Final Report
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Small Project Proposal FY 2005 (July 2005-Dec 2006)

Gall wasp Species diversity in the prairies of Central and Southern Illinois

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Introduction

Gall wasps known from the prairies in the US Midwest belong to the basal Cynipid tribe Aylacini (Cynipidae, Hymenoptera, Insecta). These wasps, while forming galls on herbaceous plants of more than 20 plant families, are specialized plant feeders, each utilizing a particular plant structure of a single or a few closely related plant species. This has probably led to the relatively high species diversity of this group, with 200 known species worldwide. The known species diversity of Aylacini of North America is disproportionately low (35 species) compared to Europe (ca 150 species), in stark contrast to Cynipini, another cynipid tribe better known as oak gall wasps. Cynipini of North America consists of about 700 known species and is more diverse than that of anywhere else (*e.g.*, ca 300 species of Cynipini are known from Europe). The relatively low species diversity of Aylacini in North America is probably due to the fact that the group has not been studied as intensively in North America as in Europe. In fact, most of the North American Aylacini species were described a century ago and the most recent taxonomic work on the group is a species catalogue dated to 1959. A recent increase of interests in cynipid gall wasps including the Aylacini has led to the discovery of two new cryptic species attacking *Silphium* spp in the prairies in Illinois, and my recent trip to prairies in Missouri has resulted in the collection of three likely new species, suggesting a more diverse Aylacini in North America.

Objectives:

a) Inventory of species diversity of Aylacini gall wasps of prairies in central and southern Illinois. The results will add to the knowledge base about biological diversity in the state of Illinois in general and the diversity of the targeted group in the remnants of the once dominant ecosystems in the region;
b) Testing whether the disproportionately low species diversity of the targeted group in North America is an artifact of insufficient research.
c) Use of DNA sequence comparison for separation of cryptic species. Gall wasps are sealed plant feeders and tend to develop convergent morphological similarities, rendering identification based on morphology unreliable. Comparison of sequences of relatively fast evolving DNA regions of the suspects has been proven to be very useful for the purpose.

Methods:

a) *Field survey*. This will be carried out in late summer or early fall, 2005. Potential host plants, especially *Silphium*, *Lygodesmia*, *Prenanthes*, *Lactuca*, *Lepeta*, *Potentilla*, and

Taraxacum, will be examined for gall wasps, plants identified as having gall wasp galls will be selectively tagged for later collection, and host plant data and GPS reading will be recorded for each spot;

b) *Collection of full grown larvae or pupae* winter before adult wasps emerge;
c) *Controlled rearing of adult wasps from galls in lab and dissection of randomly selected galls*. The collected galls will be put in separate rearing devices in lab and emergent wasps will be collected. A few galls from each population will also be dissected to collect data on gall morphology. Dissected out wasp larvae will preserved in ethanol and stored in -80℃ for molecular study needed later on;
d) *Species identification* is mostly based on morphology. However, when morphological characters are not conclusive about the species identity; molecular technology will be used to assist the identification of species;
e) *Species inventory and project report preparation*. Species data, including species name, distribution in each prairie and county, and host plants will be tabulated for easy incorporation in local/regional biodiversity databases.

Results

1. Filed Survey.

Sites of field survey are listed as in Table 1.

Table 1 List of surveyed sites

Site Number	Site Visited
1)	Beaver Dam State Park, Macoupin Co.
2)	Big River State Forest, Henderson Co.
3)	Burksville, Monroe Co.
4)	Charleston Lake areas, Coles Co.
5)	Crawford County Conservation Area, Crawford Co.
6)	Des Plaines Conservation Area, Will Co.
7)	Douglas Hart Nature Center, Coles Co.
8)	Fermilab Prairie, Kane Co.
9)	Forest Glen County Preserve, Vermilion Co.
10)	Fox Ridge State Park, Coles Co.
11)	Galesburg, Knox Co.
12)	Johnson Sauk Trail State park, Henry Co.
13)	Kankakee River State Park, Kankakee Co
14)	Kennekuk County Park, Vermillion Co.
15)	Kibbe Biological Research Station, Hancock Co.
16)	Kickapoo State Park, Vermilion Co
17)	Lincoln Log Cabin State Park, Coles Co.
18)	Middle Fork River County Forest Preserve, Champaign Co
19)	Nauvoo State Park, Hancock Co.
20)	Pana area, Rosamond Co

21) Prospect Cemetery Prairie, Champaign Co.
22) Route 45 Railway Prairie, Champaign Co.
23) Sunset by the Mississippi, Hancock Co.
24) Argyle Lake State Park, Mc Donough Co.
25) Waggoner Creek, Hancock Co.

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2. *Inventory of aylacine species diversity in central and southern Illinois.*

The last comprehensive catalog of gall wasp species of North America north of Mexico listed 15 native aylacine gall wasp species in three genera from the state of Illinois (Burks 1979, Schick et al 2003) and two additional species were recently described as new from the state (Tooker et al 2004) (Table 2).

Table 2. Aylacine species reported from Illinois (Data based on Burks 1979, Schick et al 2003, Tooker 2004)

Species	Host Plant
Aulacidea harringtoni (Ashmead)	*Lactuca villosa*
Aulacidea nabali (Brodie)	*Prenanthes sp.*
Aulacidea podagrae (Basset)	*Lactuca canadensis*
Aulacidea tumida (Basset)	*Lactuca canadensis*
Diastrophus cuscutaeformis Osten Sacke	*Rubus sp.*
Diastrophus fragariae Beutenmüller	*Fragaria virginiana*
Diastrophus niger Basset	*Potentilla canadensis*
Diastrophus potentillae Bassett	*Potentilla canadensis*
Diastrophus smilacis Ashmead	*Smilax spp.*
Diastrophus turgidus Bassett	*Rubus strigosus*
Antistrophus laciniatus Gillette	*Silphium laciniatum*
Antistrophus minor Gillette	*Silphium laciniatum*
Antistrophus rufus Gillette	*Silphium laciniatum*
Antistrophus silphii	*Silphium perforliatum*
Antistrophus bicolor Gillette	*Silphium integrifolium*

Antistrophus jeanae Tooker et al	*Silphium perforliatum*
Antistrophus meggae Tooker et al	*Silphium terebincinatum*

Only eight of the 17 recorded species have been collected by this project. Several factors have probably contributed to this: 1). the known record is for the whole state whereas the targeted area of this project is the central and southern Illinois; 2). Most aylacine species galls are cryptic and cannot be easily detected; and 3) some members of the tribe are rare or have become extinct due to decrease in habitats. For example, most of the species listed in Table 2 have not been collected since they were originally described several decades ago.

Table 3. List of Aylacini collected in central and southern Illinois (Site numbers correspond to

Species	**Host Plant**	**Site Number**
Aulacidea harringtoni (Ashmead)*	*Lactuca serreta*	15, 23, 25
Diastrophus potentillae Bassett	*Potentilla canadensis*	21 (Only galls found)
Diastrophus turgidus Bassett	*Rubus strigosus*	10, 6, 14
Antistrophus jeanae Tooker et al	*Silphium perforliatum*	6, 8, 9, 10, 12, 13, 17, 21, 22
Antistrophus meggae Tooker et al	*Silphium terebincinatum*	3, 5, 6, 8, 9, 10, 21, 22
Antistrophus minor Gillette	*Silphium laciniatum*	Probably has the same distribution as *S. rufus*, but difficult to separate from the former
Antistrophus rufus	*Silphium laciniatum*	All areas visited. Abundant in host plants along railroads.
Antistrophus silphii	*Silphium perforliatum*	17
Antistrophus sp1	*Silphium integrifolium*	8, 22
Antistrophus bicolor	*Silphium integrifolium*	5, 8, 15, 22. Very common species.
Unidentified sp1	*Unidentified species of Asteraceae*	16

3. *Is the Aylacini species diversity in the tallgrass prairies of North America under estimated?*
The primary hypothesis of this project is whether the gall wasp tribe Aylacini, whose members are often associated with tall grass prairie plant hosts, is under estimated. Result of this survey partly supports this hypothesis. Based on all field data including gall morphology, phenology, and host association, it is almost certain that the species that make terminal galls on *Silphium integrifolium* is a new species. Morphologically the species is very similar to *Antistrophus silphii* that makes similar terminal galls of *Silphium perforliatum.* An extension of the current project is trying to use

molecular data to further characterize this species and distinguish it from the others. On another Asteraceae plant that is obviously a *Helianthus* species, an Aylanini gall wasps species was collected as larvae. We were unable to identify the wasp species to genus because it was in larvae stage and we were not absolutely sure about the host plant species, and subsequent trip to the site (Kickapoo State Park, Vermilion Co) has not been able to solve this issue. However, it is highly believed that this is another new species with a host genus that has never been recorded. The *Aulacidea harringtoni* (Ashmead) collected on *Lactuca serreta* from the state is not collected from the recorded host plant species *Lactuca villosa.* In addition, another two new species has recently described (Tooker et al 2004). Given the fact that the present project has a relatively small scale and Tooker et al (2004) examined only a few host plant species, it is reasonable to believe that Aylacini species diversity in the tallgrass prairies of North America will eventually revealed to be much higher than it is known now.

4. Discovery of exotic gall wasp species in Illinois. In addition to species of the Aylacini tribe, an exotic species native to Europe was found in Kennekuk County Park, Vermillion Co. In its native place of Europe, this species is found abundant on wild rose bushes in disturbed habitats, such as forest gaps and edges of farm land. As is known to the author of this report, the species does not attack other plant species and pose no threat to its host plants. We found around a dozen of the galls on rose bushes in Kennekuk County Park, Vermillion Co.

5. ***Status of Antistrophus silphii.*** *Antistrophus silphii* makes spectacular terminal galls on *Silphium perforliatum* has not been collected for almost a century. Several recent publications concerning *Antistrophus silphii* are in fact misidentifications (Fay and Hartnett, 1991, Fay et al 1993, 1996; Fay and Throop 2005; also see discussion above new *Antistrophus* species). The population of *Antistrophus silphii* in Charleston area is the only one population found in Illinois so far, and an additional population may exist in Indiana (Tooker, pers. comm.). I have been monitoring the population in Charleston area (Table 1 and 3) since 2004, and the number of galls found on the site has been decreasing for unknown factors. Extensive efforts have been made to find more populations of the species in the state so far have not resulted in additional record. *We may have to propose to list the species for protection in the state of Illinois* and we will continue to conduct field survey throughout the spring and summer.

6. Epilogue. Field visits will be continued through the summer of 2007 field season while conduct another related IDNR project specifically designed to survey the status of *Antistrophus silphii.* to A manuscript describing the new species associated with Silphium integrifolium will be submitted for publication in end of 2007.

Literature cited

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Tooker JF, Deans AR, Hanks LM (2004) Description of the *Antistrophus rufus* (Hymenoptera: Cynipidae) species complex, including two new species. J Hymenoptera Research 13: 125–133

Digital photographs

Gall of *Antistrophus* new species on *Silphium integrifolium*, Nov 18 2006

Dissection of galls of *Aulacidea harringtoni* in stems of *Lactuca serreta,* Nov 19, 2006

Gall of Antistrophus silphii on *Silphium perfoliatum,* Dec 22, 2006

Gall of Diastrophus turgidus on *Rubus strigosus,* Dec 22, 2006