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LARVAL HABITATS AND MATE-SEEKING SITES OF FLOWER FLIES (DIPTERA: SYRPHIDAE, ERISTALINAE)

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Abstract.—Larval habitats of 26 species and mate-seeking locations of 30 species of Syrphidae (subfamily Eristalinae) are described. Males search for mates near flowering plants and/or larval habitats. These observations confirm and extend previous findings, which indicate that males seek mates near resources utilized by females.

Male syrphids search for mates near resources that attract females. Species of Eristalinae (=Milesiinae) studied by Maier and Waldbauer (1979a) use flowering plants, larval habitats, or both as sites for finding mates. Females visit blossoms to feed upon pollen and sometimes nectar, the former being necessary for rapid ovarian development (Maier, 1978; Schneider, 1948). Maier and Waldbauer (1979a, b), Morse (1981), and many others have investigated sexual and foraging behavior at flowers. Maier (1978) and Maier and Waldbauer (1979a) have examined reproductive behavior of native species near larval habitats. Individual males defend territories centered around larval habitats and thus gain access to females arriving to lay eggs (Maier and Waldbauer, 1979a).

Metcalf (1913, 1916) used his own studies and those of Verrall (1901), Williston (1886), and others to categorize syrphid larval habitats, mate-seeking sites for male Eristalinae (Maier and Waldbauer, 1979a). Valuable compilations by Coe (1953), Dixon (1960), Hartley (1961), Heiss (1938), Johannsen (1935), and others supplemented this early work. Nevertheless, larval habitats of most of the species of Eristalinae are unknown or poorly described. In this paper, I describe the larval habitats of 26 species, eight for the first time, and extend Maier and Waldbauer's (1979a) and Maier's (1980) observations on male mate-seeking behavior.

MATERIALS AND METHODS

Third-instar larvae were collected from rotting areas of cacti and trees and from sewage settling and woodland ponds between November and May

1974–1981 and were then released in uncovered Petri dishes containing their apparent food. Petri dishes were enclosed in plastic vegetable crispers that were partially filled with sand, a suitable material for pupariation. Rearing was done in growth chambers adjusted to 24 ± 2°C and to a 16 h light: 8 h dark photoperiod. Less than one month after collection, larvae pupariated in the sand. Adults eclosed 2 weeks or less after pupariation.

Male mate-seeking behavior was studied in Arizona, Connecticut, Illinois, and North Carolina between April and July 1972–1981. Individual males were observed for 30 min or until their departure from a mate-seeking location. Each observation (Table 1) represented a male that pursued conspecific flies, mated, or engaged in both activities at a mate-seeking site. Representatives of all species mentioned here are deposited in my syrphid collection.

Results and Discussion

Larval Habitats

The following list gives the larval habitats of Syrphidae in the subfamily Eristalinae. The species is followed by the locality, number reared (in parentheses), and description of larval habitat.

Brachyopini

Brachyopa vacua Osten Sacken.—Mason Co., Illinois. (6). Sap-soaked decaying wood and associated plant growth in live *Fagus grandifolia* Ehrh. and *Quercus* spp.

Myolepta nigra Loew.—Mason Co., Illinois. (4). Moist detritus in treehole of live *Quercus marilandica* Muenchh. and *Q. velutina* Lam.

Myolepta varipes Loew.—Gibson Co., Indiana. (2). Moist detritus in treehole of live *Acer saccharum* Marsh.

Cerioidini

Ceriana abbreviata (Loew).—Champaign Co., Illinois. (3). Sap-soaked detritus in treehole of live *Liquidambar styraciflua* L. (treehole with *Camponotus* sp. colony).

Eristalini

Eristalinus aeneus (Scopoli).—Champaign Co., Illinois. (200). Sewage settling pond with standing water.

Helophilus fasciatus Walker.—Champaign Co., Illinois. (5). Small, leaf-filled pools in mesic forest dominated by *Acer, Fagus,* and *Quercus* spp.

Mallota bautias (Walker).—New Haven Co., Connecticut. (2). Wet detritus in decayed center of live *Pyrus malus* L. (opening to outside less than 2 cm in diameter).

Mallota posticata (Fabricius).—New Haven Co., Connecticut. (4). Mason Co., Illinois. (200). Gibson Co., Indiana. (1). Montgomery Co., Virginia. (3). Wet detritus in large treeholes or in water-filled crotches of many species of live deciduous trees (treeholes usually with entrances of 10–20 cm diameter).

Milesiini

Blera umbratilis (Williston).—Mason Co., Illinois. (1). Moist detritus in treehole of live *Quercus velutina* Lam.

Chalcosyrphus chalybeus (Wiedemann).—New Haven Co., Connecticut. (3). Champaign Co., Illinois. (2). Moist to wet detritus in rot pockets of fallen *Acer saccharum* Marsh. logs.

Chalcosyrphus metallicus (Wiedemann).—Union Co., Illinois. (6). Pulpy wood of partially submerged *Acer* sp. log in small stream.

Chalcosyrphus nemorum (Fabricius).—Litchfield Co., Connecticut. (47). Champaign Co., Illinois. (12). Piatt Co., Illinois. (5). Union Co., Illinois. (4). Spaces (partly filled with detritus and insect frass) in firm, moist decaying wood near surface of fallen logs of *Acer* and *Ulmus* spp. in marshes and along streams. Actual site of larval development may be elsewhere in logs as these larvae were collected after feeding was completed.

Lejota aurea (Loew).—Mason Co., Illinois. (10). Friable, slightly moist decaying wood at top of *Quercus* sp. stump.

Milesia virginiensis (Drury).—Mason Co., Illinois. (2). Gibson Co., Indiana. (1). Wet detritus in water-filled center of decaying stumps.

Somula decora Macquart.—New Haven Co., Connecticut. (3). Mason Co., Illinois. (50). Moist detritus in treeholes of live *Quercus* spp. (treeholes with elongate vertical openings).

Spilomyia alcimus (Walker).—Washtenaw Co., Michigan. (5). Wet detritus in treehole of live *Quercus alba* L.

Spilomyia longicornis Loew.—Mason Co., Illinois. (3). Wet detritus along wall of treeholes in live *Quercus velutina* Lam.

Temnostoma alternans Loew.—Middlesex Co., Connecticut. (2). Firm, moist decaying wood in fallen *Betula alleghaniensis* Brit. log in marshy area (wood-boring larvae).

Temnostoma barberi Shannon.—Middlesex Co., Connecticut. (10). Same as previous species.

Temnostoma vespiforme (Linnaeus).—Middlesex Co., Connecticut. (1). Same as previous two species.

Volucellini

Copestylum apiciferum (Townsend).—Pima Co., Arizona. (20). Soupy, decaying material in rot pockets in trunk of live and dead *Ferocactus wislizenii* (Engelm.) Brit. & Rose.

Copestylum florida (Hull).—Marion Co., Florida. (35). Monroe Co., Florida. (23). Rotting areas in joints of live *Opuntia* spp.

Copestylum isabellinum (Williston).—Pima Co., Arizona. (35). Soupy, decaying material in rot pockets in upright and fallen trunks of live and dead *Carnegiea gigantea* Brit. & Rose.

Copestylum marginatum (Say).—Pima Co., Arizona. (7). Rotting areas in thin, non-basal joints of live *Opuntia phaeacantha* Engelm.

Copestylum mexicanum (Macquart).—Pima Co., Arizona. (5). Rotting areas in large, basal joints of live *Opuntia phaeacantha* Engelm.

Copestylum vittatum Thompson.—Marion Co., Florida. (69). Mason Co., Illinois. (8). Rotting areas in joints of live *Opuntia* sp. (Florida) and *O. compressa* (Salisb.) Macbr. (Illinois).

Larvae of the 26 reared species inhabited many different types of decaying material. Except for *Eristalinus aeneus* larvae collected from sewage settling ponds, all lived in natural habitats, mostly decaying parts of living and dead cacti or deciduous trees. My descriptions of larval habitats of *Ceriana abbreviata, Chalcosyrphus chalybeus, C. metallicus, Helophilus fasciatus, Spilomyia alcimus, S. longicornis, Temnostoma alternans,* and *T. barberi* are the first.

Habitats listed here are similar to those described by earlier workers (e.g. Dixon, 1960; Hartley, 1961; Heiss, 1938) for the same or congeneric species. My descriptions augment previous ones by giving data on plant identities, moisture conditions, and/or other features around the larval habitats. This new information contributes to a better understanding of the range of larval habitats used by genera and tribes of Eristalinae.

Two or three species sometimes coexisted in the same log (*Temnostoma alternans, T. barberi, T. vespiforme*), treehole (*Mallota posticata, Somula decora, Spilomyia longicornis*), or cactus (*Copestylum marginatum, C. mexicanum*). A decaying area in a particular log, rot pocket, or cactus was usually inhabited by a single species. For example, *Copestylum marginatum* and *C. mexicanum* larvae were spatially separated by about 1 m in the same cactus. *Copestylum marginatum* larvae ($n = 7$) lived in thin, non-basal joints of *Opuntia phaeacantha* Engelm.; and *C. mexicanum* larvae ($n = 5$), which are larger, inhabited thicker, basal joints.

MATE-SEEKING SITES

Males searched for females near flowering plants, potential larval habitats (=oviposition sites), or both (Table 1). Although male mate-seeking was

Table 1. Mate-seeking locations of male Syrphidae in the subfamily Eristalinae. Evidence: 1 = initiation of copulation observed near flowers; 2 = initiation of copulation observed near larval habitat; 3 = mating pair(s) observed near flowers; 4 = mating pair(s) observed near larval habitat; and 5 = males chased conspecific flies and other flying insects of similar size and grappled with conspecifics (territorial defense).

Tribe and Species	Number Observed	Evidence
A. Flowering plants		
Brachyopini		
Neoascia distincta Williston	4	5
N. globosa (Walker)	>40	1, 3, 5
Sphegina flavimana Malloch	3	5
S. keeniana Williston	13	1, 5
S. lobata Loew	5	5
S. rufiventris Loew	21	5
Eristalini		
Lejops albiceps (Macquart) = Polydontomyia curvipes	12	5
L. anausis (Walker) = A. lunulatus	3	5
L. bilinearis (Williston)	32	1, 5
L. chrysostomus (Wiedemann)	15	1, 5
(A) *L. stipatus* (Walker)	9	1, 5
Parhelophilus anniae (Brimley) = flavifacies	6	5
Milesiini		
Blera analis (Macquart)	4	5
Chalcosyrphus chalybeus (Wiedemann)	2	1, 5
Criorhina verbosa (Walker)	11	1, 5
Tropidia albistylum Macquart	2	1, 5
Xylota angustiventris Loew	3	5
Rhingiini		
Rhingia nasica Say	>30	5
Volucellini		
Copestylum mexicanum (Macquart)	15	5
Volucella bombylans (Linnaeus)	2	5
B. Larval habitat		
Milesiini		
Chalcosyrphus metalliferus (Bigot)	4	2, 5
C. nemorum (Fabricius)	>40	2, 5
C. plesia Curran	2	5
C. Both A and B		
Brachyopini		
Sphegina campanulata Robertson	>100	1, 2, 3, 5
Merodontini		
Eumerus tuberculatus (Fabricius)	23	4, 5
Merodon equestris Rondani	4	5

Table 1. Continued.

Tribe and Species	Number Observed	Evidence
Milesiini		
Brachypalpus oarus (Walker)	9	1, 2, 5
Temnostoma alternans Loew	16	1, 2, 3, 4, 5
T. balyras Walker	>80	2, 3, 5
Xylota bicolor Loew	7	5

concentrated near these resources, its behavioral characteristics varied among species. As described by Maier and Waldbauer (1979a), males of most species alternately rested on flowering plants and patrolled blossoms to locate potential mates at flowers. Hovering near blossoms sometimes accompanied patrolling or occurred by itself. For example, on July afternoons between 1200 and 1500 EST, groups of 2–20 *Rhingia nasica* Say males hovered directly above patches of flowering *Impatiens biflora* Walt. These males were equally spaced except when they pursued flying insects or conspecific males that entered or passed by their aerial territories. After pursuits males returned to their original hovering spot, suggesting they have visual spatial memory (Collett and Land, 1975).

Within 1 m of larval habitats, males defended territories. They spent 80–90% of their time resting in places that afforded an unobstructed view of females arriving to oviposit. Representative examples of mate-seeking behavior at flowering plants and larval habitats are more fully described by Gruhl (1924) and Maier and Waldbauer (1979a).

Fifteen species of Eristalinae, eight listed by Maier and Waldbauer (1979a, Table 4) and seven recorded here (Table 1), employ dual mate-seeking strategies. As larval habitats of more species become known, this number will surely grow. The present evidence, however, strongly suggests that dual mate-seeking strategies are common among species of Eristalinae. Comprehensive studies are necessary to determine the entire range of mate-seeking strategies utilized in the other two subfamilies, the Microdontinae and the Syrphinae.

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