Flowering Plant Hosts of Adult Hymenopteran Parasitoids of Central Illinois

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ABSTRACT We tabulated flowering plant species visited by 151 species of parasitic Hymenoptera. These data were extracted from records of C. Robertson who collected >15,000 insect visitors of flowering plants in central Illinois during a 33-yr period. Species diversity of parasitoids was highest on plant species of the Apiaceae and Asteraceae. The most abundant parasitoids were 2 tiphiid and a scoliid species. Parasitoid species in 6 dominant families (Ichneumonidae, Braconidae, Chrysididae, Tiphiidae, Pteromalidae, and Eucoilidae) showed similar preferences for 10 plant species. Most parasitoid species visited a limited range of host plants, which may have implications for conservation biological control and conservation biology.

KEY WORDS biological control, flower, prairie, pollination, conservation

ADULTS OF MANY species of parasitic Hymenoptera visit flowering plants to feed on nectar or pollen (Jervis et al. 1993). These floral resources increase longevity and fecundity of parasitoids and so may influence rates of parasitism (Leius 1963, 1967a ; Syme 1975, 1977). For example, the presence of flowering plants increases parasitism rates of tent caterpillars as much as 18-fold (Leius 1967b). Although the availability of flowering plants has important implications for biological control of insect pests, little is known of the specific associations between parasitoid and flowering plant species (Jervis et al. 1993). This information is crucial because it can be used to predict where parasitoid species are likely to occur and provide valuable information for studies of biological control, insect ecology, and taxonomy. For example, natural enemies can be encouraged by increasing plant diversity, which provides alternative hosts for immatures, floral resources for adults, and hospitable microclimates (van Emden 1962, Risch 1981, Agnew and Smith 1989, Riechert and Bishop 1990). Higher plant diversity may result in increased insect diversity (Dean and Milton 1995) that may, in turn, lead to reduced levels of herbivory (Yue et al. 1994).

Here, we update and analyze information on host plant associations of parasitic Hymenoptera originally presented by Robertson (1928), who documented 15,172 insects visiting flowers of 453 plant species in the vicinity of Carlinville, IL, during a 33-yr period ". . . For the purpose of ascertaining the different kinds of insect visitors." Utility of this data set has been limited because collection records are arranged by plant species with no index to insect species, making it difficult to evaluate host ranges. We render Robertson's data more accessible by determining current species names of plants and the parasitic Hymenoptera that visited them, and listing host plant species for each insect species. We have analyzed the data set to identify plant species that were preferred by parasitoids, and to test for differences in host preference among parasitoid families.

Materials and Methods

We restricted our treatment of Robertson's data set to hymenopteran parasitoid families of the Parasitica and other families that are primarily parasitic (Clausen 1940, LaSalle and Gauld 1993), including Bethylidae, Chrysididae, Mutillidae, Sapygidae, Scoliidae, and Tiphiidae. We excluded families that are primarily predaceous, such as Pompilidae and Sphecidae. Hymenopteran species names and taxonomic affiliations were updated using the Hymenoptera catalog of Krombein et al. (1979). For species not listed in their catalog, we determined current names by locating and identifying Robertson's specimens, which are housed in the collection of the Illinois Natural History Survey. We checked plant species names using the latest edition of Robertson's original reference (Fernald 1950) and updated names with a more recent reference (Kartesz 1994).

Our analysis of Robertson's data was limited by a lack of information on his collection methods, such as time of season he collected, time of day, number of individuals collected, and whether he collected exhaustively or focused on rarer species. Robertson (1928) did however provide a qualitative index of abundance by indicating which wasp species were "abundant" or "frequent" visitors to particular plant species.

For Robertson's data, we ranked plant families and species by diversity of wasp visitors, ranked plant species by abundance of wasp species, ranked wasp families and species by their level of polyphagy, and used

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the nonparametric Kruskal–Wallis test to determine whether the dominant wasp families differed in the plant species they favored.

Results

Flowering Plant Hosts of Parasitoids. Robertson collected parasitic Hymenoptera from 112 species of flowering plants in 30 families (Table 1). Of these plants, 32 species (29%) were in the Asteraceae, 16 were in the Apiaceae (14.2%), 8 in the Fabaceae and Lamiaceae (7.1%), and 6 in the Asclepiadaceae (5.4%); the remaining plant families were represented by 4 or fewer species (<4%).

Species diversity of wasps was highest in the Apiaceae (umbellifers) with an average of 12.5 wasp species per plant species (Table 2), followed by the Berberidaceae (6.0 species), Euphorbiaceae (5.0 species), Polygonaceae (4.5 species), Lauraceae (4.0 species), Fabaceae (3.3 species), and Asteraceae (3.1 species), with only 1–3 wasp species per plant species for the remaining families. Among plant species, the greatest diversity of wasps was collected from umbellifers *Sium suave* Walter (with 38 species of wasps; Table 2), *Cicuta maculata* L. (37 species), *Pastinaca sativa* L. (36 species), *Oxypolis rigidior* (L.) Rafinesque-Schmaltz (33 species), and *Heracleum maximum* Bartram (20 species). Wasp diversity was also high on *Solidago canadensis* L. (Asteraceae; 16 species), *Perideridia americana* (Nuttall) Reichenbach (Apiaceae; 11 species), *Chamaecrista fasciculata* (Michaux) Green (Fabaceae; 11 species), *Aster pilosus* Willdenow (Asteraceae; 9 species), and *Eupatorium serotinum* Michaux (Asteraceae; 9 species).

Plant species on which parasitoids were particularly abundant (based on Robertson's "frequent" and "abundant" assessments; Table 2) included *Bidens aristosa* (Michaux) Britton (with 2 wasp species listed as numerous), *S. canadensis* (3 species) and *Solidago missouriensis* Nuttall (3 species) of the Asteraceae and umbellifers *C. maculata* (4 species) and *O. rigidior* (2 species).

Parasitoids That Visited Flowers. Among the 151 parasitoid species collected from flowers, the ichneumonids were best represented with 48 species (31.8% of all wasp species recorded; Table 2), followed by Braconidae (19.2%), Chrysididae (10.6%), Tiphiidae (7.3%), Pteromalidae (6.0%), and Eucoilidae (5.3%).

Wasp species that were most abundant on flowering plants included the tiphiid *Myzinum quinquecinctum* (F.), listed as abundant or frequent on 15 plant species in 8 families (Table 2), followed by scoliid *Scolia bicincta* F. on 6 plant species in 2 families, and tiphiid *Myzinum maculatum* (F.) on 3 species in 3 families; most wasp species were associated with only 1 or 2 plant species (Table 2). Scoliids and tiphiids showed the highest levels of average polyphagy (Table 3); a single leucospid species (*Leucospis* sp.) was also both abundant and highly polyphagous. Chrysidids showed an intermediate level of polyphagy (Table 3), whereas ichneumonids, braconids, and eucoilids had relatively narrow ranges of floral hosts (≈1 plant species per wasp species).

Wasps in the dominant families showed similar preferences for the 10 most visited plant species (Table 4; Kruskal–Wallis statistic = 8.33; $P = 0.14$; Sokal and Rohlf 1995; PROC NPAR1WAY, SAS Institute 1988); however, there were differences between families in the most and least preferred host plants. The plant species that were most preferred by wasps (with lowest rank proportion of wasp species; Table 4) were umbellifers *C. maculata*, *S. suave*, *O. rigidior*, and *P. sativa.*

Discussion

Flowering Plant Hosts of Parasitoids. The popularity of Apiaceae among parasitoids is explained by their floral structure; exposed nectaries and anthers are easily accessible by insects with generalized mouthparts. Many species of parasitic Hymenoptera do not have mouthparts specifically adapted for extracting pollen or nectar and so must feed on flowers with such open structure (Patt et al. 1997). Although, flowers of the Polygonaceae, Fabaceae, and Asteraceae have more concealed anthers and nectaries and so may exclude some wasp species (Jervis et al. 1993), they were nevertheless visited by wasp species of many families (Table 2).

Among the 5 most-visited species of flowering plants (umbellifers *S. suave*, *C. maculata*, *P. sativa*, *O. rigidior*, and *H. maximum*) the number of visiting wasp species could have been influenced by plant species abundance: very abundant plant species may have been sampled more intensively for insects than rarer plants. However, these 5 species range from rare to common in Illinois, depending on the region of the state being considered (Mohlenbrock 1986). For example, *S. suave* occurs only "occasionally" throughout the state, whereas *H. maximum* is "occasional" in the northern two-thirds (Mohlenbrock 1986); Robertson's sample area (Carlinville, IL) is in west central Illinois. Moreover, plant species that received lower diversities of visitors, such as *E. serotinum* and *A. pilosus* (9 wasp species each), are considered "common" throughout Illinois (Mohlenbrock 1986). Therefore, the species diversity of wasps on particular plant species may not be a consequence of plant species abundance, but rather a reflection of foraging preferences among wasp species.

Parasitoids That Visited Flowers. Many species in the wasp families collected by Robertson are important natural enemies of phytophagous insects and so may be considered beneficial to humans. For example, ichneumonids and pteromalids parasitize a wide range of hosts including Lepidoptera, Hymenoptera, Diptera, and Coleoptera (Clausen 1940, Debach and Rosen 1991), and a few species have been used effectively as biological control agents (Greathead 1986). Braconids also parasitize a similarly broad range of hosts (Debach and Rosen 1991); they are considered almost entirely beneficial (Clausen 1940) and many species have been introduced or conserved in biolog-

Table 1. Plant species from which parasitic Hymenoptera were collected by Robertson (1928)

Current plant species name	Species name cited (if different from current)	Species code	Family	No. of wasp spp. collected
Acer saccharum Marshall	—	*Acesac*	Aceraceae	1
Amorpha canescens Pursh	—	*Amocan*	Fabaceae	1
Antennaria plantaginifolia (L.) Richards	—	*Antpla*	Asteraceae	1
Arabis shortii (Fernald) Gleason	*A. dentata*	*Arasho*	Brassicaceae	1
Arnoglossum atriplicifolia (L.) H. E. Robinson	*Cacalia atriplicifolia*	*Arnatr*	Asteraceae	1
Arnoglossum plantagineum Rafinesque-Schmaltz	*Cacalia tuberosa*	*Arnpla*	Asteraceae	1
Asclepias incarnata L.	—	*Ascinc*	Asclepiadaceae	4
Asclepias longifolia Michaux	*Acerates floridana*	*Asclon*	Asclepiadaceae	2
Asclepias sullivantii Engelmann	—	*Ascsul*	Asclepiadaceae	2
Asclepias syriaca L.	—	*Ascsyr*	Asclepiadaceae	4
Asclepias verticillata L.	—	*Ascver*	Asclepiadaceae	3
Aster anomalus Engelmann	—	*Astano*	Asteraceae	1
Aster lanceolatus Willdenow	*A. paniculatus*	*Astlan*	Asteraceae	3
Aster pilosus Willdenow	*A. ericoides var. villosus*	*Astpil*	Asteraceae	9
Bidens aristosa (Michaux) Britton	—	*Bidari*	Asteraceae	5
Bidens laevis (L.) Britton, Sterns, Poggenberg	—	*Bidlae*	Asteraceae	2
Blephilia hirsuta (Pursh) Bentham	—	*Blehir*	Lamiaceae	1
Boltonia asteroides (L.) L'Heritier de Brutelle	—	*Bolast*	Asteraceae	2
Campanulastrum americanum (L.) Small	*Campanula americana*	*Camame*	Campanulaceae	1
Caulophyllum thalictroides (L.) Michaux	—	*Cautha*	Berberidaceae	6
Ceanothus americanus L.	—	*Ceaame*	Rhamnaceae	3
Cephalanthus occidentalis L.	—	*Cepocc*	Rubiaceae	1
Chaerophyllum procumbens (L.) Crantz	—	*Chapro*	Apiaceae	4
Chamaecrista fasciculata (Michaux) Green	*C. chamaecrista*	*Chafas*	Fabaceae	11
Chamaesyce nutans (Lagasca) Small	*E. preslii*	*Chanut*	Euphorbiaceae	1
Cicuta maculata L.	—	*Cicmac*	Apiaceae	37
Circaea lutetiana L.	—	*Cirlut*	Onagraceae	1
Clematis virginiana L.	—	*Clevir*	Ranunculaceae	1
Conyza canadensis L.	*Erigeron canadensis*	*Concan*	Asteraceae	1
Coreopsis palmata Nuttall	—	*Corpal*	Asteraceae	1
Cornus racemosa Lamarck	*C. paniculata*	*Corrac*	Cornaceae	1
Crataegus intricata Lange	*C. coccinea*	*Craint*	Rosaceae	1
Cryptotaenia canadensis (L.) DeCandolle	—	*Crycan*	Apiaceae	7
Cynanchum laeve (Michaux) Persoon	*Gonolobus laevis*	*Cynlae*	Asclepiadaceae	2
Dalea candida Michaux	*Petalostemum candidum*	*Dalcan*	Fabaceae	2
Dalea purpurea (Ventenat) Rydberg	*Petalostemum purpureum*	*Dalpur*	Fabaceae	2
Echinocystis lobata (Michaux) Torrey & Gray	—	*Echlob*	Cucurbitaceae	2
Enemion biternatum Rafinesque-Schmaltz	*Isopyrum biternatum*	*Enebit*	Ranunculaceae	1
Erechtites hieracifolia (L.) Rafinesque-Schmaltz	—	*Erehie*	Asteraceae	1
Erigenia bulbosa (Michaux) Nuttall	—	*Eribul*	Apiaceae	1
Erigeron strigosus Muhlenberg	*E. ramosus*	*Eristr*	Asteraceae	3
Eryngium yuccifolium Michaux	—	*Eryyuc*	Apiaceae	8
Eupatorium altissimum L.	—	*Eupalt*	Asteraceae	5
Eupatorium perfoliatum L.	—	*Eupper*	Asteraceae	8
Eupatorium serotinum Michaux	—	*Eupser*	Asteraceae	9
Eupatorium sessilifolium L.	—	*Eupses*	Asteraceae	1
Euphorbia corollata L.	—	*Eupcor*	Euphorbiaceae	5
Euthamia graminifolia (L.) Salisbury	*Solidago graminifolia*	*Eutgra*	Asteraceae	2
Geum canadense Jacquin	—	*Geucan*	Rosaceae	1
Gnaphalium obtusifolium L.	*G. polycephalum*	*Gnaobt*	Asteraceae	5
Helianthus laetiflorus Persoon	—	*Hellae*	Asteraceae	1
Helianthus tuberosus L.	—	*Heltub*	Asteraceae	1
Heliopsis helianthoides (L.) Sweet	—	*Helhel*	Asteraceae	1
Heracleum maximum Bartram	*H. lanatum*	*Hermax*	Apiaceae	20
Justicia americana (L.) Vahl	*Dianthera americana*	*Jusame*	Acanthaceae	1
Ludwigia polycarpa Short & Peter	—	*Ludpol*	Onagraceae	1
Lycopus americanus Muhlenberg	—	*Lycame*	Lamiaceae	4
Melanthium virginicum L.	—	*Melvir*	Liliaceae	1
Melilotus officinalis (L.) Lamarck	*M. alba*	*Meloff*	Fabaceae	2
Mentha arvensis L.	—	*Menarv*	Lamiaceae	2
Nelumbo lutea Willdenow	—	*Nellut*	Nymphaeaceae	2
Nepeta cataria L.	—	*Nepcat*	Nymphaeaceae	1
Orbexilum onobrychis (Nuttall) Rydberg	*Psoralea onobrychis*	*Orbono*	Fabaceae	1
Osmorhiza longistylis (Torrey) DeCandolle	—	*Osmlon*	Apiaceae	2
Oxypolis rigidior (L.) Rafinesque-Schmaltz	—	*Oxyrig*	Apiaceae	33
Parthenium integrifolium L.	—	*Parint*	Asteraceae	4
Pastinaca sativa L.	—	*Passat*	Apiaceae	36
Perideridia americana (Nuttall) Reichenbach	*Eulophus americanus*	*Perame*	Apiaceae	11
Physostegia virginiana (L.) Bentham	—	*Phyvir*	Lamiaceae	1
Polygonum hydropiperoides Michaux	—	*Polhyd*	Polygonaceae	8
Polygonum lapathifolium L.	—	*Pollap*	Polygonaceae	4

Table 1. Continued

Current plant species name	Species name cited (if different from current)	Species code	Family	No. of wasp spp. collected
Polygonum pennsylvanicum L.	—	*Polpen*	Polygonaceae	3
Polygonum scandens L.	—	*Polsca*	Polygonaceae	4
Polytaenia nuttallii DeCandolle	—	*Polnut*	Apiaceae	2
Prunus americana Marshall	—	*Pruame*	Rosaceae	1
Ptelea trifoliata L.	—	*Ptetri*	Rutaceae	2
Pycnanthemum flexuosum (Walter) Britton, Sterns, Poggenberg	—	*Pycfle*	Lamiaceae	8
Pycnanthemum verticillatum var. pilosum (Nuttall) Cooperrider	*P. pilosum*	*Pycver*	Lamiaceae	4
Pycnanthemum virginianum (L.) Durand & Jackson	—	*Pycvir*	Lamiaceae	4
Rhus aromatica Aiton	*R. canadensis*	*Rhuaro*	Anacardiaceae	1
Rhus copallinum L.	*R. copallina*	*Rhucop*	Anacardiaceae	4
Rhus glabra L.	—	*Rhugla*	Anacardiaceae	1
Rorippa teres (Michaux) Stuckey	*Radicula obtusa*	*Rorter*	Brassicaceae	2
Rudbeckia hirta L.	—	*Rudhir*	Asteraceae	1
Rudbeckia laciniata L.	—	*Rudlac*	Asteraceae	1
Rudbeckia subtomentosa Pursh	—	*Rudsub*	Asteraceae	3
Rudbeckia triloba L.	—	*Rudtri*	Asteraceae	4
Saggitaria latifolia Willdenow	—	*Saglat*	Alismaceae	2
Salix amygdaloides Andersson	—	*Salamy*	Salicaceae	1
Salix exigua Nuttall	*S. longifolia*	*Salexi*	Salicaceae	2
Salix humilis Marshall	—	*Salhum*	Salicaceae	3
Salix nigra Marshall	—	*Salnig*	Salicaceae	2
Sanicula marilandica L.	—	*Sanmar*	Apiaceae	1
Sassafras albidum (Nuttall) Nees	*S. variifolium*	*Sasalb*	Lauraceae	4
Silphium perfoliatum L.	—	*Silper*	Asteraceae	1
Sium suave Walter	*S. cicutaefolium*	*Siusua*	Apiaceae	38
Solidago canadensis L.	—	*Solcan*	Asteraceae	16
Solidago missouriensis Nuttall	—	*Solmis*	Asteraceae	7
Solidago ulmifolia Muhlenberg	—	*Solulm*	Asteraceae	1
Stellaria media (L.) Villars	—	*Stemed*	Caryophyllaceae	3
Strophostyles helvola (L.) Elliott	—	*Strhel*	Fabaceae	7
Symphoricarpus orbiculatus Moench	—	*Symorb*	Caprifoliaceae	3
Taenidia integerrima (L.) Drude	—	*Taeint*	Apiaceae	5
Thaspium trifoliatum (L.) Gray	—	*Thatri*	Apiaceae	1
Tilia americana L.	—	*Tilame*	Tiliaceae	1
Trifolium repens L.	—	*Trirep*	Fabaceae	1
Verbena hastata L.	—	*Verhas*	Verbenaceae	1
Verbena stricta Ventenat	—	*Verstr*	Verbenaceae	1
Verbena urticifolia L.	*V. urticaefolia*	*Verurt*	Verbenaceae	2
Verbesina alternifolia (L.) Britton	*Actinomeris alternifolia*	*Veralt*	Asteraceae	1
Zanthoxylum americanum Miller	—	*Zaname*	Rutaceae	1
Zizia aurea (L.) Koch	—	*Zizaur*	Apiaceae	5

Plant species codes are the first 3 letters of genus and species names.

ical control programs (Greathead 1986). Most tiphiid wasps are ectoparasites of scarab beetle larvae, and some species have been used as biological control agents against pest species; an example is *Tiphia popilliavora* Rohwer, introduced into the United States to control Japanese beetle (Clausen 1940). Eucoilids are larval-pupal parasitoids of Diptera (Clausen 1940, Krombein et al. 1979) and have been used as biological control agents against blow flies and horn flies (Legner 1977a, b).

Among these parasitoid families, those collected by Robertson did not differ significantly in their preference for the most popular host plants (Table 4). This finding suggests that these 10 plant species had broad appeal across wasp taxa and probably offer resources that are easily accessed by wasps of different sizes and with variable mouthpart morphology. Closer examination of the data reveals that most species of wasps were only collected from a small number of plant species, suggesting that many wasp species are oligophagous. This host plant fidelity may be advantageous for biological control programs because certain flowering species may be planted to attract species of parasitic wasps that attack specific pests.

Our summary of Robertson's data could be useful in selecting plant species to attract parasitoid species. For example, one of the wasp species that visited the greatest number of flowering plant species (Table 2), *M. quinquecinctum*, attacks beetle larvae of the genus *Phyllophaga* (Scarabaeidae: Melolonthinae; Krombein et al. 1979), which feed on roots of grasses and other plants. Many *Phyllophaga* species are economically important pests of lawns, pastures, and agricultural crops (Metcalf et al. 1962), and tiphiids are among their most important natural enemies (Clausen 1940). Parasitism rates inflicted by one species, *Tiphia vernalis* Rohwer, are greater where there is access to their adult food source; honeydew from aphids feeding on maple, elm, and other tree species (Gardner 1938). Because species of *Tiphia* are attracted to a variety of flower species (Table 2), levels of parasitism of *Phyl-*

Table 2. Parasitoid/host plant associations reported by Robertson (1928)

Wasp superfamily/ Family	Current wasp species name	Species name cited (if different from current)	Plant family and species code
Bethyloidea			
Bethylidae	*Goniozus* sp.	—	API: *Siusua*
Chrysididae	*Ceratochrysis kansensis* (Viereck)	*Gonochrysis* sp.	API: *Cicmac, Zizaur;* AST: *Astpil, Eupser, Gnaobt*
	Chrysis coerulans F.	*Tetrachrysis caerulans, T. nortonii*	API: *Cicmac, Oxyrig, Passat, Perame, Siusua*
	Chrysis inaequidens Dahlbom	*Chrysis texana*	FAB: *Chafas;* POL: *Polhyd*
	Chrysis intricata Brulle	—	API: *Taeint;* FAB: *Chafas*
	Chrysis montana Aaron	*Tetrachrysis montana*	API: *Cicmac;* AST: *Eristr;* FAB: *Chafas*
	Chrysis nitidula F.	*Tetrachrysis nitidula*	POL: *Polhyd*
	Chrysis venusta Cresson	*Tetrachrysis venusta*	API: *Cicmac, Oxyrig;* AST: *Gnaobt;* FAB: *Strhel*
	Chrysura sp.	—	API: *Cicmac*
	Chrysura pacifica (Say)	*Holochrysis hilaris*	API: *Eribul, Osmlon;* AST: *Antpla;* RUT: *Zaname;* SAL: *Salhum, Salnig*
	Hedychridium dimidiatum (Say)	—	API: *Cicmac*
	Hedychrum parvum Aaron	—	API: *Crycan;* AST: *Parint;* EUP: *Chanut;* FAB: *Strhel*
	Hedychrum violaceum Brulle	—	API: *Crycan, Oxyrig, Passat, Perame;* AST: *Eupper, Eupser, Solcan, Solulm;* LAM: *Pycfle;* POL: *Polhyd, Polsca;* RHA: *Ceaame;* ROS: *Geucan*
	Hedychrum wiltii Cresson	—	API: *Cicmac, Perame;* AST: *Eupalt, Eupper, Eupser, Solmis*[a]*;* EUP: *Eupcor;* LAM: *Lycame, Pycver, Pycvir;* POL: *Polhyd, Pollap*
	Holopyga sp.	—	API: *Cicmac*[b]*, Hermax, Oxyrig, Passat*[b]*, Perame, Siusua;* ASC: *Ascver;* AST: *Gnaobt;* EUP: *Eupcor;* FAB: *Chafas;* POL: *Polhyd*
	Notozus sp.	—	API: *Cicmac*
	Trichrysis doriae (Gribodo)	*Holochrysis verticalis*	API: *Siusua*
Chalcidoidea			
Chalcididae	*Ceratosmicra debilis* (Say)	*Smiera debilis*	API: *Siusua;* ONA: *Cirlut*
	Chalcis sp.	—	API: *Cicmac, Perame, Siusua;* AST: *Astpil*
	Haltichella onatas (Walker)	*H. ornata*	API: *Hermax, Siusua*
	Haltichella xanticles (Walker)	—	API: *Siusua*
	Spilochalcis side (Walker)	*Smicra torvina*	CAR: *Stemed;* COR: *Corrac*
Eulophidae	*Chrysocharis oscinidis* Ashmead	—	API: *Chapro*
	Elasmus sp.	—	API: *Hermax, Siusua*
Eurytomidae	*Bruchophagus* sp.	—	API: *Cicmac, Oxyrig, Siusua*
	Eurytoma sp.	—	API: *Polnut, Siusua*
Leucospidae	*Leucospis* sp.	—	ANA: *Rhucop;* API: *Cicmac, Eryyuc, Oxyrig, Passat, Siusua;* AST: *Eristr, Solcan*[b]*;* EUP: *Eupcor;* POL: *Polsca;* RHA: *Ceaame;* RUT: *Ptetri*
Pteromalidae	*Euperilampus triangularis* (Say)	*Perilampus triangularis*	API: *Cicmac, Passat;* LIL: *Melvir*
	Eutrichosoma sp.	—	API: *Oxyrig*
	Mesopolobus sp.	—	API: *Siusua*
	Pachyneuron sp.	—	API: *Passat*
	Perilampus fulvicornis Ashmead	—	API: *Hermax, Oxyrig, Perame;* AST: *Solcan*
	Perilampus hyalinus Say	*P. cyaneus*	API: *Cicmac, Oxyrig, Passat, Perame, Siusua;* AST: *Eupper, Solmis;* FAB: *Chafas;* POL: *Polsca*
	Perilampus platygaster Say	—	API: *Passat;* POL: *Polsca*
	Perilampus robertsonii Crawford	—	AST: *Solcan*
	Syntomopus sp.	—	API: *Siusua*
Cynipoidea			
Eucoilidae	*Cothonaspis* sp.	—	API: *Oxyrig*
	Eucoila erythropa (Ashmead)	*Psilodora erythropus*	API: *Cicmac, Siusua*
	Eucoila impatiens (Say)	*Psilodora impatiens*	API: *Cicmac, Passat, Perame, Siusua*
	Eucoila sp.	—	API: *Hermax*
	Eucoilidea sp.	—	API: *Hermax, Siusua, Zizaur*
	Eucoilidea canadensis Ashmead	—	API: *Cicmac*
	Kleidotoma sp.	*Trirhoptrasema* sp.	API: *Siusua*
	Pseudeucoila stigmata (Say)	*Eucoila mellipes*	API: *Siusua*[b]
Figitidae	*Figites impatiens* Say	—	API: *Oxyrig*[b]*, Siusua*
	Neralsia sp.	*Xyalosema* sp.	API: *Oxyrig, Perame, Siusua*
	Paraspicera sp.	*Aspicera* sp.	API: *Oxyrig, Passat*
	Xyalophora quinquelineata (Say)	*Figites "5-lineata"*	API: *Cicmac*
Evanoidea			
Evaniidae	*Hyptia* sp.	—	API: *Passat*
Gasteruptiidae	*Gasteruption assectator* (L.)	*Foenus incertus*	API: *Crycan, Passat, Taeint*
	Gasteruption tarsatorium (Say)	*Foenus tarsatorius*	API: *Cicmac, Crycan, Hermax, Osmlon, Passat, Thatri;* AST: *Solcan*

Table 2. Continued

Wasp superfamily/ Family	Current wasp species name	Species name cited (if different from current)	Plant family and species code
Ichneumonoidea			
Braconidae	*Agathis areolata* Spinola	—	API: *Oxyrig;* AST: *Solcan*[b]
	Agathis sp.	*Aenigmostomus* sp., *Microdus* sp.	AST: *Bidari, Rudhir*[b]*, Solmis;* SAL: *Salnig*[b]
	Agathis simillima Cresson	—	API: *Oxyrig*
	Apanteles crassicornis (Provancher)	—	API: *Oxyrig*
	Apanteles terminalis (Gahan)	—	API: *Siusua;* FAB: *Chafas*
	Atanycolus simplex (Cresson)	*Bracon simplex*	AST: *Solcan*
	Bracon sp.	*Habrobracon* sp., *Macrodyctium* sp.	API: *Hermax, Oxyrig, Passat*
	Bracon mellitor Say	*B. vernoniae*	API: *Cicmac;* AST: *Solcan;* BER: *Cautha*
	Bracon pygmaeus Provancher	*B. trifolii*	BER: *Cautha*
	Cardiochiles abdominale (Cresson)	*Toxoneuron abdominale*	API: *Oxyrig;* AST: *Corpal, Eupser*
	Cardiochiles sp.	—	API: *Passat*
	Chelonus sp.	—	API: *Oxyrig, Siusua;* AST: *Astano, Astpil, Gnaobt, Solcan*
	Coeloides scolytivorus Cresson	*Bracon longicauda*	AST: *Astlan, Eristr*
	Cremnops ashmeadi (Morrison)	*Bracon ashmeadi*	API: *Cicmac, Sanmar*
	Cremnops vulgaris (Cresson)	*Agathis vulgaris*	API: *Cicmac;* AST: *Astpil, Parint;* FAB: *Strhel*
	Dacnusa sp.	—	BER: *Cautha*
	Earinus sp.	—	ACE: *Acesac*
	Iphiaulax sp.	*Monogonogastra* sp.	API: *Cicmac, Oxyrig, Passat, Siusua;* AST: *Solcan*[a]
	Leiophron sp.	*Euphorus* sp.	API: *Passat*
	Microgaster sp.	—	API: *Cicmac;* BER: *Cautha*
	Microplitis ceratomiae Riley	—	API: *Siusua*
	Microplitis croceipes (Cresson)	—	API: *Oxyrig*
	Microplitis gortynae Riley	—	API: *Oxyrig, Passat*
	Microplitis illinoisensis Ashmead[c]	*Apanteles illinoensis*	API: *Siusua*
	Opius gahani Muesebeck	*O. fuscipennis*	API: *Oxyrig*
	Opius provancheri Dalla Torre	*O. provancheri*	BER: *Cautha*
	Orgilus sp.	—	API: *Cicmac, Passat;* ASC: *Asclon*
	Urosigalphus sp.	—	API: *Oxyrig*
	Vipio sp.	—	ANA: *Rhugla;* AST: *Parint*
Ichneumonidae	*Agrothereutes abbreviator iridescens* (Cresson)	*Gambrus albonotatus*	API: *Chapro*
	—[d]	*Agrothereutes limatus*	API: *Passat*
	Apophua simplicipes Cresson	*Glypta simplicipes*	API: *Passat*
	Calliephialtes notandus (Cresson)	*Pimpla notanda*	SAL: *Salexi*
	Ceratogastra sp.	*Ceratosoma* sp.	API: *Oxyrig*[a]*;* AST: *Bidari, Bolast, Concan, Eupalt, Eupper, Eupser, Hellae, Rudsub, Solcan, Solmis*[b]*;* EUP: *Eupcor;* POL: *Polpen*
	Colpognathus sp.	—	API: *Passat;* SAL: *Salhum*
	Cremastus cressoni Kerrich	*Porizon albipennis*	AST: *Eupper, Eupser*
	Cremastus epagoges (Gahan)	—	API: *Zizaur*
	Cryptus mundus Provancher	*Agrothereutes mundus*	API: *Siusua*
	Cryptus persimilis (Cresson)	—	API: *Siusua*
	Delomerista novita (Cresson)	*Pimpla novita*	CAR: *Stemed*
	Diadegma sp.	*Angitia* sp.	API: *Taeint*
	Diadegma pattoni (Ashmead)	*Limneria eurycreontis*	API: *Siusua;* AST: *Solcan*
	Diplazon sp.	—	FAB: *Strhel*
	Eiphosoma sp.	—	API: *Passat*
	Endasys subclavatus (Say)	*Phygadeuon vulgaris*	API: *Hermax*
	Eutanyaora succinctus (Brulle)	—	API: *Passat*
	Exetastes obscurus Cresson	—	AST: *Astpil*
	Exetastes suaveolens Walsh	—	AST: *Bidari*[b]*, Bidlae, Rudtri*
	Exyston clavatum (Cresson)	—	API: *Zizaur*[a]
	Gambrus apicatus (Provancher)	—	API: *Chapro*
	Glypta rufiscutellaris Cresson	—	LAU: *Sasalb;* SAL: *Salamy*[b]
	Glypta tricincta Provancher	*Lissonota tricincta*	API: *Crycan*
	Hemiteles sp.	—	API: *Passat*
	Ichneumon ambulatens (F.)	*I. flavizonatus, I. jucundus*	API: *Cicmac, Hermax, Oxyrig, Passat, Siusua;* ASC: *Ascsul*
	Ichneumon annulaterus (F.)	*I. funestus*	API: *Hermax;* SAL: *Salhum*
	Ichneumon longulus (Cresson)	—	API: *Hermax*
	Idiolispa sp.	—	LAU: *Sasalb*
	—[d]	*Lampronota coxalis*	ANA: *Rhuaro*
	Lissonata sp.	*Bathycetes* sp.	ROS: *Pruame*
	Lissonota montana (Cresson)	*Lampronota americana*	API: *Hermax;* AST: *Astlan, Solcan*
	Metopius pollinctorius (Say)	—	AST: *Astpil, Gnaobt, Solcan*
	Ophion sp.	—	LAU: *Sasalb*
	Ophionellus sp.	*Pharsalia* sp.	API: *Taeint*

Table 2. Continued

Wasp superfamily/ Family	Current wasp species name	Species name cited (if different from current)	Plant family and species code
	Pimpla annulipes (Brulle)	—	LAU: *Sasalb*
	—[d]	*Pimpla marginata*	API: *Chapro*
	Polyblastus sp.	—	API: *Crycan*
	Polysphincta sp.	—	API: *Crycan*
	Proclitus sp.	—	API: *Passat*
	Sinophorus furus (Cresson)	*Limneria fura*	FAB: *Strhel*
	Tersilochus conotracheli (Riley)	*Porizon conotracheli*	API: *Hermax, Passat*
	Trathala retiniae (Cresson)	*Crematus retiniae*	API: *Siusua;* AST: *Solcan*
	Trogus sp.	—	API: *Passat*
	Trogus pennator (F.)	*T. vulpinus*	API: *Hermax*
	Trychosis subgracilis (Cresson)	*Cryptus rufoannulatus*	API: *Passat*
	Trychosis exulans (Cresson)	*Cryptus exulans*	API: *Perame*
	Tryphon americanus Cresson	*T. affinis*	API: *Hermax*
	Tryphon seminiger Cresson	*Metopius terminalis*	API: *Hermax, Passat;* BRA: *Rorter*
Platygasteroidea			
Scelionidae	*Teleas* sp.	—	API: *Passat*
	Trimorus longipennis (Ashmead)	*Prosacantha* sp.	BER: *Cautha*
Vespoidea			
Mutillidae	*Ephuta scrupea* (Say)	*Mutilla scrupea*	FAB: *Strhel*
	Pseudomethoca sp.	—	API: *Cicmac*
	Sphaeropthalma sp.	—	API: *Cicmac, Oxyrig, Passat, Siusua;* FAB: *Chafas, Strhel;* POL: *Polhyd*
	Timulla sayi (Blake)	*Mutilla sayi*	API: *Cicmac;* FAB: *Chafas*
	Timulla vagans vagans (F.)	*Mutilla hexagona*	API: *Cicmac, Eryyuc, Oxyrig, Passat;* FAB: *Chafas*[b]
Sapygidae	*Sapyga* sp.	—	BRA: *Arasho;* CAR: *Stemed;* RAN: *Enebit*
Scoliidae	*Campsomeris* sp.	—	ACA: *Jusame;* ASC: *Ascsyr;* FAB: *Dalpur, Trirep;* LAM: *Pycfle;* RUT: *Ptetri*
	Scolia bicincta F.	—	ANA: *Rhucop;* API: *Cicmac*[b], *Eryyuc, Oxyrig, Siusua;* ASC: *Ascinc, Ascsyr;* AST: *Astpil, Bidari*[a], *Bidlae*[b], *Bolast, Arnatr, Eupalt, Eupper*[a], *Eupser, Eupses, Eutgra, Heltub, Helhel, Rudlac, Rudsub*[b], *Rudtri, Silper, Solmis*[b], *Veralt;* CAP: *Symorb;* CUC: *Echlob;* LAM: *Lycame, Phyvir, Pycfle, Pycver, Pycvir;* NYM: *Nellut;* POL: *Pollap, Polpen;* RAN: *Clevir;* VER: *Verhas, Verurt*
	Scolia nobilitata nobilitata F.	—	API: *Eryyuc;* LAM: *Pycfle*
	—[d]	*Scolia thoracica*	API: *Eryyuc*
Tiphiidae	*Methocha* sp.	*Methoca* sp.	API: *Perame, Siusua*
	Myzinum carolinianum collare (Say)	*Elis thoracica*	API: *Cicmac;* LAM: *Pycfle*
	Myzinum maculatum (F.)	*Elis interrupta*	ALI: *Saglat;* ANA: *Rhucop;* API: *Cicmac*[b], *Eryyuc, Siusua;* ASC: *Ascinc, Ascver, Cynlae;* AST: *Astpil, Eupalt, Eupper*[a], *Rudtri, Solmis;* FAB: *Dalcan;* LAM: *Lycame*[b], *Menarv, Pycfle, Pycver, Pycvir;* NYM: *Nellut;* ONA: *Ludpol;* POL: *Pollap*
	Myzinum obscurum (F.)	*Elis obscura*	API: *Cicmac, Eryyuc;* ASC: *Ascinc, Ascsyr;* CAP: *Symorb;* LAM: *Pycfle*[a]
	Myzinum quinquecinctum (F.)	*Elis "5-cincta"*	ALI: *Saglat;* ANA: *Rhucop;* API: *Cicmac*[a], *Eryyuc, Oxyrig, Passat, Siusua;* ASC: *Ascinc*[b], *Asclon, Ascsul, Ascsyr, Ascver*[b], *Cynlae*[b]; AST: *Arnpla, Astpil, Astlan, Bidari, Erehie, Eupalt, Eupper*[b], *Eupser, Eutgra, Parint, Rudsub, Rudtri, Solmis*[a]; CAM: *Camame;* CAP: *Symorb*[b]; CUC: *Echlob;* EUP: *Eupcor*[b]; FAB: *Amocan, Dalcan*[a], *Dalpur*[b], *Meloff, Orbono;* LAM: *Blehir, Lycame*[b], *Menarv*[b], *Nepcat, Pycfle*[a], *Pycver*[a], *Pycvir;* POL: *Polhyd, Pollap, Polpen*[b]; RHA: *Ceaame;* RUB: *Cepocc;* SAL: *Salexi;* TIL: *Tilame;* VER: *Verstr, Verurt*
	Tiphia illinoensis Robertson	*T. robertsoni*	API: *Cicmac;* AST: *Eupser;* FAB: *Chafas*
	Tiphia inornata Say	—	API: *Hermax, Polnut*
	Tiphia intermedia Malloch	*T. punctata*	API: *Oxyrig, Siusua;* AST: *Solcan;* FAB: *Chafas*
	Tiphia letalis Roberts	—	API: *Hermax, Oxyrig, Taeint, Zizaur;* BRA: *Rorter;* POL: *Polhyd;* ROS: *Craint*
	Tiphia transversa Say	—	API: *Cicmac, Oxyrig*
	Tiphia vulgaris Robertson	—	API: *Hermax*[a], *Passat;* FAB: *Meloff*

Plant families are abbreviated to 3 letters (see Table 1) and species to the first 3 letters of genus and species names (see Table 1).
[a] Plant species on which particular wasp species were listed by Robertson (1928) as "abundant."
[b] Plant species on which particular wasp species were listed by Robertson (1928) as "frequent."
[c] Nomen nudum.
[d] Could not confirm current name and specimen could not be located.

Table 3. Species diversity and level of polyphagy for parasitoid species collected by Robertson (1928)

Family	No. of species	No. of genera	No. of plant species visited	No. of plant genera visited	No. of plant families visited	Avg. no. of plant species visited per wasp species
Ichneumonidae	48	35	37	29	12	0.8
Braconidae	29	18	25	22	8	0.9
Chrysididae	16	8	38	29	11	2.4
Tiphiidae	11	3	63	48	21	5.7
Pteromalidae	9	6	12	11	5	1.3
Eucoilidae	8	5	7	7	1	0.9
Chalcididae	5	4	8	8	5	1.6
Mutillidae	5	4	8	8	3	1.6
Figitidae	4	4	5	5	1	1.3
Scoliidae	4	2	42	32	14	10.5
Eulophidae	2	2	3	3	1	1.5
Eurytomidae	2	2	4	4	1	2
Gasteruptiidae	2	1	8	8	2	4
Scelionidae	2	2	2	2	2	1
Bethylidae	1	1	1	1	1	1
Evaniidae	1	1	1	1	1	1
Leucospididae	1	1	12	12	7	12
Sapygidae	1	1	3	3	3	3
Mean	8.4	5.6	15.5	12.9	5.5	2.9
Standard deviation	12.1	8.4	17.9	3.2	1.3	3.3

lophaga species could be increased by planting a diversity of appropriate flowers in the area. Another example of an application of these data would be encouraging the ichneumonid *Glypta rufiscutellaris* Cresson, to control oriental fruit moth, *Grapholitha molesta* (Busck) (Krombein et al. 1979), by planting its floral host *Salix amygdaloides* Andersson (Table 2).

The fact that the level of polyphagy was higher in the more abundant wasp species (such as *S. bicincta* and *M. quinquecinctum;* Table 2) suggests that our measure of host specificity is an artifact of sample size (see Jervis et al. 1993). A significant positive relationship between host range of wasp species (number of plant species listed as hosts) and the number of plant species on which they were listed as abundant or frequent (Fig. 1) suggests that abundant wasp species tended to be collected from a greater number of plant species. Nevertheless, this correlation may also be a result of polyphagous species simply being more abundant than species with narrow host ranges. To test this alternative hypothesis, we regressed host range of 11 wasp species in 8 families on an unbiased index of species abundance in the state of Illinois, the number of specimens in the museum of the Illinois Natural History Survey. There was no significant linear relationship between host range (number of plant species visited) and wasp abundance (number of specimens; $r^2 = 0.36$, $P > 0.05$). These findings suggest that more abundant wasp species are not necessarily more polyphagous when feeding on flowering plants.

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Table 4. Proportion of species within the dominant wasp families that were associated with the 10 plant species that yielded the most wasp specimens (those having >5 wasp species; from Robertson [1928])

Plant species	Plant family	Proportion of wasp species (rank)						
		Ichneumonidae	Braconidae	Chrysididae	Tiphiidae	Pteromalidae	Eucoilidae	Mean rank
Pastinaca sativa	Apiaceae	30.8 (1)	15.8 (2)	9.1 (3)	7.4 (4)	22.2 (1)	7.7 (4)	2.5
Heracleum maximum	Apiaceae	23.1 (2)	2.6 (5)	3.0 (4)	11.1 (3)	5.6 (4)	15.4 (3)	3.5
Sium suave	Apiaceae	12.8 (3)	13.2 (3)	9.1 (3)	14.8 (2)	16.7 (2)	38.5 (1)	2.3
Solidago canadensis	Asteraceae	12.8 (3)	13.2 (3)	3.0 (4)	3.7 (5)	11.1 (3)	0.0 (5)	3.8
Oxypolis rigidior	Apiaceae	5.1 (4)	28.9 (1)	12.1 (2)	14.8 (2)	16.7 (2)	7.7 (4)	2.5
Aster pilosus	Asteraceae	5.1 (4)	5.3 (4)	3.0 (4)	7.4 (4)	0.0 (5)	0.0 (5)	4.3
Eupatorium serotinum	Asteraceae	5.1 (4)	2.6 (5)	9.1 (3)	7.4 (4)	0.0 (5)	0.0 (5)	4.3
Cicuta maculata	Apiaceae	2.6 (5)	15.8 (2)	27.3 (1)	22.2 (1)	11.1 (3)	23.1 (2)	2.3
Perideridia americana	Apiaceae	2.6 (5)	0.0 (6)	12.1 (2)	3.7 (5)	11.1 (3)	7.7 (4)	4.2
Cassia fasciculata	Fabaceae	0.0 (6)	2.6 (5)	12.1 (2)	7.4 (4)	5.6 (4)	0.0 (5)	4.3

Plant species are arranged by increasing rank within the Ichneumonidae.

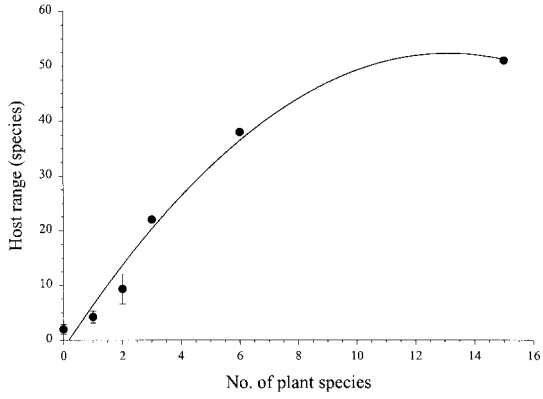

Fig. 1. Relationship between number of plant species on which wasp species were abundant or frequent and the mean ± SD number of plant species. Data are for 129 wasp species of the dominant 9 families (see text); sample sizes were 110, 13, 3, 1, 1, and 1 for X values of 0, 1, 2, 3, 6, and 15, respectively. Best fit regression equation: $Y = -0.31X^2 + 8.2X - 1.5$, $r^2 = 0.98$; $P < 0.005$.

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