 1822.
Caeoma lysimachiatum Link, in Willd. Sp. Pl. 6²:45. 1825.
Puccinia Limosae Magn. Amtl. Ber. Vers. Deutsch. Naturf. u. Aerzte 1877:200. 1877.

On Primulaceae: I.

Lysimachia terrestris (L.) B. S. P., Seaford, June 5, 1908, (2084).

Klebahn (Jahr. Wiss. Bot. 34:396. 1910) has shown that the European *A. Lysimachiae* Schlecht. is genetically connected with *P. Limosae* Magn. He succeeded in obtaining infection resulting in the development of urediniospores on *Carex limosa* following sowings with aeciospores from *Lysimachia thyrsiflora* and *L. vulgaris*. No cultures have been conducted in America, but since no essential morphological difference can be detected in the aecia and several collections on Carex have been recognized by Arthur which agree with European material referred to *P. Limosae*, there seems to be no good reason for considering the American form distinct from the European.

68. Puccinia macrospora (Pk.) Arth. Mycol. 1:244. 1909.
Aecidium macrosporum Pk. Ann. Rep. N. Y. State Mus. 23:61. 1873.
On Smilaceae: I.
Smilax rotundifolia Seaford, July 9, 1907, (1651); Lewes, Aug. 14, 1907; June 6, 1908, (2089); Townsend, June 11, 1890; A. Commons (1437); Newark, July 1891, A. Commons (Distributed in E. & E. N. A. Fungi 2708).
On Cyperaceae: II, III.
Carex comosa Boott, Lewes, Aug. 14, 1907, II, (1686), Nov. 16, 1907, III, (1853).

As noted above, on Aug. 14, 1907, the writer collected the uredo stage of a rust on Carex comosa at Lewes. Nearby was a vine of *Smilax rotundifolia* bearing aecia of *Aecidium macrosporum* Pk. *Aecidium Nesaeae* Ger. on *Decodon verticillata* was also collected at Lewes in the immediate vicinity of the rust on *Carex comosa*.

The material collected was sent to Dr. Arthur, who stated that the form on *Carex comosa* probably represented an undescribed species. A trip to the same vicinity was made at Dr. Arthur's request in November 1907 for the purpose of collecting this and other forms for culture work. Telia were collected on *Carex comosa* at that time, showing the form to be a Puccinia. The following spring Dr. Arthur (Mycol. 1:243. 1909) sowed this on various hosts, including *Smilax hispida* and the typical aecia of *Aecidium macrosporum* Pk. were produced.

69. Puccinia malvacearum Bert. Gay's Hist. de Chile 8:43. 1852.
On Malvaceae:
Althaea rosea Cav., Newark, Oct. 16, 1909, J. Taubenhaus.
Malva rotundifolia L., Newark, May 24, 1913, Julia Clark, May 25, 1916, C. O. Houghton.

70. Puccinia marylandica Lindr. Medd. f. Stockh. Hogsk. Bot. Inst. 4:(2). 1901.
On Ammiaceae:
Sanicula canadensis L., Collins Beach, Oct. 1, 1907, (1815).

71. Puccinia Menthae Pers. Syn. Fung. 227. 1801.
On Labiatae:
Koellia mutica (Michx.) Britt., Clayton, July 24, 1907, (1709).
Monarda punctata L., Seaford, July 9, 1907.

72. Puccinia minutissima Arth. Bull. Torrey Club 34:587. 1907.

Aecidium Nesaeae Ger. Bull. Torrey Club 4:47. 1873. (Not *P. Nesaeae* E. & E. 1895.)

On Lythraceae: I.

Decodon verticillata (L.) Ellis, Seaford, July 9, 1907, (2256); Lewes, Aug. 14, 1907, (1690).

The Aecidium on Decodon was shown by Arthur in 1914 (Mycol. 7:86. 1915) to be the aecial stage of *P. minutissima*. Typical aecia were developed on Decodon, following inoculation with telial material on *Carex filiformis* from Ontario. The telial stage has not been found in Delaware and has apparently been collected but rarely. Species referred here in the Arthur herbarium occur on *C. teretiuscula*, *C. filiformis* and *C. aquatilis*.

73. Puccinia Nesaeae Ell. & Ev. Bull. Torrey Club 22:363. 1895. (Not *Aecidium Nesaeae* Ger. 1873.)

Aecidium Ludwigiae E. & E. Proc. Phil. Acad. 1893:155. 1893.

Puccinia Ludwigiae Holw. N. A. Ured. 1[3]:72. 1907. (Not *P. Ludwigiae* Tepper 1890.)

Allodus Ludwigiae Orton, Mem. N. Y. Bot. Gard. 6:189. 1916.

On Onagraceae: I.

Ludwigia sphaerocarpa Ell., Ellendale, Sept. 1, 1892, A. Commons, (1983).

This collection is the type of *Aecidium Ludwigiae* E. & E. The name here used for this species was applied by Ellis and Everhart to a rust thought to be on Necium (Decodon). The host has been shown by Holway (l. c.) to be *Ludwigia polycarpa*. The name has frequently been misapplied to *Aecidium Nesaeae* Ger. on Necium which has been shown by Arthur (Mycol. 7:86. 1915) to be the aecial stage of *P. minutissima* (c. f. 67).

The rust is evidently an opsis form. Telia have been rarely collected, occurring in the Arthur herbarium only on *L. polycarpa* from Iowa and on *L. virgata* from Florida.

74. Puccinia nolitangeris Corda, Icones 4:16. 1840.

Puccinia argentata Wint. Rabh. Krypt. Fl. 1[2]:194. 1881.

On Balsaminaceae: III.

Impatiens biflora Wald., Newark, Sept. 7, 1905; Sept. 15, 1906; Sept. 1907; (1552, 1535, 2005).

Bubak (Cent. Bakt. 10^2:574. 1903) has shown by cultures that the European *P. argentata* has its aecial stage on *Adoxa moschatellina*. Arthur in 1910 (Mycol. 4:20. 1912) successfully infected *Impatiens aurea* by sowing with aeciospores from *Adoxa moschatellina* collected in Iowa, thus proving the American and European rusts are the same.

75. Puccinia obtecta Pk. Bull. Buffalo Soc. Nat. Hist. 1:66. 1873.

Aecidium compositarum Bidentis Burrill; DeToni, in Sacc. Syll. Fung. 7:799. 1888.

On Cyperaceae:

Scirpus fluviatilis (Torr.) A. Gray? Wilmington, Nov. 5, 1885, A. Commons (1076).

Scirpus americanus Pers., Wilmington, Oct. 11, 1889, A. Commons (1026).

Arthur in 1907 (Jour. Myc. 14:20. 1908) has shown that *P. obtecta* Pk. has its aecial stage on Bidens. Successful sowings of teliospores from *A. americanus* collected in Indiana were made on *B. frondosa* and *B. comata*.

76. Puccinia orbicula Pk. & Curt. Ann. Rep. N. Y. State Mus. 30:53. 1879.

On Cichoriaceae:

Nabalus sp., Newark, 1907, M. T. Cook.

77. Puccinia Pammelii (Trel.) Arth. Jour. Myc. 11:56. 1905.

Puccinia Panici Diet. Erythea 3:80. 1895.

Aecidium Pammelii Trel. Trans. Wis. Acad. Sci. 6:136. 1885.

On Poaceae:

Panicum virgatum L., Selbyville, Oct. 4, 1907, (1789).

Stuart (Proc. Ind. Acad. Sci. 1901:284. 1902) shows by cultures that *Aecidium Pammelii* on *Euphorbia corollata* is the aecial stage of *P. panici*. These results were confirmed by Arthur in 1904 and 1905 (Jour. Myc. 11:56. 1905; 12:16. 1906) by sowing telial material on *P. virgatum* from Indiana, on *E. corollata* with resulting infection and development of aecia. In 1907 (Jour. Myc. 14:16. 1908) successful infection on *E. maculata* was obtained following sowings of teliospores from the same host collected in Nebraska. At the same time negative results were obtained on *E. corollata*. These results indicate the presence of physiological races in this species.

78. Puccinia Pimpinellae (Strauss) Mart. Fl. Mosq. Ed. II:226. 1817.

Uredo Pimpinellae Strauss, Wettst. Ann. 2:102. 1810.

Aecidium Osmorrhizae Pk. Ann. Rep. N. Y. State Mus. 24:92. 1872.

Puccinia Osmorrhizae C. & P.; Peck in Ann. Rep. N. Y. State Mus. 29:73. 1878.

On Ammiaceae:

Washingtonia brevistylis DC., Newark, May 2, 1907, I (1575), May 29, 1907, III, (1659).

79. Puccinia poculiformis (Jacq.) Wettst. Verhl. Zool.-Bot. Ges. Wien 35:544. 1885.

Lycoperdon poculiforme Jacq. Coll. Austr. 1:122. 1786.

Aecidium Berberidis Pers. in J. F. Gmel Syst. Nat. 2:1473. 1791.

Puccinia graminis Pers. Neues Mag. Bot. 1:119. 1794.

Puccinia Phlei-pratensis Erikss. & Henn. Zeit. f. Pflanzenkr. 4:140. 1894.

On Poaceae:

Agrostis alba L., Newark, Aug. 23, 1907, (1715, 1713).

Phleum pratense L., Newark, Aug. 23, 1907, (1720).

Triticum vulgare L., Newark, Aug. 23, 1907, (1721).

DeBary (Monatsber. K. Akad. d. Wiss. Berlin 25. 1865) was the first to show that the well known *Puccinia graminis* developed its aecial form on Berberis. In 1864 he first sowed telia from *Agropyron repens* and *Poa pratensis* on leaves of Berberis resulting in the development of pycnia and aecia. He later (1865) infected *Secale cereale* by sowing aeciospores from Berberis. This is the first record of the connection of two stages of an heteroecious rust by inoculation. Since DeBary's first publication of the life history of this species a large number of mycologists in all parts of the world have conducted culture work confirming DeBary's results and adding to our knowledge of the species. For a review of this work see Klebahn (Die Wirtswechs Rostpilze Berlin 205-235. 1904).

In America the most important work has been conducted by Carleton (Div. Veg. Phys. & Path. U. S. D. A. Bull. 16. 1899; Bur. Pl. Ind. U. S. D. A. Bull. 63. 1904); Arthur (Jour. Myc. 8:53. 1902; 11:57.

1905; 12:17. 1906; 13:198. 1907; 14:16. 1908; Mycol. 2:227. 1910; 4:18. 1912); Freeman & Johnson (Bur. Pl. Ind. U. S. D. A. Bull. 216. 1911); Stakman (Minn. Exp. Sta. Bull. 138. 1914; Jour. Agr. Research 4:193-199. 1915); Stakman and Piemeisel (Jour. Agr. Research 6:813-816. 1916; 10:429-495. 1917).

80. Puccinia Podophylli Schw. Schrift. Nat. Ges. Leipzig 1:72. 1822.

On Berberidaceae:

Podophyllum peltatum L., Newark, May 1890, F. D. Chester, May 15, 1906, I, (1621), June 19, 1907, III, (1660); Hockessin, May 5, 1913; C. O. Houghton.

81. Puccinia Polygoni-amphibii Pers. Syn. Meth. Fungi 227. 1801.

Aecidium Geranii-maculati Schw. Schr. Nat. Ges. Leipzig 1:67. 1822.

Aecidium Sanguinolentum Lindr. Bot. Not. 1900:241. 1900.

On Geraniaceae: I.

Geranium maculatum L., Wilmington, June 29, 1893, A. Commons (2099).

On Polygonaceae: II, III.

Persicaria muhlenbergii (S. Wats.) Small (*Polygonum emersum* (Michx.) Britton), Wilmington, Aug. 17, 1886, A. Commons (297).

Persicaria pennsylvanicum (L.) Small (*Polygonum pennsylvanicum* L.), Newark, Sept. 17, 1890, F. D. Chester.

Dr. Tranzschel first showed (Centr. f. Bakt. 11^2:106. 1903) that this species on Polygonum was connected with *Aecidium Sanguinolentum* on Geranium sp. These results were confirmed in America by Arthur (Jour. Myc. 11:59. 1905) who used aeciospores from *Geranium maculatum* to inoculate *Polygonum emersum*. Uredinia and telia developed from this culture. In 1905 (Jour. Myc. 12:18. 1906) these results were confirmed by successfully sowing teliospores from *Polygonum emersum* on *Geranium maculatum* resulting in the typical aecia of *A. Sanguinolentum*. These results prove that the European and American rusts referred to this species are identical.

82. Puccinia Polygoni-Convolvuli Hedw. f., Poiret. Encycl. Meth. Bot. 8:251. 1808.

Puccinia Polygoni A. & S. Consp. Fung. 132. 1805. (Not *P. Polygoni* Pers. 1794.)

On Polygonaceae:

Polygonum Convolvulus L., Lewes, Aug. 14, 1907, II, (1692).

83. Puccinia pustulatum (Curtis) Arth. Jour. Myc. 10:18. 1904.

Aecidium pustulatum Curtis; Peck, Ann. Rep. N. Y. State Mus. 23:60. 1873.

On Poaceae:

Schizachyrium scoparium (Michx.) Nash (*Andropogon scoparius* Michx.), Seaford, Nov. 15, 1907, (1760).

This species of Andropogon rust is difficult to separate from *P. Andropogonis* Schw. In the latter, however, the uredospore markings are finely verrucose-echinulate with the pores 3-4 scattered (rarely appearing equatorial) while in the form here considered the uredospore markings are of the echinulate type and the pores 4-6 scattered.

The life history of this heteroecious rust was first determined by Arthur in 1903 (Jour. Myc. 10:17. 1904). He sowed germinating teliospores from *Andropogon furcatus* and *A. scoparius* collected in Indiana on *Comandra umbellata* and obtained the development of pycnia and aecia of *Aecidium pustulatum*. These experiments were successfully verified in 1905 and 1910 (Jour. Myc. 12:16. 1906; Mycol. 4:17. 1912) using telial material on *A. furcatus* from Indiana and Colorado.

84. Puccinia recedens Syd. Monog. Ured. 1:146. 1902.

On Carduaceae:

Senecio aureus L., Naaman's Creek, July 28, 1893, A. Commons (2129).

This species has previously been confused with *P. Asteris* Duby.

It is a micro-Puccinia common on *Senecio aureus* in the northeastern United States. It is known on other hosts from the Atlantic to the Pacific in the more northern states.

85. Puccinia Rhamni (Pers.) Wettst. Verhl. Zool-Bot. Ges. Wein. 35:545. 1885.

Aecidium Rhamni Pers. in Gmel. Syst. Nat. 2:1472. 1791.

Puccinia coronata Corda, Icones 1:6. 1837.

On Poaceae:

Avena sativa L., Newark, July 17, 1903, C. O. Smith; Clayton, July 24, 1907, (1708).

This species is the common coronate spored rust and occurs throughout the United States on cultivated oats and on a great variety of native grasses. DeBary (Monat. Akad. Wiss. 211. 1866.) was the first to conduct culture experiments indicating the genetic connection with aecia on Frangula and Rhamnus in Europe. Since that time many European authors have conducted culture experiments, a summary of which has been made by Klebahn (Wirtw. Rostp. 254-262. 1904).

In America this species has been studied by Carleton (Div. Veg. Phys. & Path. 16:48. 1899), who obtained uredinia on cultivated oats, *Arrhenatherum elatius* and *Phalaris caroliniana* by sowing aeciospores from *Rhamnus lanceolata*. Carleton also carried out extensive cross inoculations between oats and many native grasses. (See also Bur. Pl. Ind. Bull. 63:15. 1904.)

At about the same time Arthur (Bull. Lab. Nat. Hist. State Univ. Iowa 4:398. 1898) obtained infection on oats with aeciospores from *R. lanceolata*. In 1904 the same author (Jour. Myc. 11:58. 1905) successfully confirmed the results of European and other investigators by sowing aeciospores from *Rhamnus cathartica, R. caroliniana, R. lanceolata* on *Avena sativa* resulting in the production of urediniospores in all cases. In 1910 the same author (Mycol. 4:18. 1912) successfully infected *Rhamnus cathartica* by sowing teliospores from *Calamagrostis canadensis* from Nova Scotia.

86. Puccinia rubella (Pers.) Arth. Bot. Gaz. 34:15. 1902.

Aecidium rubellum Pers. in Gmel. Syst. Nat. 2:1473. 1791.

Uredo Phragmites Schum. Enum. Pl. Saell. 2:231. 1803.

Puccinia Phragmites Koern. Hedwigia 15:179. 1876.

On Poaceae:

Phragmites Phragmites (L.) Karst., Wilmington, Nov. 1, 1893, A. Commons (2364).

Winter (Hedwigia 14:115. 1875) was the first to show the relation between *Puccinia Phragmites* and *Aecidium rubellum*. He successfully infected *Rumex hydrolapathum* with sporidia from Phragmites. He also infected the latter host, using aeciospores. These results have been

confirmed by several European investigators. The summary of their results will be found in Klebahn (Die Wirtsw. Rostp. 283. 1904).

Arthur in 1899 (Bot. Gaz. 29:269. 1900) produced aecia on *Rumex crispus* and *R. obtusifolius* with sowings of teliospores from *P. Phragmites*. These results have been repeatedly confirmed by the same author and reported in Jour. Myc. 9:220. 1903; 14:15. 1908; and Mycol. 2:225. 1910; 4:54. 1912.

Bates (Jour. Myc. 9:219. 1903) made some interesting field cultures and observations on the natural occurrence of the aecial stage on Rheum and Rumex (3 species) lending confirmatory evidence to the results of previous investigators.

87. Puccinia Sambuci (Schw.) Arth. Bot. Gaz. 35:15. 1903.

Aecidium Sambuci Schw. Schr. Nat. Ges. Leipzig 1:67. 1822.

Puccinia Bolleyana Sacc. Am. Microsc. Jour. 169. 1889.

Puccinia Atkinsoniana Diet. in Atk. Bull. Cornell Univ. 3:19. 1897.

Puccinia Thompsonii Hume, Bot. Gaz. 29:353. 1900.

On Caprifoliaceae: I.

Sambucus canadensis L., Seaford, July 9, 1907, (1650), April 23, 1908, (2022).

Sambucus pubens Michx., Newark, June 9, 1907, (1665).

On Cyperaceae: II, III.

Carex bullata Schk., Seaford, June 4, 1908, (2083).

Carex lurida Wahl., Newark, Aug. and Sept., 1907, (171b, 1819); Felton, Sept. 5, 1907, (1738); Collins Beach, Oct. 1, 1907, (1788); Seaford, Nov. 14, 1907, (1767, 1858); June 5, 1908, (2082).

Arthur in 1901 conducted culture experiments (Jour. Myc. 8:55. 1902) proving that *Aecidium Sambuci* on *Sambucus canadensis* was specifically connected with *Puccinia Bolleyana* on *Carex trichocarpa*. In 1902 further experiments were conducted (Bot. Gaz. 35:14. 1903) confirming the above results and showing that *Puccinia Atkinsoniana* on *Carex lurida* is also a synonym and has its aecial stage on Sambucus. See also the results of culture work in 1904 (Jour. Myc. 11:58. 1905) and 1905 (Jour. Myc. 12:14. 1906) and 1906 (Jour. Myc. 13:195. 1907) in which *Carex lupulina* and *C. Frankii* are definitely proven to bear telia of *P. Sambuci*. The results of 1902 were confirmed in 1908 (Mycol. 1:233.

1909). Kellerman (Jour. Myc. 9:7. 1903) confirmed Arthur's results as to the connection of *Aecidium Sambuci* with *P. Atkinsoniana* on *Carex lurida* and with *P. Bolleyana* on *C. trichocarpa*.

88. Puccinia Smilacis Schw. Schr. Nat. Ges. Leipzig 1:72. 1822.
Aecidium Smilacis Schw. Schr. Nat. Ges. Leipzig 1:69. 1822.
On Smilaceae:
Smilax glauca Walt., Selbyville, Oct. 4, 1907, (1752).
Smilax rotundifolia L., Newark, October 1907, (2007); Collins Beach, Oct. 1, 1907, (1816); Selbyville, Oct. 4, 1907, (1754).

This is an autoecious long cycle rust common throughout the eastern United States. No aecial collections have been made in Delaware. The aecia may be distinguished from the aecia of *Puccinia macrospora* (Pk.) Arth., which occur on Smilax in the same range, by the size of the aeciospores. In *P. Smilacis* the aeciospores are 17-22x20-30μ with the walls 1-1.5μ while the aecispores of *P. macrospora* measure 32-42x37-51μ with thick walls 1.5-2.5μ, thickened above to 5-10μ.

89. Puccinia Sorghi Schw. Trans. Am. Phil. Soc. II. 4:295. 1832.
Puccinia Maydis Bereng. Atti Sci. Hal. 6:475. 1844.
Aecidium Oxalidis Thüm. Flora 59:425. 1876.
On Poaceae:
Zea Mays L., Faulkland, Sept. 8, 1885, A. Commons (210); Newark, Sept. 17, 1890, F. D. Chester; Sept. 1907; Felton, Sept. 5, 1907, (1735).

The corn rust is very common in Delaware and has been repeatedly observed but apparently does little damage.

Arthur in 1904 (Bot. Gaz. 38:64. 1904; Jour. Myc. 11:65. 1905) shows that the corn rust has its aecial stage on Oxalis. These results were confirmed in 1905 by the same author (Jour. Myc. 12:17. 1906) who successfully infected corn with aeciospores from *Oxalis cymosa*.

90. Puccinia subnitens Diet. Erythea 3:81. 1895.
On Chenopodiaceae: I.
Atriplex hastata L., Lewes, April 1908, (2041), June 6, 1908, (2038).
On Cruciferous seedling: I.
Lewes, April 23, 1908, (2025).

On Polygonaceae: I.

Polygonum aviculare L., Lewes, April 25, 1908, (2020).

On Poaceae: II, III.

Distichlis spicata (L.) Greene, Lewes, Aug. 14, 1907, (1677), Nov. 16, 1907, (1854, 1855), April 25, 1908, (2021), June 6, 1908, (2039).

Arthur (Bot. Gaz. 35:19. 1903 first showed that the above species has its aecial form on Chenopodiaceae having produced aecia on *Chenopodium album* by sowings of teliospores from *Distichlis spicata*. In 1904 (Jour. Myc. 11:54. 1905) he records successful infection results on *Chenopodium album, Cleome spinosa, Lepidium apetalum, L. virginicum, Sophia incisa, Erysimum asperum*, from sowings of teliospores from *Distichlis spicata*. This is remarkable since the above hosts represent three distinct families of flowering plants.

In 1905 (Jour. Myc. 12:16. 1906) *Bursa Bursa pastoris* is added to the above list, since aecia were produced following sowings of teliospores from *Distichlis spicata*. Further results are recorded by the same author in 1906 (Jour. Myc. 13:197. 1907) and in 1907 (Jour. Myc. 14:15. 1908).

In 1908 Arthur records successful infection on *Chenopodium album* resulting from sowings of teliospores from *Distichlis spicata* collected at Lewes, Del., and sent to Dr. Arthur by the writer (Mycol. 1:234. 1909). Cultures from Nebraska made in the same year were successful on *C. album*. Material from Nevada successfully infected *C. album, Atriplex hastata*, and *Sarcobatus vermiculatus*.

Further culture work with this species is recorded by Arthur in Mycol. 2:225. 1910; 4:18. 1912. (See also Bethel, Phytopath. 7:92-94. 1917.)

91. Puccinia Taraxaci (Rebent.) Plowr. Brit. Ured. and Ust. 186. 1889.

Puccinia Phascoli var. *Taraxaci* Rebent. Fl. Neomarch 256. 1804.

On Cichoriaceae:

Taraxacum Taraxacum (L.) Karst., — Newark, July 1907, (1671).

This is doubtless a brachy-form though no pycnia have yet been demonstrated to accompany the primary uredinia. Cultures will be

necessary to determine its life history with certainty. It seems probable that the uredinia are able to carry the fungus over the winter.

92. Puccinia triticina Erikss. Ann. Sci. Nat. VIII, 9:270. 1899.

On Poaceae:

Triticum vulgare L., Newark, July 2, 1907, (1882), June 21, 1907, (1662).

This is the common leaf rust of wheat found in all parts of the United States as well as in most sections of the world where wheat is cultivated. The life history is unknown. It is a sub-epidermal form and is morphologically very similar to leaf rusts on wild grasses commonly referred to *P. tomipara* and *P. Agropyri* (*P. clematidis* (DC.) Lagerh.), having aecia on Thalictrum, Clematis and other Ranunculaceous hosts.

93. Puccinia urticata (Lk.) Kern, Mycologia 9:214. 1917.

Aecidium Urticae Schum. Enum. Pl. Saell. 2:222. 1803.

Caeoma urticatum Link, in Willd. Sp. Pl. 6^2:62. 1825.

Puccinia Urticae Lagerh. Mitt. Bad. Ver. 2:72. 1889. (Not *P. Urticae* Barcl. 1887.)

On Cyperaceae: II, III.

Carex stricta Lam., Seaford, April 23, 1908, (2029).

Magnus in 1872 (Vehr. Bot. Ver. Prov. Brandbg. 14:1872.) first showed that *Aecidium Urticae* on *Urtica dioica* was the aecial stage of *P. Caricis* (Schum.) Rebent. on *Carex hirta*. Many other European investigators have repeated this work with additional hosts, including Schroeter, Cornu, Plowright, Ed. Fischer and Klebahn. A general review is given by Klebahn (Wirtsw. Rostp. 293. 1904).

In America Arthur (Bot. Gaz. 29:270. 1900) was the first to conduct successful cultures. He obtained the development of uredinia on *Carex stricta* by inoculating with spores of *Aecidium Urticae*.

Later cultures (Jour. Myc. 8:52. 1902; Bot. Gaz. 35:16. 1903) showed that aeciospores developed on Urtica gracilis following sowings of teliospores from *Carex stricta* collected in Nebraska and *C. riparia* from Iowa. In 1905 (Jour. Myc. 12:15. 1906) teliospores on *C. stipata* from Indiana and from *C. aquatilis* collected in Colorado, were used in successful cultures on *U. gracilis*. In 1907 (Jour. Myc. 14:14. 1908) Arthur again conducted successful sowings of teliospores from Indiana material on *C. stipata* and from Nebraska material on *C. riparia*. In

1909 the same author (Mycol. 2:223. 1910) used teliospores from *C. aristata* from North Dakota to successfully infect *U. gracilis* with production of aecia. In 1910 (Mycol. 4:17. 1912) the results of 1909 were repeated and successful sowings on *U. gracilis* were again made by using Indiana material to infect *U. gracilis*.

Kellerman in 1902 (Jour. Myc. 9:9. 1903) was also successful in obtaining infection on *U. gracilis* by using telial material on *C. riparia* and *C. stricta* from Ohio.

94. Puccinia Violae (Schum.) DC. Fl. Fr. 6:62. 1815.
Aecidium Violae Schum. Enum. Pl. Saell. 2:224. 1803.
On Violaceae:
Viola affinis LeConte, Newark, May 15, 1906, I, (1622).
Viola Labradorica Schw. (?), Faulkland, Aug. 1, 1884, II, III, A. Commons, (193).
Viola lanceolata L., Selbyville, Oct. 4, 1907. (1938).

95. Puccinia Windsoriae Schw. Trans. Am. Phil. Soc. II 4:295. 1832.
Aecidium Ptelcae Berk. & Curtis; Berkeley, Grevillea 3:60. 1874.
On Poaceae: II, III.
Tricuspis sesleriodes (Michx.) Torr., Lewes, Nov. 16, 1907, (1852); Newark, Oct. 16, 1907, (1834).

This species has been shown to be connected with *Aecidium Ptelcae* on *Ptelea trifoliata* by Arthur in 1899 (Bot. Gaz. 29:273. 1900). He succeeded in obtaining the development of typical uredinia of this species on *Tricuspis sesleriodes* by inoculating with aeciospores of *Aecidium Ptelcae* from Indiana. These results were confirmed in 1902 (Bot. Gaz. 35:16. 1903) and again in 1904 (Jour. Myc. 11:56. 1905).

96. Puccinia Xanthii Schw. Schr. Nat. Ges. Leipzig 1:73. 1822.
On Ambrosiaceae:
Ambrosia trifida Mill., Newark, Sept. 15, 1905, (1556); July 26, 1906, (1616); Aug. 23, 1907, (1723).
Xanthium sp., Newark, Sept. 15, 1905, (1540); Lewes, Aug. 14, 1907, (1691).

This common species is a lepto-form possessing telia only in the life history.

Carleton (Bur. Pl. Ind. U. S. D. A. Bull. 63:26. 1904) in 1897 and 1898 conducted culture experiments showing that this species is auto-

ecious. He repeatedly infected Xanthium seedlings by inoculating with teliospores from same host but was unable to infect *Ambrosia trifida*. He believes this species to be distinct from the form on *Ambrosia trifida*.

In 1905 and 1906 Arthur (Jour. Myc. 12:20. 1906; 13:198. 1907) confirmed Carleton's work. He also failed to infect *Ambrosia trifida* with spores from Xanthium. No pycnia have been found in herbarium specimens nor did they develop in the cultures recorded above.

It is evident from these culture experiments that we have here a rust, while morphologically indistinguishable on the two host genera, yet exists in two independent races.

97. Ravenelia epiphylla (Schw.) Dietel, Hedwigia 33:27. 1894.
Sphaeria epiphylla Schw. Schr. Nat. Ges. Leipzig 1:40. 1822.
On Fabaceae:
Cracca virginiana L., Townsend, June 11, 1890, A. Commons (1438).

98. Tranzschelia punctata (Pers.) Arth. Result Sci. Congr. Bot. Vienna 340. 1906.
Aecidium punctatum Pers. Ann. Bot. Usteri 20:135. 1796.
Puccinia Pruni-spinosae Pers. Syn. Fung. 226. 1801.
On Ranunculaceae: I.
Anemone quinquefolia L., Newark, May 8, 1897, F. D. Chester, May 10, 1907, (1656).
Hepatica Hepatica (L.) Karst, Faulkland, May 3, 1884, A. Commons, Newark, May 22, 1907, (1566), May 1908, (2254).
On Amygdalaceae: II, III.
Prunus serotina Ehrh., Greenbank, Aug. 24, 1886, A. Commons (26).

Dr. Tranzschel in 1904 (Trans. Mus. Bot. Acad. St. Petersb. 11:67-69. 1905) first showed that *Aecidium punctatum* on Anemone was the aecial stage of *P. Pruni-spinosae*. He succeeded in obtaining the characteristic uredinia of this species on *Amygdalus communis, Prunus spinosa* and *P. divaricata* following sowings with aeciospores from *Anemone coronaria*. Aecia on *Anemone ranunculoides* were also used to infect *Prunus spinosa* with similar results.

In America Arthur in 1905 (Jour. Myc. 12:19. 1906) showed that this species has its aecia on *Hepatica acutiloba* (*Aecidium Hepaticum*

Schw.) having successfully infected *Prunus serotina* with aeciospores from that host. These results were confirmed in 1906 (Jour. Myc. 13:199. 1907); a successful infection resulting in uredinia having been obtained on *P. serotina* and *P. pumila* following inoculation with aecia on Hepatica. Failure to obtain infection on *P. americana*, *P. cerasus* and *Amygdalus Persica*, however, indicates that in America at least there are distinct races.

It is probable that the uredinial spores are able to carry this species over the winter in some localities.

The aecial stage is perennial and the affected leaves are characteristically modified. On Hepatica the leaves stand upright and are much reduced in size and greatly thickened.

99. Uromyces appendiculatus (Pers.) Fries, Summa Veg. Scand. 514. 1849.

Uredo appendiculata Pers. Ann. Bot. Usteri 15:16. 1795.

Uromyces Phaseoli Wint. in Rab. Krypt. Fl. 1[1]:157. 1881.

Nigredo appendiculata Arth. Result. Sci. Congr. Bot. Vienna 343. 1906.

On Fabaceae:

Phaseolus vulgaris L., Lewes, Aug. 14, 1907, (1684); Newark, September 1905, (1632); Selbyville, Oct. 4, 1907, (1981).

Strophostyles helvola (L.) Britt., Lewes, Aug. 14, 1907, (1682); Felton, Sept. 5, 1907, (1736).

Strophostyles umbellata (Muhl.) Britt., Selbyville, October 4, 1907, (1987); Wilmington, Oct. 11, 1907, (1932).

That the above is an autoecious form was shown by Arthur in 1903 (Jour. Myc. 10:14. 1904). He cultured the form on *Strophostyles helvola*. Pycnia and aecia followed inoculation with over-wintered teliospores on the same host.

100. Uromyces Caladii (Schw.) Farl. Ellis, N. A. Fungi 232. 1879.

Aecidium Caladii Schw. Schr. Nat. Ges. Leipzig 1:69. 1822.

Uromyces Peltandrae Howe, Bull. Torrey Club 5:3. 1874.

Nigredo Caladii Arth. Result. Sci. Congr. Bot. Vienna 343. 1906.

On Araceae:

Arisaema dracontium Schott., Faulkland, June 4, 1885, A. Commons.

Arisaema triphyllum (L.) Schott., Newark, May 1892, I, F. D. Chester, May 15, 1906, (1619); Faulkland, July 18, 1885, III, A. Commons.

Peltandra virginica (L.) Kunth, Smyrna, June 9, 1894, A. Commons; Seaford, July 9, 1907, (1672, 1864); Lewes, Aug. 14, 1907, (2261); Wilmington, Oct. 11, 1907, (1931).

101. Uromyces caryophyllinus (Schrank.) Wint. in Rab. Krypt. Fl. 1^1:149. 1881.

Lycoperdon caryophyllinum Schrank. Baier. Fl. 2:668. 1789.

On Caryophyllaceae:

Dianthus caryophyllus L., Wilmington, Jan. 1909, C. O. Houghton.

102. Uromyces Eragrostidis Tracy, Jour. Myc. 7:281. 1893.

Nigredo Eragrostidis Arth. Result. Sci. Congr. Bot. Vienna 343. 1906.

On Poaceae:

Eragrostis pectinacea (Michx.) Steud., Selbyville, Oct. 4, 1907, (1792).

103. Uromyces fallens (Des.) Kern, Phytopathology 1:6. 1911.

Uredo fallens Desmaz. Pl. Crypt. 1325. 1843.

Nigredo fallens Arth. N. Am. Flora 7^3:254. 1912.

On Fabaceae:

Trifolium incarnatum L., Newark, spring 1905, C. O. Smith.

Trifolium pratense L., Newark, October 1888, F. D. Chester; Nov. 10, 1910, C. O. Houghton; Seaford, July 9, 1907, (1654); Clayton, July 24, 1907, (1710); Selbyville, Oct. 4, 1907 (1992).

The rust on red clover is widely distributed in the state and probably occurs wherever this host is cultivated. It is, however, rare on the crimson clover; only one other collection in America is known to the writer, and that was collected in South Dakota. This species is readily separated from the only other long cycled Uromyces on Trifolium occurring in North America by the uredinial pore characters. In the species under discussion the pores are 4-6, scattered, while in *U. Trifolii* the pores are 3-4 in an equatorial zone.

104. Uromyces graminicola Burrill, Bot. Gaz. 9:188. 1884.

Uromyces Panici Tracy, Jour. Myc. 7:281. 1893.

Nigredo graminicola Arth. Result Sci. Congr. Bot. Vienna 343. 1906.

On Poaceae:

Panicum virgatum L., Collins Beach, Oct. 1, 1907, (1779); Selbyville, Oct. 4, 1907, (1790).

This species is inseparable morphologically from *Puccinia Panici* Diet. except in the number of cells in the teliospore. The Puccinia has been studied culturally by Stuart (Proc. Ind. Acad. Sci. 1901:284. 1902) and Arthur (Jour. Myc. 11:56. 1905; 12:16. 1906; 14:16. 1908) and shown to be connected genetically with *Aecidium Pammelii* Trel. on *Euphorbia corollata* in Indiana and *E. marginata* in Nebraska. Aecia on various Euphorbiaceous hosts have also been referred to that species on morphological grounds.

While no cultures of the Uromyces have been successfully carried out, it is probable that the aecial stage will be found on some member of the Euphorbiaceae. The field evidence at present available suggests that *A. Stellingiae* Tracy & Earle, which occurs on various species of Stellingia and Sebastina in the south and southwest is a very probable aecial connection. This aecidium is morphologically indistinguishable from *A. Pammelii* and it is possible that some of the forms now referred to that species will be found to belong here.

105. Uromyces Halstedii DeToni in Sacc. Syll. Fung. 7:557. 1888.

Uromyces digitatus Halsted, Jour. Myc. 3:138. 1887. (Not *U. digitatus* Wint. 1886.)

Nigredo Halstedii Arth. N. Am. Flora 7[3]:226. 1912.

On Poaceae:

Homalocenchrus oryzoides (L.) Poll. (*Leersia oryzoides* (L.) Sw.), Seaford, April 23, 1908, (2034).

The aecial stage of this rather rare grass rust is at present unknown. The telial stage is known to the writer on the above host otherwise only from Wisconsin and South Dakota.

106. Uromyces Hedysari-paniculati (Schw.) Farl. Ell. N. A. Fungi 246. 1879.

Puccinia Hedysari-paniculati Schw. Schr. Nat. Ges. Leipzig 1:74. 1822.

Nigredo Hedysari-paniculati Arth. Result Sci. Congr. Bot. Vienna 343. 1906.

On Fabaceae:

Meibomia Dillenii (Darl.) Kuntze, Faulkland, Aug. 24, 1886, A. Commons (319); Newark, Sept. 10, 1905, (1626); Aug. 23, 1907, (1726).

Meibomia laevigata (Nutt.) Kuntze, Selbyville, July 18, 1895, A. Commons (946).

Meibomia Marylandica (L.) Kuntze, Felton, Sept. 5, 1907, (1748); Selbyville, Oct. 4, 1907, (1986).

Meibomia obtusa (Muhl.) Vail, Felton, Sept. 5, 1907, (1747).

Meibomia paniculata (L.) Kuntze, Felton, Sept. 5, 1907, (1745); Selbyville, Oct. 4, 1907, (1985); Lewes, Aug. 14, 1907, (1200); Newark, Aug. 23, 1907, (1714).

Meibomia stricta (Pursh) Kuntze, Selbyville, Oct. 4, 1907, (1984).

107. Uromyces houstoniatus (Schw.) J. Sheldon, Torreya 9:55. 1909.
Aecidium houstoniatum Schw. Tran. Am. Phil. Soc. II. 4:309. 1832.
Nigredo houstoniata Sheldon, Torreya 9:55. 1909.

On Rubiaceae:

Houstonia coerulea L., Newark, May 1908, I, (2267); Wilmington, May 31, 1914, C. O. Houghton.

Sheldon (l. c.) was the first to prove by culture experiments that *Aecidium houstoniatum* Schw. on *Houstonia coerulea* was genetically connected with a telial form occurring on *Sisyrinchium gramineum*. Arthur (Mycologia 1:237. 1908) confirms Sheldon's work using living plants of *Houstonia coerulea* bearing aecia collected by the writer at the above noted locality near Newark, and sent to Dr. Arthur at his request for that purpose. A search was made for the telial stage in the field but without success. The telia have been collected only in Maine and West Virginia.

108. Uromyces Howei Pk. Ann. Rep. N. Y. State Mus. 30:75. 1879.

On Asclepiadaceae:

Asclepias pulchra Shrk., Newark, Sept. 14, 1905, (1631).

Asclepias Syriaca L., Wilmington, August 1894, A. Commons (issued as E. & E. Fungi Columb. 648); Newark, Sept. 7, 1905, (1551); Wilmington, Oct. 11, 1907, (1930).

The life history of this common species is in doubt. It seems probable that it is autoecious though no aecia have ever been collected. Attempts to culture this species have been unsuccessful owing to a failure of the teliospores to germinate. In future study of this species it should be borne in mind that the species may be heteroecious or a brachy-form.

109. Uromyces Hyperici-frondosi (Schw.) Arth. Bull. Minn. Acad. Nat. Sci. 2²:15. 1883.

Aecidium Hyperici-frondosi Schw. Schr. Nat. Ges. Leipzig 1:68. 1822.

Nigredo Hyperici-frondosi Arth. Result Sci. Congr. Bot. Vienna 344. 1906.

On Hypericaceae:

Hypericum mutilum L., Felton, Sept. 5, 1907, (1751); Selbyville, Oct. 4, 1907, (1991).

Triandeum virginicum (L.) Raf., Selbyville, Oct. 4, 1907, (2247).

110. Uromyces Junci-effusi Sydow, Monog. Ured. 2:290. 1910.

Nigredo Junci-effusi Arth. N. Am. Flora 7³:239. 1912.

On Juncaceae:

Juncus effusus L., Newark, Oct. 14, 1905, (1537); Clayton, July 24, 1907, (1703); Collins Beach, Oct. 1, 1907, (1779).

This species is common throughout the eastern United States on this host and is separated from *U. Silphii* on Juncus by the presence of 3-4 equatorial germ pores in the uredospores. In the latter there are but 2 pores arranged slightly above the middle.

111. Uromyces Lespedezae-procumbentis (Schw.) Curt. Cat. Pl. N. Car. 123. 1867.

Puccinia Lespedezae-procumbentis Schw. Schr. Nat. Ges. Leipzig 1:73. 1822.

Nigredo Lespedezae-procumbentis Arth. N. Am. Flora 7:247. 1912.

On Fabaceae:

Lespedeza frutescens (L.) Britton, Felton, Sept. 5, 1907, III, (1749); Selbyville, Oct. 4, 1907, III, (1983); Newark, Sept. 11, 1905, III, (1625).

Lespedeza hirta (L.) Hornem., Clayton, July 24, 1907, I, (1705).
Lespedeza virginica (L.) Britt., Newark, Sept. 10, 1907, III, (1730); Selbyville, Oct. 4, 1907, (1988).

This species is very common and widely distributed east of the Rocky mountains on various species of Lespedeza and has been shown to be autoecious by Arthur (Jour. Myc. 10:14. 1904). The aecial form known as *A. leucostictum* having been produced by infecting *Lespedeza capitata* with teliospores from the same host.

112. Uromyces Medicaginis Pass. Thüm. Herb. Myc. Oecon. 156. 1874.
Nigredo Medicaginis Arth. N. Am. Flora 7:256. 1912.
On Fabaceae:
Medicago lupulina L., Wilmington, June 22, 1889, A. Commons (920).

The aecia of this species in Europe have been shown by Schroeter (Krypt. Fl. Schl. 3[1]:306. 1887) and by Trebaux (Ann. Myc. **10**:74. 1912) to occur on various species of Euphorbia.

No aecia in America have been found which can be referred to this species. There is, however, no evidence at present available for believing the American species different from the European.

113. Uromyces pedatatus (Schw.) Sheldon, Torreya **10**:90. 1910.
Caeoma pedatatum Schw. Trans. Am. Phil. Soc. II. 4:293. 1832.
Uromyces Andropogonis Tracy, Jour. Myc. 7:281. 1893.
On Violaceae: I.
Viola lanceolata L., Lewes, April 25, 1908, (2036).
Viola sagittata L., Newark, June 12, 1897, F. D. Chester; Porters, June 1908; Lewes, April 14, 1908.
On Poaceae: II, III.
Andropogon glomeratus (Walt.) B. S. P., Selbyville, Oct. 4, 1907, (1795, 1805, 1796, 1797), (Barth. Fungi Columb. 3088); Lewes, Nov. 16, 1907, (1857).
Andropogon virginicus L., Newark, Sept. 10, 1907, III, (1732); Lewes, April 23, 1908, II, (2037), June 7, 1908, III, (2088).

Dr. J. L. Sheldon (Torreya 9:55. 1909) was the first to show that in West Virginia the aecial stage of this species on Andropogon occurred on Viola, having obtained successful infection resulting in aecia by using

teliospores from *Andropogon virginicus* L. Arthur in 1909 (Mycol. 2:229. 1910) confirmed the results of Sheldon by obtaining infection resulting in abundant pycnia on *Viola cucullata* following sowings of teliospores from *Andropogon virginicus* sent by Sheldon from West Virginia.

Long (Phytopath. 2:165. 1912) reports successful infection of *Viola primulifolia* and *V. cucullata* by inoculation with teliosporic material from the same telial host used by Sheldon and Arthur. Aeciospores from *V. primulifolia* were used to inoculate the telial host resulting in typical uredinia of *U. pedatatus*.

114. Uromyces perigynius Halsted, Jour. Myc. 5:11. 1889.

Uromyces caricina E. & E. Bull. Torrey Club 22:58. 1895.

Uromyces Solidagini-Caricis Arth. Jour. Myc. **10**:16. 1904.

Nigredo perigynia Arth. Result Sci. Congr. Bot. Vienna 334. 1906.

On Cyperaceae:

Carex scoparia Schk., Newark, Sept. 10, 1907, (1731, 1734), April 5, 1908; Felton, Sept. 5, 1907, (1743); Collins Beach, Oct. 1, 1907, (1775).

Carex tribuloides Wahl., Collins Beach, Oct. 1, 1907, (1782); Felton, Sept. 5, 1907, (1739).

This species is correlated with a Puccinia occurring on Carex and Dulichium which has been referred to under various specific names. (See *P. asteratum*.) The species are morphologically indistinguishable except in the number of cells in the teliospore.

The Uromyces has been studied in culture by Arthur and Fraser. The first study leading to an understanding of the species was made by Arthur (Jour. Myc. **10**:16. 1904) who used telial material on *Carex varia* from Indiana and obtained infection resulting in aecia on *Solidago canadensis*, *S. serotina*, *S. flexicaulis* and *S. caesia*. The results were confirmed in 1910 by the same author (Mycol. 4:21. 1912) when infection resulting in aecia was obtained on *S. rugosa* using telial material on *C. deflexa* collected in Nova Scotia and Maine. This species was, at this time, also shown to have aecia on Aster by successful sowings of teliospores from *Carex intumescens* collected in Nova Scotia on *A. paniculatus* and from *C. deflexa* from Maine on *A. ericoides*.

Fraser in 1911 (Mycol. 4:181. 1912) successfully infected *S.*

rugosa (?) and *S. bicolor* by sowing teliospores from *Carex deflexa* from Nova Scotia. Similar results were obtained on *Euthamia graminifolia* when infected with teliospores from *C. scoparia* and on Solidago sp. from *C. intumescens.*

Arthur in 1912 (Mycol. 7:75. 1915) reports infection of *Aster paniculatus* and *S. canadensis* following sowings of teliospores from *C. intumescens* collected in New York and in 1914 (Mycol. 7:83. 1915) on *A. Tweedyi* from *C. tribuloides* collected in Indiana.

The aecia obtained in these cultures are indistinguishable from the aecia resulting from sowings of the correlated Puccinia. Field collections of aecia on Aster, Solidago, etc., can be properly referred only when close observations of the source of infection are made.

115. Uromyces plumbarius Peck, Bot. Gaz. 4:127. 1879.
Uromyces Oenotherae Burrill, Bot. Gaz. 9:187. 1884.
Nigredo plumbaria Arth. N. Am. Flora 7:262. 1912.
On Onagraceae: I.
Oenothera biennis L., Newark, May 1908, I (2266).
Oenothera laciniata Hill, Seaford, June 4, 1908, I (2044).

116. Uromyces Polemonii (Peck) Barth. N. Am. Ured. 597. 1913.
Aecidium Polemonii Peck, Bot. Gaz. 4:230. 1878.
Uromyces acuminatus Arth. Bull. Minn. Acad. Sci. p. 35. 1883.
Nigredo Polemonii Arth. N. Am. Flora 7^3:231. 1912.
On Poaceae: II, III.
Spartina glabra alternifolia (Loisel) Merr., Lewes, Oct. 16, 1907, (1774, 1850).

When teliosporic material from *S. cynosuroides* collected in Nebraska was used by Arthur to inoculate *Steironema ciliata* (Jour. Myc. 12:25. 1906; 14:17. 1908) aecia developed. In 1909 Arthur (Mycol. 2:229. 1910) confirmed the results with *S. ciliata* and also records successful infection of *S. lanceolata.* In 1910 (Mycol. 4:29. 1912) the development of aecia was obtained on *Polemonium reptans* following sowings of teliospores from *S. cynosuroides* collected in North Dakota and Colorado.

Fraser in 1911 (Mycol. 4:186. 1912) obtained infection resulting in aecia on *Arenaria lateriflora* following sowings with teliosporic ma-

terial from *Spartina Michauxiana* and on *Spergula canadensis* from *Spartina glabra* var. *alternifolia* and on *Spergula canadensis* from *Spartina patens*.

In 1912 Arthur again conducted cultures (Mycol. 7:77. 1915) and obtained infection and development of aecia on *Collomia linearis* when telial material from Colorado was used.

From these successful results, taken together with the negative results recorded by the investigators mentioned, it would appear that well marked biological races of this species exist or that distinct species are here included.

Orton (Mycol. 4:202. 1912) pointed out that it is not possible to distinguish this species from *Puccinia Distichlidis* E. & E., the telial stage of which occurs on Spartina sp., except in the possession of one-celled teliospores. Arthur in 1915 (Mycol. 8:136. 1916) has shown that the aecial stage of the Puccinia develops on Steironema and is morphologically identical with *Aecidium Polemonii*, thus strengthening the morphological evidence of the relationship between the two forms.

117. Uromyces Polygoni (Pers.) Fuckl. Symb. Myc. 64. 1869.
Puccinia Polygoni Pers. Neues Mag. Bot. 1:119. 1794.
Nigredo Polygoni Arth. Result Sci. Congr. Bot. Vienna 344. 1906.
On Polygonaceae:
Polygonum aviculare L., Newark, Aug. 17, 1907, III, (1712).
Polygonum erectum L., Newark, September 1888, F. D. Chester, June 21, 1907, II, (1668).

118. Uromyces Pontederiae W. Gerard, Bull. Torrey Club 6:31. 1875.
Nigredo Pontederiae Arth. N. Am. Flora 7:238. 1912.
On Pontederiaceae:
Pontederia cordata L., Milford, Sept. 1, 1892, A. Commons (1986).

This species is evidently rather rare, having been recorded in North America by Arthur (l. c.) in but four states on the Atlantic coast from New York to Florida and in Missouri. Only four other collections are known to the writer. It also occurs in South America. This species is assumed to be autoecious though no aecia have been found.

119. Uromyces proeminens (DC.) Pass. Rab. Fungi Eur. 1795. 1873.

Uredo proeminens DC. Fl. Fr. 2:235. 1805.

Uromyces Euphorbiae C. & P.; Peck, Ann. Rep. N. Y. State Mus. 25:90. 1873.

Nigredo proeminens Arth. N. Am. Flora 7[3]:259. 1912.

On Euphorbiaceae:

Euphorbia maculata L., Newark, September 1905, (1633), Lewes, Aug. 14, 1907, (1695), Selbyville, Oct. 4, 1907, (1980).

Euphorbia Preslii Guss., Newark, Sept. 14, 1907, III, (1630), Seaford, July 9, 1907, I, (1666); July 9, 1907, II, III, (1655), Selbyville, Oct. 4, 1907, (1994).

That this species is autoecious was first demonstrated by Arthur in 1899 (Bot. Gaz. 29:270. 1900) and later confirmed by the same author (Jour. Myc. 8:51. 1902; Bot. Gaz. 35:12. 1903). The results, however, indicate that well marked biological forms are present.

120. Uromyces Rhyncosporae Ellis, Jour. Myc. 7:274. 1893.

Nigredo Rhyncosporae Arth. Result Sci. Congr. Bot. Vienna 344. 1906.

On Cyperaceae: II, III.

Rynchospora axillaris (Lam.) Britton, Lewes, Aug. 14, 1907, (1687).

Rynchospora glomerata (L.) Vahl., Selbyville, Oct. 4, 1907, (1801, 1811); Seaford, Nov. 15, 1907, (1768, 1769), April 23, 1908, (2031); Lewes, Nov. 16, 1907, (1856).

All cultures so far attempted with this species have yielded negative results. It is very close morphologically to *Uromyces perigynius* which has been shown to have aecia on Aster and Solidago. In spite of the fact that attempts to infect these genera by Arthur (Mycol. 7:65. 1915) were unsuccessful, the writer is inclined to the view that it will ultimately be shown that this species has its aecia on Aster and Solidago.

121. Uromyces Scirpi (Cast.) Burrill, Par. Fungi Ill. 168. 1885.

Uredo Scirpi Cast. Cat. Pl. Mars. 214. 1845.

On Ammiaceae: I.

Hydrocotyle Canbeyi C. & R., Lewes, Aug. 14, 1907, I, (1688), June 6, 1908, (2090).

Sium cicutaefolium Gmel., Wilmington, July 11, 1890, 1, A. Commons (1483).

On Cyperaceae: II, III.

Scirpus americanus Pers., Lewes, Aug. 14, 1907, II, (1679, 1689), June 6, 1908, (2091); Selbyville, Oct. 4, 1907, (1806).

Scirpus fluviatilis (Torr.) A. Gray, Collins Beach, Oct. 1, 1907, III, (1787).

In Europe P. Dietel (Hedwigia 29:149. 1890) was the first to successfully connect this species with its aecial form. He showed by cultures that aecia are produced on *Sium latifolium* and *Hippurus vulgaris*. Plowright (Gard. Chron. III. 7:682. 1890) added *Glaux maritima* as an aecial host of this species. Bubak in Bohemia (Cent. Bakt. 9^2:926. 1902) discovered a form which only infected *Berula angustifolia*. Further cultures carried out by Klebahn (Jahr. Hamb. Wiss. Anst. 20:33. 1903) brought out new hosts and interesting biological relations.

In America Arthur in 1906, 1907 and 1908 (Jour. Myc. 13:199. 1907; 14:17. 1908; Mycol. 1:237. 1909) showed that in America *Cicuta maculata* was an aecial host. Fraser (Mycol. 4:178. 1912) confirmed Arthur's work using telia on *Scirpus campestris paludosus*.

The aecidium on *Hydrocotyle Canbeyi* is included here partly on morphological grounds and partly on field observations. As noted above the writer collected at Lewes, on Aug. 14, 1907, the aecidium on Hydrocotyle. The aecia were old and there was no evidence of uredinia or telia of *P. Hydrocotyles* (with which form the aecidium has previously been combined) on any of the affected leaves or on other plants in the vicinity. Surrounding the plants, however, were plants of *Scirpus americanus* abundantly affected with the uredinia of *U. Scirpi*. Observations and collections were again made in the same spot on June 6, 1908, when aecia were again found in abundance showing evidence of having been mature for about two weeks. A few culms of Scirpus were growing in such a position that the tips were hanging immediately above the Hydrocotyle plants bearing the aecia. On these tips fresh uredinial sori of *U. Scirpi* were present. No infection on Scirpus was found elsewhere at that date though the plants were very abundant over a wide area.

122. Uromyces seditiosus Kern, Torreya 11:212. 1911.

Aecidium Plantaginis Burrill, Bull. Ill. Lab. Nat. Hist. 2:232. 1885.

Nigredo seditiosa Arth. N. Am. Flora 7:225. 1912.

On Poaceae:

Aristida sp., Lewes, 1908.

Culture experiments reported by Arthur (Bot. Gaz. 35:17. 1903) prove the aecidial stage of *Uromyces Aristidae* to be *Aecidium Plantaginis*. He used telial material on *A. oligantha* Michx. from Texas and successful infection of *Plantago Rugelii* was obtained followed by pycnia and aecia.

Field observations made by Arthur and Fromme indicate also that *Aecidium Oldenlandianum* Ellis & Tracy, which occurs on various species of Houstonia in the southern states, also belongs here though confirming cultures have not yet been made.

123. Uromyces Silphii (Burrill) Arth. Jour. Myc. 13:202. 1907.

Aecidium Silphii Sydow, Ured. 1546. 1901.

Nigredo Silphii Arth. N. Am. Flora 7:239. 1912.

On Juncaceae:

Juncus dichotomus Ell., Sussex Co., June 18, 1875, A. Commons.

Juncus tenuis Willd., Lewes, Aug. 14, 1907, (1700); Newark, Aug. 23, 1907, (1714); Sept. 1907, (1823, 1824); Selbyville, Oct. 4, 1907, (1793, 1800).

Arthur (Jour. Myc. 13:202. 1907; 14:17. 1908) has shown that this common species has its aecia on Silphium. Using telial material on *J. tenuis* from Indiana, West Virginia and Nebraska, five successful infections of *Silphium perfoliatum* were obtained, all of which resulted in the development of pycnia and aecia. The aecia on Silphium have been collected, so far as known to the writer, only in the Mississippi Valley from Ohio to Wisconsin, Kansas and Missouri, on three species of Silphium. The range of the telial collections referred here, however, is much greater including nearly the entire United States and Canada except the south Pacific slope. It seems probable that some plants other than Silphium, at present unrecognized, also serve as aecial hosts for this species. From field observations it seems probable that certain species of Aster serve as hosts for the aecia of this species in some localities.

This species is distinguished from the only other Uromyces on Juncus occurring in the eastern United States (*U. Junci-effusi* Syd.) which occurs commonly on *J. effusus*, by the number and position of the pores in uredospores. In *U. Silphii* there are two superequatorial pores; while in *U. Junci-effusi* the pores are 3-4 and equatorial.

124. Uromyces Spermacoces (Schw.) Curt. Cat. Pl. N. Car. 123. 1867.
Puccinia Spermacoces Schw. Schr. Nat. Ges. Leipzig 1:74. 1822.
Nigredo Spermacoces Arth. N. Am. Flora 7:266. 1912.
On Rubiaceae:
Diodia teres Walt., Newark, Sept. 18, 1905, (1627); Selbyville, Oct. 4, 1907, (1934); Cooch's Bridge, Sept. 18, 1915, C. O. Houghton.

This is doubtless an autoecious form though no cultures have been conducted. It is a very common species in the south and south central States. The above collections are near the northeastern limits of its range.

Unconnected Forms.

125. Aecidium Apocyni Schw. Schr. Nat. Ges. Leipzig 1:68. 1822.
On Apocynaceae:
Apocynum pubescens L., Seaford, July 9, 1907, (1649, 1653), June 4, 1907, (2053); Clayton, July 24, 1907, (2253).

This Aecidium is known otherwise only from North Carolina and New Jersey on the above host and on *A. cannabinum* L. only from the District of Columbia and North Carolina (according to Schweinitz). It is easily separated from *Aecidium obesum* Arth., which occurs on *A. Sibiricum*, by the possession of a firm peridium and much smaller aeciospores with thin walls. The latter agrees with *A. Cephalanthi* Seym. which has been shown by Arthur (Jour. Myc. 12:24. 1906; Mycol. 1:236. 1909; 4:19. 1912) to be the aecial form of *Puccinia Seymouriana* Arth. with uredinia and telia on Spartina.

126. Aecidium Compositarum Authors.
On Carduaceae:
Rudbeckia triloba L., Naamans Creek, April 27, 1894, A. Commons.

This Aecidium like many others on Compositae is doubtless heteroecious and may belong with telia on some Cyperaceous or Juncaceous

host. Since its exact affinities are at present unknown it is best for the present referred to as above.[1]

127. **Aecidium Ivae** sp. nov.

O. Pycnia amphigenous, crowded in yellowish spots, 3-15 mm. in diameter, noticeable, subepidermal, light yellow to light chestnut-brown, punctiform, 80-160 by 95-160μ, ostiolar filaments up to 80μ long.

I. Aecia usually hypophyllous, sometimes amphigenous, crowded on spots with the pycnia, cupulate, 0.2-0.4 mm. in diameter; peridium brownish yellow, recurved, erose; peridial cells rhomboidal in longitudial section, 19-27 by 35-51μ, overlapping, wall 5-7μ thick, outer wall smooth, transversely striate, inner wall closely and coarsely verrucose; aeciospores globoid or ellipsoid 21-29 by 26-23μ; wall colorless or pale yellow, 2-3μ thick, finely and closely verrucose.

On Ambrosiaceae:

Iva ovaria Bartlett (*I. frutescens* A. Gray not L.), Lewes, Aug. 14, 1907, (1676).

This species is evidently a heteroecious form and occurs otherwise, so far as is known, in salt marshes along the Atlantic coast and Gulf of Mexico in Virginia, Florida and Louisiana. It differs from *Aecidium intermixtum* Pk. (*Puccinia intermixta* Pk.) in the larger aeciospores and in the fact that the aecia develop from a limited mycelium.

128. Aecidium Uvulariae Schw. Nat. Ges. Leipzig 1:69. 1822.

On Convallariaceae:

Uvularia sessifolia L., Seaford, June 4, 1908, (2059); Cooch's Bridge, May 25, 1915, C. O. Houghton.

The above Aecidium is scarcely distinguishable from *Aecidium Majanthae* Schum. which has been shown by European investigators to be connected with uredinia and telia on Phalaris. In America aecidia occurring on Salamonia, Unifolium and Vagnera have been similarly referred to *P. Majanthae* (Schw.) Arth. (*P. sessilis* Schw.) though no successful cultures have been made. Since slight morphological differ-

[1] Since the above was written cultures conducted in this laboratory and reported by Arthur (Mycol. 9:307. 1917) show that aecia on *Rudbeckia laciniata* are genetically connected with uredinia and telia on Carex referred to *Uromyces perigynius* (cf. 114). He obtained successful infection resulting in aecia on *R. laciniata* following exposure to germinating telia on *Carex sparganioides*. It is therefore probable that the collection listed here from Delaware on *R. triloba* should be similarly referred.

ences exist between the form on Uvularia and those mentioned above it seems desirable to retain it as a separate species for the present.

129. Uredo Andromedae Cooke, DeToni in Sacc. Syll. Fung. 7:853. 1888.

On Ericaceae:

Pieris mariana (L.) Benth. & Hook., Wilmington, Oct. 1891, A. Commons (in E. & E. N. Am. Fungi 2717).

Xolisma ligustrina (L.) Britt., Selbyville, Oct. 4, 1907, (1941).

This species, included by Arthur in *Melampsoropsis Cassandrae* (P. & C.) Arth. (N. Am. Flora 7:119. 1907) is clearly not that species, as the urediniospores are echinulate. Its affinities are probably with Pucciniastrum. The ostiolar cells of the peridium however are not well developed and it seems best to retain it under the above name for the present.

Index to Species.

Host Index.

Purdue University, Lafayette, Ind.