On the Heteroecious Plant Rusts of Indiana.

By Aaron G. Johnson.

In the study of any organism, a knowledge of its life history is one of the things of first interest. Particularly is this true in the study of the heteroecious plant rusts, exhibiting, as they do, alternating phases on entirely different host plants. The complexity, which these plant parasites present, adds varied interest to their study, although the same complexity offers abundant obstacles in determining the connection of the various forms.

It is the purpose of this paper briefly to show what has been done in the way of connecting forms represented in the State, and what remains to be done in this particular line. In presenting the unattached forms, particularly the unattached aecia, it is hoped to help engage the interest of others in assisting in any way possible in properly connecting up these forms. The three lists given below show respectively the connected forms, with the authorities and dates of connection for each species, the unattached telial forms, and lastly the unattached aecial forms. The first two tables are based on Dr. Arthur's Revised List of Indiana Plant Rusts (Proc. Ind. Acad. Sci. for 1903.) For convenience, the familiar genus names *Uromyces* and *Puccinia* are used, the species names, as far as possible, being revised to date. The third table is based on specimens in Dr. Arthur's herbarium, as are also the aecial forms appearing in the first table which have been connected up since the presentation of Dr. Arthur's list. For host names Britton's Manual (2nd. Ed.) is followed. The sincere gratitude of the writer is here expressed to Prof. J. C. Arthur for access to his very valuable herbarium as well as to his extensive library. Most able assistance was also given throughout by both Dr. Arthur and Mr. F. D. Kern, for which the writer is very greatly obliged.

The life histories of thirty-four species of heteroecious rusts represented in Indiana are now known. The aecial stage, however, of nine of this number is not known to occur within the State. In some cases

it may have been missed by collectors, as on Larix, for example, and may subsequently be found; in others, however, it is doubtful if the aecial stage occurs here. In this case the species doubtless depends entirely upon its urediniospores for reinfection of its host from year to year. Such, for instance, is no doubt the case with the Poa rust (*P. epiphylla*) and the leaf rust of cereals and certain grasses (*P. Rubigo-vera*).

In view of these facts it seems very doubtful that all of the sixteen still unattached telial forms in the State have their respective aecia here. In the first place, only nine unattached aecia are reported for the State, though others may occur. In the second place, and apparently much the better reason for the inference, of the thirty-four connected-up species previously mentioned, only twenty-five have their aecial forms reported for the State, while all of the connected-up aecial forms reported for the State have their telial forms here also. This latter being very natural to suppose for the teliospores are not readily transported by the wind or otherwise, and the sporidia, which give the aecial infection, are very perishable and entirely incapable of being blown very great distances and still remain viable. Hence there seems little if any question but that some unattached telial forms come into the State by uredinial infections, and are thus kept up through the season and possibly even from season to season in some cases. The aecia belonging to such forms may, therefore, be far distant.

This condition, then, centers our interest in connecting unattached forms, largely on the unattached aecia. For of necessity, their respective alternate forms must be somewhere in the immediate vicinity of their occurrence, except in the few cases where the aecial mycelium is perennial, in which cases the forms may become somewhat separated. By carefully searching for and finding unattached telial forms, especially near where the unattached aecia occur in abundance, clews may often be obtained that may ultimately lead to proof of the genetic relationship of such forms.

The tables are as follows:

CONNECTED TELIAL AND AECIAL FORMS.

EXPLANATION OF SYMBOLS USED.

* Cultured in Europe.
** Cultured in Europe, verified in America.
† Form not yet reported for Indiana.
†† Form not yet reported for America.

Coleosporium Solidaginis (Schw.) Thuem. (Solidago spp. & Aster spp.)	†Peridermium acicolum Und. & Earle (Pinus rigida)	Clinton 1906
Melampsora Medusae Thuem. (Populus spp.)	††Caeoma sp. (1) (Larix sp.)	Arthur 1903
Melampsora Bigelowii Thuem. (Salix spp.)	†Caeoma sp. (Larix spp.)	Arthur 1904
Melampsoridium Betulae (Schum.) Arth. (Betula lutea)	††Peridermium Laricis Arth. & Kern (Larix sp.)	*Plowright 1890
Gymnosporangium Juniperi-virginianae Schw. (Juniperus Virginiana)	Roestelia pyrata Thaxt. (Malus spp. & Pyrus communis)	Thaxter 1886
Gymnosporangium globosum Farl. (Juniperus Virginiana)	Roestelia globosa Farl. (Crataegus spp.)	Thaxter 1887
Uromyces acuminatus Arth. (Spartina cynosuroides)	†Aecidium sp. (2) (Steironema ciliatum)	Arthur 1905

1. Proven by cultures, not yet collected.
2. Connection not yet verified with Indiana material.

Uromyces Solidagini-Caricis Arth. (Carex spp.)	Aecidium sp. (Solidago spp.)	Arthur 1903
Uromyces Silphii (Syd.) Arth. (Juncus tenuis)	Aecidium Silphii (Bur.) Syd. (Silphium perfoliatum)	Arthur 1906
Puccinia Sorghi Schw. (Zea Mays)	Aecidium oxalidis Thuem. (Oxalis cymosa)	Arthur 1904
Puccinia pustulata (Curt.) Arth. (Andropogon spp.)	Aecidium pustulatum Curt. (Comandra umbellata)	Arthur 1903
Puccinia Andropogi Schw. (Andropogon spp.)	Aecidium Pentstemonis Schw. (Pentstemon hirsutus)	Arthur 1899
Puccinia Pammelii (Trel.) Arth. (Panicum virgatum)	Aecidium Pammelii Trel. (Euphorbia corollata)	Stuart 1901
Puccinia Majanthae (Schum.) A. & H. (Phalaris arundinacea)	†Aecidium Majanthae Schum. (Salomonia & Vagnera)	*Sopitt 1889
Puccinia verbenicola (K. & S.) Arth. (Sporobolus longifolius)	Aecidium verbenicola K. & S (Verbena stricta)	Arthur 1899
Puccinia Rhamni (Pers.) Wettst. (Avena sp. & Calamogrostis sp.)	Aecidium Rhamni Pers. (Rhamnus lanceolata)	**DeBary 1865
Puccinia Windsoriae Schw. (Tricuspis seslerioides)	Aecidium Pteleae B. & C. (Ptelea trifoliata)	Arthur 1899

Puccinia Eatoniae Arth. (Eatonia Pennsylvanica)	Aecidium Rannuculi Schw. (Rannuculus abortivus)	Arthur 1903
Puccinia epiphylla (L.) Wettst. (Poa pratensis)	Aecidium Tussilaginis Pers. (3) (Petasites frigida)	*Nielson 1876
Puccinia Impatientis Arth. (Elymus Virginicus)	Aecidium Impatientis Schw. (Impatiens spp.)	Arthur 1902
Puccinia poculiformis (Jacq) Wettst. (Various grasses and grains)	Aecidium Berberidis Pers. (Berberis vulgaris)	**DeBary 1864
Puccinia Rubigo-vera (DC.) Wint. (Various grains)	††Aecidium asperifolii Pers. (Anchusa arvensis)	*DeBary 1865
Puccinia canaliculata (Schw.) Lagerh. (Cyperus strigosus)	Aecidium Compositarum Xanthii Burr. (Xanthium Canadense)	Arthur 1905
Puccinia Eleocharidis Arth. (Eleocharis palustris)	Aecidium Compositarum Eupatorii DeT. (Eupatorium perfoliatum)	Arthur 1905
Puccinia obtecta Pk. (Scirpus sp.)	†Aecidium Compositarum Bidentis Burr. (Bidens frondosa)	Arthur 1907
Puccinia angustata Pk. (Eriophorum spp. & Scirpus spp.)	Aecidium Lycopi Ger. (Lycopus Americanus)	Arthur 1899

3. Nielson, in his cultures, employed Tussilago Farfara L. which is the host of this not uncommon aecium in Europe. So far as is known to the writer, this aecium has not been collected on this host in North America, but the one on Petasites frigida, which seemingly is morphologically identical, has been collected by Piper in Alaska, and by Macoun on St. George's I., Behring Sea.

Puccinia albiperidia Arth. (Carex spp.)	Aecidium albiperidium Arth. (Ribes spp.)	Arthur 1901
Puccinia Caricis-asteris Arth. (Carex spp.)	Aecidium asterum Schw. (Aster spp.)	Arthur 1901
Puccinia Caricis-Erigonitis Arth. (Carex spp.)	Aecidium erigeronatum Schw. (Erigeron spp.)	Arthur 1901
Puccinia Caricis-Solidaginis Arth. (Carex spp.)	Aecidium Solidaginis Schw. (Solidago spp.)	Arthur 1902
Puccinia Sambuci (Schw.) Arth. (Carex spp.)	Aecidium Sambuci Schw. (Sambucus canadensis)	Arthur 1901
Puccinia Peckii (DeT.) Kellerm. (Carex spp.)	Aecidium Peckii DeToni (Onagra biennis)	Kellerman 1902
Puccinia Urticae (Schum.) Lagh. (Carex spp.)	Aecidium Urticae Schum. (Urtica gracilis)	**Magnus 1872
Puccinia Polygoni-amphibii Pers. (Polygonum spp.)	Aecidium sanguinolentum Lindr. (Geranium maculatum)	**Tranzschel 1903

SUMMARY.

	1864	1865	1872	1876	1886	1887	1889	1890	1899	1901	1902	1903	1904	1905	1906	1907	Total for Each Worker.
DeBary	1	2															3
Magnus			1														1
Nielson				1													1
Thaxter					1	1											2
Plowright								1									1
Sopitt							1										1
Arthur									4	4	2	4	2	3	1	1	21
Stuart										1							1
Kellerman											1						1
Tranzschel												1					1
Clinton															1		1
Total for each year	1	2	1	1	1	1	1	1	4	5	3	5	2	3	2	1	

TELIAL FORMS WHOSE AECIAL CONNECTIONS ARE UNKNOWN.

Coleosporium Ipomoeae (Schw.) Burr.	on Ipomoea pandurata.
Coleosporium Vernoniae B. & C.	on Vernonia spp.
Pucciniastrum Agrimoniae (DC.) Diet.	on Agrimonia spp.
Pucciniastrum Hydrangeae (B. & C.) Arth.	on Hydrangea arborescens.
Uromyces graminicola Burr.	on Panicum virgatum.
Uromyces Rynchosporae Ellis	on Rynchospora alba.
Uromyces perigynius Halst.	on Carex virescens.
Puccinia Ellisiana Thuem.	on Andropogen scoparius.
Puccinia emaculata Schw.	on Panicum capillare.
Puccinia Muhlenbergiae A. & H.	on Muhlenbergia spp.
Puccinia vexans Farl.	on Atheropogon curtipendulus.
Puccinia Melicae Syd.	on Melica diffusa.
Puccinia apocrypta E. & T.	on Hystrix Hystrix.
Puccinia Dulichii Syd.	on Dulichium arundinaceum.
Puccinia vulpinoidis D. & H.	on Carex vulpinoidea.
Puccinia ludibunda E. & E.	on Carex sparganioides.

AECIAL FORMS WHOSE TELIAL CONNECTIONS ARE UNKNOWN.

Aecidium sp.	on Syndesmon thalictroides (Rue Anemone).
Aecidium sp.	on Anemone Virginiana (Tall Anemone).
Aecidium Dicentrae Trel.	on Bicuculla cucullaria (Dutchman's Breeches).
Aecidium sp.	on Euphorbia commutata (Tinted Spurge).
Aecidium Napaeae Arth.	on Napaea dioica (Glade Mallow).
Aecidium hydnoideum B. & C.	on Dirca palustris (Leather-wood).
Aecidium Polemonii Pk.	on Polemonium reptans (Greek Valerian).
Aecidium Physalidis Pk.	on Physalis heterophylla (Ground-cherry).
Aecidium Compositarum Ambrosiae Burr.	on Ambrosia trifida (Great Ragweed).