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FLOWER ASSOCIATIONS OF MIMETIC SYRPHIDAE (DIPTERA) IN NORTHERN MICHIGAN

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ABSTRACT

Collections of specialized (high fidelity) mimetic Syrphidae in northern Michigan revealed 19 species associated with 18 flowering plants. Almost 97% of these syrphids were taken on seven plant species or species groups, all with conspicuous white or yellow blossoms, and all but one with aggregate inflorescences. *Pastinaca sativa* (Umbelliferae) is visited by many mimetic syrphids in northern Michigan but by very few in central Illinois; the opposite is true of *Sambucus canadensis* (Caprifoliaceae). In northern Michigan mimetic syrphids exploit a sequence of blossoming plants that more or less replace each other as the season progresses. The cooling effect of Lake Michigan slows the development of vegetation and the appearance of mimetic syrphids along the shore by over two weeks as compared to a transect only 6.5 to 17 km inland. Because of the normally cooler temperatures in northern Michigan, syrphids appear on flowers later in the day and remain there longer than they do in central Illinois.

Syrphidae that are specialized (high fidelity) mimics of aculeate Hymenoptera occur mostly in spring, when their hymenopteran models are least abundant, rather than from mid- to late summer when their models are the most abundant. This seemingly paradoxical phenology is adaptive because the mimics in this way avoid the severe threat in mid-summer when young birds that have not yet learned to avoid stinging Hymenoptera leave the nest to forage on their own (Waldbauer and Sheldon 1971, Waldbauer et al. 1977). Mimicry is effective in spring because migratory birds return with their avoidance response to stinging Hymenoptera intact (Evans and Waldbauer 1982). The blossoming plants that are exploited by mimetic syrphids for pollen and nectar are thus of particular interest because their phenologies affect the phenologies of the mimics, and because identifying these plants is a prerequisite to devising an efficient sampling procedure to determine the seasonal distribution of the mimics.

The literature on the flower associations of Syrphidae (see Weems 1953, Maier and Waldbauer 1979b, Gilbert 1981, Owen 1981) is scattered and includes relatively little information on North American Eristalinae (= Milesiinae), the subfamily that includes most of the specialized mimics. Many associations of mimetic syrphids and flowering plants can be extracted from Robertson's (1928a) voluminous data from southern Illinois. Weems (1953) cited some of the older literature and listed plants on which syrphids are generally collected. Maier and Waldbauer (1979a,b) presented quantitative data on the flowers visited by several mimetic eristaline Syrphidae. Many Syrphidae feed on both nectar and pollen (Gilbert 1981), and in some species pollen has been shown to be necessary for normal ovarian development (Schneider 1948, Maier 1978).

The data from northern Michigan presented here concern a group of little studied, high fidelity mimetic Syrphidae that are particularly numerous in the ecotone between the boreal and deciduous forests. The phenological relationships of these syrphids with their models, insectivorous birds, and flowering plants are especially interesting because of the phenological compression resulting from the shortness of the growing season in this area.

These data are part of a phenological study of high fidelity syrphid mimics of bumblebees or vespoid wasps as defined by Waldbauer and Sheldon (1971) and Waldbauer et al. (1977). Bumblebee mimics are defined as having a bumblebee-like color

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pattern and being at least moderately pilose. Few syrphids other than bumblebee mimics are moderately to heavily pilose. Vespoid mimics are defined as having a vespoid-like color pattern as well as one or both of the following: (1) a band of brown pigment along the costal margin of the wing in imitation of the furled vespoid wing; (2) lengthened antennae or the use of the forelegs to mimic the long dark antennae of the wasps. With few exceptions non-mimetic or bumblebee-mimicking Syrphidae have the short antennae typical of the cyclorrhaphous Diptera (Waldbauer 1970). They do not use the legs to mimic antennae, and they do not have a brown costal band.

MATERIALS AND METHODS

Collections were made at three sites in northern Michigan that are easily located on the Michigan Transportation Commission's county highway maps. Emmet County, at the tip of the Lower Peninsula, includes two sites: (1) the Reed Road site is a 10.5 km transect just west of Highway 31, running south along Reed Road from near Carp Lake to about 5 km north of Pellston. It includes clearings, side roads and an abandoned railway within 1 km on either side of Reed Road; (2) the Wilderness site, on the Lake Michigan shore about 6.5 km southwest of Mackinaw City, runs west from French Farm Creek for about 2.5 km along Wilderness Park Drive. Mackinac County, in the Upper Peninsula just across the Straits of Mackinac from Emmet County, includes the third site, a 1-km length of Round Lake Road about 11 km northwest of Evergreen Shores. These sites are characterized by second growth stands of mixed conifers and non-coniferous trees on the uplands and by spruce-tamarack bogs on the lowlands.

In 1982 samples were taken with a hand net on 15, 16, and 22 May, on every clear or partly clear day from 2 June to 18 August, and on 25 August and 4 September. Collections were made at the forest edge along roadsides, clearings, and the abandoned railway. Every plant in blossom was checked several times to determine if it attracted mimetic syrphids. Those that did were regularly sampled. Sampling usually began in early morning before syrphids had started to visit flowers and continued until the number of syrphids present diminished, usually from early to mid-afternoon. Every high fidelity mimic seen was pursued; about 75% were caught. The syrphids were identified by the author. Voucher specimens are held in his collection. Voucher specimens of the plants are held by the herbarium, Department of Botany, University of Illinois. Air temperature and percent relative humidity were measured in the shade at breast height with a motor driven psychrometer.

RESULTS AND DISCUSSION

Collections of 19 species of high fidelity mimetic Syrphidae were made (Table 1). Four species, *Eristalis barda, Mallota bautias, M. posticata*, and *Volucella bombylans*, are bumblebee mimics; the others mimic various vespoid wasps. One bumblebee mimic, *Eristalis bastardii* Macquart, was not collected quantitatively. It was scarce at Reed Road but common at the Wilderness site around *Physocarpus opulifolius*. It was much more difficult to collect than any of the other mimics because, rather than visiting the upper portions of these shrubs, it darts among the ground cover plants at the bases of the shrubs and visits mostly low *P. opulifolius* blossoms partly hidden by the ground cover. Including this species in the study would have greatly decreased the catch of all mimics.

Mimetic Syrphidae were collected from 18 species or species groups of blossoming plants, but almost 97% (941 specimens) were associated with the seven listed in Table 1. *Cornus alternifolia* was also attractive to mimetic syrphids but is poorly represented in the collections (seven specimens) because only two individuals of this plant species were found. Twenty-four specimens were taken from the following plants: *Clematis virginiana* L., *Cornus rugosa* Lam., *Eupatorium maculatum* L., *Nasturtium officinale* R.Br.,

Table 1. Number of mimetic Syrphidae taken on or near the blossoms of the indicated plants during the summer of 1982. All collections from the Reed Road, Wilderness, and Round Lake Road sites are included.

SYRPHIDAE	*Anemone canadensis* L.	*Cornus stolonifera* L.f.	*Pastinaca sativa* L.[a]	*Physocarpus opulifolius* (L.)	*Solidago* spp.[a,b]	*Viburnum cassinoides* L.	*Viburnum trilobum* Marsh.	Other plants	TOTALS
Ceriana abbreviata (Loew)	0	0	1	0	0	1	0	0	2
Chrysotoxum sp.	0	0	2	0	1	0	0	4	7
Doros aequalis Loew	1	1	0	3	0	2	1	0	8
Eristalis barda (Say)	2	0	6	17	1	0	0	5	31
Mallota bautias (Walker)	0	0	0	8	0	3	0	0	11
M. posticata (Say)	0	5	1	8	0	4	3	0	21
Sericomyia chrysotoxoides Macquart	7	3	2	4	0	2	0	1	19
S. militaris Walker	2	1	0	2	0	1	0	2	8
Somula decora Macquart	1	0	1	1	0	2	1	0	6
Sphecomyia vittata Wiedemann	1	0	0	2	0	1	0	1	5
Spilomyia fusca Loew	0	0	77	0	9	0	0	4	90
S. quadrifasciata (Say)	0	0	0	0	37	0	0	0	37
Temnostoma alternans Loew	58	44	11	144	0	61	64	4	386
T. balyras (Walker)	7	18	0	2	0	2	14	2	45
T. barberi Shannon	48	22	2	44	0	31	31	7	185
T. obscurum Loew	3	3	0	5	0	1	1	0	13
T. venustum Williston	0	0	0	0	0	2	0	0	2
T. vespiforme (L.)	10	13	3	29	0	33	3	1	92
Volucella bombylans (L.)	1	0	2	1	0	0	0	0	4
TOTALS	141	110	108	270	48	146	118	31	972

[a]Plants blossoming from late July to September; all others are spring and early summer species.
[b]*Solidago* spp. = *S. rugosa* Mill., *S. canadensis* L., and *S. gigantea* Ait.

Prunus virginiana L., *Rhus glabra* L., *Salix bebbiana* Sarg., *Spiraea alba* DuRoi, *Verbascum thapsus* L., and *Viburnum lentago* L.

The blossoms of the major host plants (Table 1) all have nectar or pollen readily accessible to Syrphidae with relatively short mouthparts. The blossoms of the spring and early summer plants are white, while those of the late summer plants are yellow (Table 1). Except for *Anemone canadensis*, all of them have large and very conspicuous aggregate inflorescences with many small blossoms. The large petal-like sepals of *A. canadensis* are also quite conspicuous. The host plants not listed in Table 1 also have more or less readily accessible nectar or pollen; all are white or yellow except for the yellowish-green *Rhus glabra* and the pink *Eupatorium maculatum*; and all have conspicuous aggregate inflorescences. Only three of the plants from which syrphids were collected during the present study are not native; *Nasturtium officinale, Pastinaca sativa*, and *Verbascum thapsus* are all introduced from Europe.

Robertson (1928b) reported that 1165 pollinating visits to flowers by syrphids were distributed as follows: 58.8% to white, 33.9% to yellow, and 7.2% to red blossoms. He found that, of 90 syrphid species, only *Rhingia nasica* Say preferred red blossoms. Weems (1953) stated that most blossoms visited by syrphids are white, yellow, or green. Furthermore, most of the syrphid flowers that he listed have conspicuous aggregate inflorescences.

Weems (1953) found that the utilization of a blossoming plant by syrphids may vary geographically. This is illustrated by a comparison of *Pastinaca sativa* and *Sambucus canadensis* L. in central Illinois and northern Michigan. In central Illinois *P. sativa* blossoms in June when high fidelity syrphid mimics are most abundant, but it attracts very few of them, although it is visited by many other common syrphids. The paucity of high fidelity mimics among the syrphid visitors may be due to the fact that this plant seldom grows near the woodland larval habitats of the mimics, and that it blossoms at the same time as several native plants that are abundant and highly attractive to mimetic syrphids, notably *Sambucus canadensis* and several species of *Cornus*. In contrast, in northern Michigan *P. sativa* attracts many high fidelity syrphid mimics (Table 1). In this area, larval habitat for these mimics is widespread, occurring near most stands of *P. sativa*. Furthermore, this plant blossoms when other good syrphid flowers are relatively scarce, after *Anemone canadensis* has finished blossoming and before the common species of *Solidago* have started (Fig. 1). *Sambucus canadensis* is visited by many high fidelity mimetic Syrphidae in central Illinois (Maier and Waldbauer 1979a,b) but not in northern Michigan. In 1980 and 1981, when mimetic syrphids were very abundant in northern Michigan, a few were taken on *S. canadensis*, but in 1982, when they were less abundant, none were found on *S. canadensis*. In central Illinois, *S. canadensis* blossoms in June and early July when high fidelity mimetic syrphids are abundant. In northern Michigan it blossoms during the last three weeks of July when they are almost absent.

The high fidelity mimetic Syrphidae of northern Michigan are served by a sequence of blossoming plants that more or less replace each other as the season progresses, the syrphid population shifting from plant to plant as each passes its blossoming peak (Fig. 1). *Cornus stolonifera*, the two *Viburnum* species, and *Anemone canadensis* are exploited by a group of spring and early summer mimics, the most numerous of which are the *Temnostoma* listed in Table 1. The *Solidago* species and *Pastinaca sativa* are exploited by a group of late summer mimics that is largely different from the early group in species composition. Two *Spilomyia* (Table 1) are the most abundant members of the late group. The late group's mimicry is presumably effective because this group appears after most young birds of the year have learned to avoid bumblebees and vespoid wasps. *Pastinaca sativa* is visited mostly by late mimics but blossoms just early enough to attract the last few of the early mimics. *Anemone canadensis* continues to blossom from the period of peak abundance of the early mimics until July when there is a hiatus between the early and late mimic groups. *Physocarpus opulifolius* does not appear in Figure 1 because the Reed Road site, where it was rare, and the Wilderness site, where it was abundant, are phenologically different, as discussed below, and are thus not comparable.

At the Wilderness site plants blossomed over two weeks later than at the nearby Reed Road site (Table 2). The Reed Road site is inland, but the Wilderness site runs along the

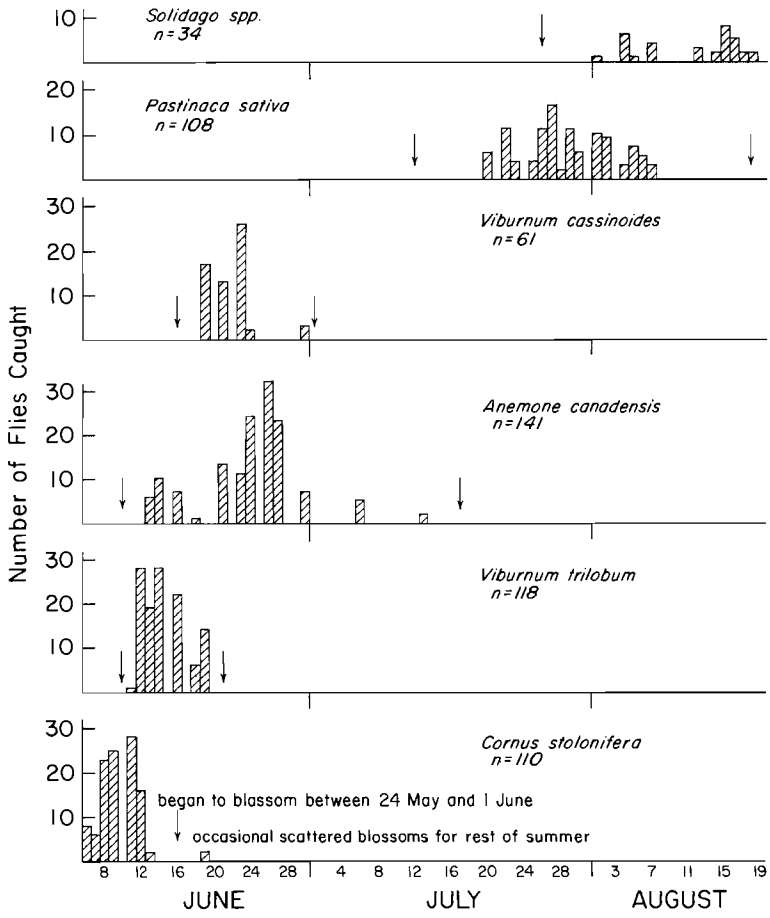

Fig. 1. Total numbers of 19 species of mimetic Syrphidae taken daily from their major host plants along Reed Road during summer 1982. Arrows indicate the approximate first and last dates of blossoming of the plant specimens from which flies were collected.

Straits of Mackinac and is at most a few hundred meters from the Lake Michigan shore. Strommen (1974) stated that there is a pronounced lake effect, with the cold water of Lake Michigan lowering the air temperature in spring and thus delaying the development of vegetation along the shore. The lake effect is far less noticeable only a few kilometers inland. The northern end of the Reed Road transect, about 6.5 km south of the Straits, differed in blossoming times from the south end of the transect, about 17 km south of the Straits, by no more than two days. The data given by Strommen (1974) for the weather stations closest to the Reed Road and Wilderness site (Pellston and Mackinaw City, respectively) indicate that the lake effect is due mainly to a lower mean daily maximum temperature along the shore in May and June.

Although the data for the Wilderness and Round Lake Road sites cover only parts of late June and early July, they indicate that the appearance of mimetic Syrphidae near the

Table 2. Approximate difference between the Reed Road site and an area along the Straits of Mackinac (includes Wilderness site) in the peak blossoming dates of several plants.

	Blossom peak at Reed Road	Delay of peak at Straits of Mackinac[a]
Prunus virginiana	⟨May 22	⟩12 days
Syringa vulgaris L.	June 3	16 days
Viburnum cassinoides	June 19	15 days
Physocarpus opulifolius	June 23[b]	17 days[b]
Cornus rugosa	June 24	16 days

[a]All except *V. cassinoides* were growing on the south shore of the Straits between Mackinaw City and Wilderness State Park. *V. cassinoides* grew ca. 2.4 km north of the north shore of the Straits at the Round Lake Road site.

[b]Refers only to plants growing in partial shade; plants in full sun blossomed about 10 days earlier at both sites.

Straits of Mackinac is delayed by about as long as is the development of the vegetation. Mimetic syrphids had almost disappeared from Reed Road by late June and early July, but they were abundant at the Wilderness site from 28 June to 10 July and at the Round Lake Road site from 2 July to 5 July. The later site is in the Upper Peninsula about 2.4 km north of Lake Michigan.

Climatic differences cause a difference in the diurnal activity patterns of mimetic Syrphidae in central Illinois and northern Michigan. In central Illinois the air warms rapidly after sunrise and there is a corresponding decrease in the percent relative humidity, subjecting flies to severe hygrothermal stress by late morning. Consequently, except on

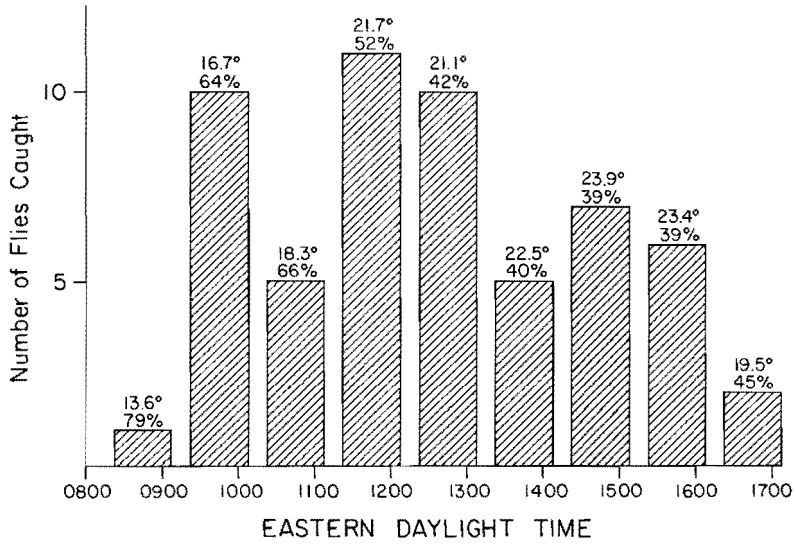

Fig. 2. Number of mimetic Syrphidae caught during the second half of each hour while flying near or sitting on the blossoms or foliage of *Physocarpus opulifolius* at the Wilderness site on 1 July 1982. Temperature and percent relative humidity at the beginning of the collecting period are indicated above each bar.

unusually cool days, mimetic Syrphidae are active at flowers by 0800 CDT; the number present peaks by 0900 and then drops abruptly after 1100. Most of them have retreated to the shady forest by 1200 (Maier and Waldbauer 1979b). In northern Michigan, the activity schedule at flowers was similar on two or three exceptionally hot days. However, on most days the air was slow to warm in the morning and even the afternoons remained cool. Figure 2 shows mimic activity at *Physocarpus opulifolius* on a fairly typical clear day in Northern Michigan. No flies appeared at the blossoms until 0900 EDT. (On cool mornings the first mimics seen were sometimes basking in the sun on leaves.) The flies were abundant by 1000; their numbers did not decline until after 1300, and they were present in reduced numbers until the air temperature began to drop at about 1700.

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