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HIGHER DIPTERA ASSOCIATED WITH THE MARSH SPIKE-RUSH, *ELEOCHARIS PALUSTRIS* (CYPERACEAE), IN NORTHEASTERN OHIO

B. A. Foote

Department of Biological Sciences, Kent State University, Kent, Ohio 44242 (e-mail: bfoote@kent.edu)

Abstract.—Information is given on 28 of the 50 species of higher Diptera that were found in stands of the marsh spike-rush, *Eleocharis palustris* (L.) Roemer & Schultes, in northeastern Ohio. Seasonal distributions, abundances, and larval feeding habits of selected species are presented.

Key Words: *Eleocharis*, Diptera, freshwater marshes, Ohio

This is the ninth paper in a series that focuses on the species of higher Diptera (Schizophora) that occur in freshwater marshes in northeastern Ohio (Todd and Foote 1987a, b; Rogers et al. 1991; Wearsch and Foote 1994; Larson and Foote 1997; Keiper et al. 1998; Foote 2004a, b). The present study gives survey data obtained during one field season of collecting higher Diptera from a near-monoculture stand of the marsh spike-rush, *Eleocharis palustris* (L.) Roemer & Schultes, growing in a roadside drainage ditch near Kent in northeastern Ohio. Information is given on seasonal occurrence and larval feeding habits of 28 of the 50 associated species.

Materials and Methods

Eleocharis palustris is a widespread, narrow-leaved, emergent, perennial species of Cyperaceae having horizontal, mat-forming rhizomes (Ball et al. 2002). The study stand was located in a shallow drainage ditch bordering Hodgeman Lane, a small road leading to the Kent Water Treatment Plant on the east side of the city in Portage County (41° 08′ 33″N × 81° 19′ 19″W). The stand was long and narrow (100 × 5 m) and consisted of a near monoculture of *E. palustris*, although a few individuals of rice cut grass, *Leersia oryzoides* (L.) Swartz, were scattered throughout the stand. The stand was bordered on either side by an undetermined species of grass and by narrow-leaved cattail (*Typha angustifolia* L.) at its northern end. The study site was mowed periodically by county maintenance crews throughout the summer months. Water, at a depth of some 10 cm, was present during the spring months. Water depths receded steadily as summer advanced, although summer rains caused temporary fluctuations. By late August, no standing water was present.

Specimens of Diptera were obtained by sweep samples consisting of 15 back and forth movements of a 15 inch diameter standard aerial insect net through the stand. Sampling took place weekly for 22 weeks between 6 May and 30 September, 2004. Nearby stands of rice cutgrass and other undetermined grass species were swept for comparative purposes.

Rearings were initiated from larvae or adults collected from the host plant.

Rearing containers were small (5.5 × 7.0 cm) plastic jars from which the bottom had been removed. The jar was then inserted into a Petri dish containing a layer of moist peat moss. The top of the jar was covered with fine-mesh nylon. A small pellet of moistened honey and yeast was affixed to the wall of the jar to serve as food for the adults.

Once larvae were obtained, they were transferred to Petri dishes containing fragments of the host plant or a field-collected sample of detritus or algae. Larvae were killed in hot water and preserved in 70% ethanol. Puparia that produced adults were placed in small plastic vials and pinned beneath the emerged adults. Voucher specimens are deposited in the insect collection of the author.

Results

A total of 875 specimens from 35 genera and 50 species were collected from the stand of *Eleocharis* during the summer of 2004 (Table 1). In the following annotated list, 28 species are covered in greater detail with respect to their seasonal occurrence, relative abundance, and larval feeding habits.

Annotated List of Selected Species

Family Chloropidae

Chlorops obscuricornis Loew.—This Nearctic species is a stem borer of *Eleocharis*, having been reared from stems of *E. palustris* and *E. obtusa* (Willd.) (Wearsch and Foote 1994). It was an univoltine species having a flight period from late May to early August. Adults were particularly common in June. Eggs found on the surface of *Eleocharis* stems had an incubation period of 5–7 days. Newly hatched larvae bored through the stem cuticle and subsequently fed on the tissue within the stem. Larvae overwintered as first and second instars within stems, with the third instar being reached the following late April or May. Mature larvae migrated to the rhizomes where they formed puparia in May. The pupal period ranged from 10–15 days under laboratory conditions. Stem infestation rates were quite low, with 5 samples of 30 field-collected stems each having emergence rates ranging from 0 to 5%. Infested stems rarely produced inflorescences.

Diplotoxa inclinata Becker.—This strictly Nearctic species has a transcontinental distribution in North America and was abundant in the study stand between early May and early September. It was usually the first species of *Diplotoxa* to appear at the study site. Based on evidence obtained from the sweep samples and from laboratory rearings, it was an univoltine species. Mated females confined with *Eleocharis* in breeding jars readily deposited eggs on the stems, although a few eggs were also deposited on the underlying peat moss. Most of the eggs were placed at the base of the stem just above the peat moss, but a few were attached at greater heights. None was placed on inflorescence. The incubation period lasted 4–5 days. Newly hatched larvae crawled down the stem and entered young shoots at the base of the plant where they began feeding on the stem tissue. Older larvae moved downward within the stem and penetrated into the rhizomes attached to the crown of the plant. They then continued to feed within the meristematic tissue of the rhizome. Overwintering occurred as inactive second instars, and feeding recommenced during early April. Puparia were formed within the rhizomes during the last two weeks of April. Larvae and puparia were easily distinguished from those of *Chlorops* and other species of *Diplotoxa* by their greenish color. The life cycle was elucidated by Wearsch and Foote (1994) who also described and illustrated the egg and all larval instars.

Table 1. Species, numbers collected, and trophic guilds of higher Diptera associated with *Eleocharis palustris* in northeastern Ohio.

Species	Number of Adults Collected	Trophic Guild
Agromyzidae		
Cerodontha dorsalis (Loew)	1	Leaf miner of grasses
Undetermined sp.	2	Unknown
Anthomyzidae		
Anthomyza sp.	1	Stem borer
Mumetopia occipitalis Melander	2	Stem borer
Chloropidae		
Apallates neocoxendix (Sabrosky)	26	Unknown
Apallates particeps (Becker)	1	Unknown
Chlorops obscuricornis Loew	209	Stem borer of *Eleocharis*
Diplotoxa inclinata Becker	112	Stem borer of *Eleocharis*
Diplotoxa nigripes (Coquillett)	30	Stem borer of *Eleocharis*
Diplotoxa near *versicolor*	14	Stem borer of *Eleocharis*
Elliponeura debilis Loew	11	Seed predator of *Eleocharis*
Eribolus longulus (Loew)	1	Secondary invader of damaged stems
Incertella minor (Adams)	1	Secondary invader of damaged stems
Incertella incerta (Becker)	1	Secondary invader of damaged stems
Meromyza americana Fitch	1	Stem borer of grasses
Oscinella frit Linneaus	4	Stem borer of grasses
Pseudopachychaeta approximatonervis (Zett.)	14	Seed predator of *Eleocharis*
Rhopalopterum carbonaria (Loew)	51	Secondary invader of damaged stems
Thaumatomyia glabra (Meigen)	1	Predator of root aphids
Drosophilidae		
Scaptomyza pallida (Zetterstedt)	11	Scavenger of detritus
Ephydridae		
Hydrellia formosa Loew	2	Leaf miner of grasses
Hydrellia griseola (Fallén)	1	Leaf miner of many plant taxa
Leptopsilopa atrimana (Loew)	1	Scavenger of detritus
Notiphila caudata Fallén	44	Scavenger of detritus
Notiphila scalaris Loew	9	Scavenger of anaerobic detritus
Ochthera anatolikos Clausen	2	Insect predator
Pelina truncatula Loew	1	Consumer of Cyanobacteria
Scatella stagnalis (Fallén)	10	Scavenger, phycovore
Typopsilopa atra (Loew)	12	Secondary invader of damaged stems
Milichiidae		
Phyllomyza securicornis Fallén	1	Unknown
Opomyzidae		
Opomyza petrei Mesnil	81	Stem borer of grasses
Otitidae		
Chaetopsis massyla (Walker)	7	Secondary invader of damaged stems
Sciomyzidae		
Atrichomelina pubera (Loew)	9	Predator of stranded aquatic snails
Pherbellia nana (Fallén)	16	Predator of stranded aquatic snails
Pherbellia parallela (Walker)	4	Predator of stranded aquatic snails
Pherbellia schoenherri maculata (Cresson)	2	Predator of amber snails
Dictya borealis Curran	1	Predator of aquatic snails
Dictya expansa Steyskal	1	Predator of aquatic snails
Dictya sabroskyi Steyskal	9	Predator of aquatic snails

Table 1. Continued.

Species	Number of Adults Collected	Trophic Guild
Dictya steyskali Valley	1	Predator of aquatic snails
Sepedon armipes Loew	8	Predator of aquatic snails
Sepedon fuscipennis Loew	28	Predator of aquatic snails
Sepedon tenuicornis Cresson	5	Predator of aquatic snails
Sepsidae		
Enicomira minor (Haliday)	5	Scavenger of detritus
Sepsis punctum (Fabricius)	6	Scavenger of detritus, feces
Sphaeroceridae		
Leptocera sp.	39	Scavenger of detritus
Muscidae		
Coenosia tigrina (Fabricius)	18	Insect predator
Lispa sp.	29	Insect predator
Schoenomyza chrysostoma Loew	21	Stem borer of *Eleocharis*
Schoenomyza dorsalis Loew	8	Stem borer of *Eleocharis*

Number of species: 50.
Number of genera: 35.
Number of individuals: 875.

Diplotoxa nigripes (Coquillett).—An uncommon species in the stand of *E. palustris*, this small, dark species was common to abundant in nearby stands of the annual spike-rush, *E. obtusa* (Willd.) Scultes. The larvae are stem borers. The life cycle and the immature stages were described and illustrated by Wearsch and Foote (1994).

Diplotoxa sp. near *versicolor* (Loew).—The late Curtis W. Sabrosky (personal communication) recognized this form as a distinct species near *D. versicolor*, based upon the presence of white hairs on the dorsum of the abdomen instead of the dark hairs found in the *D. versicolor*. It was a fairly common species in the stand of *Eleocharis*, whereas adults of *D. versicolor* itself were far more commonly encountered on stands of the path rush, *Juncus tenuis* Willd. (Juncaceae). This stem borer was an univoltine species in northeastern Ohio, with a flight period extending from early May to late September. Overwintering occurred as second instars within the plant stems. Fully grown larvae were found near the bases of *Eleocharis* during late March and early April. Puparia were formed within the stems in early April, with emergence occurring in early May. The wasp *Chaenusa* sp. (Hymenoptera: Braconidae) was an important parasitoid, as 15 of 16 collected puparia were infested. The life cycle and immature stages were described and illustrated by Wearsch and Foote (1994).

Elliponeura debilis Loew.—This was an uncommon, multivoltine seed predator, having a flight period extending from mid-May to late September. Eggs were attached to the lower bracts subtending the inflorescence, with only 1 or 2 eggs being found on each inflorescence. Examination of inflorescence collected from the stand revealed infestation rates varying from zero to 27%. Larvae fed on the developing achenes, with each larva consuming 3–5 seeds. Puparia were formed in the inflorescence within the space formerly filled by an eaten achene. The pupal period lasted 6–8 days.

Pseudopachychaeta approximatonervis (Zetterstedt).—Like *E. debilis*, this species fed on the developing achenes, and had a similar life cycle and flight period.

However, older larvae and puparia were yellowish in color, whereas those of *E. debilis*, were greenish. Interestingly, only one species of the two seed predators was found in each infested inflorescence. An indication that this species is not strictly a seed predator was the rearing of adults from larvae that were feeding within damaged stems of yellow nelumbo, *Nelumbo lutea* (Willd.) Persoon (Nymphaeaceae), that had been attacked by larvae of the moth *Bellura obliqua* (Walker) (Noctuidae) in northern Ohio (J. B. Keiper, personal communication).

Rhopalopterum carbonaria (Loew).—This was a common species within the stand, with over 50 specimens being collected. Its larvae are secondary invaders of culms of wetland monocots that previously had been damaged by primarily phytophagous species (Valley et al. 1969).

Family Drosophilidae

Scaptomyza pallida (Zetterstedt).—This was a fairly common species within the stand being found in low numbers throughout the summer months. Its larvae are saprophagous in decaying plant material (Ferrar 1987).

Family Ephydridae

Notiphila caudata Fallén.—This was an abundant species during late May and early June. Its larvae were non-selective consumers of unicellular algae and decaying particulate plant material (Eastin and Foote 1971).

Notiphila scalaris Loew.—A few specimens of this small species were taken within the *Eleocharis* stand, but it was far more abundant in nearby stands of rice cutgrass. Keiper and Walton (2002) collected numerous adults from a monoculture stand of California bulrush, *Schoenoplectus californicus* (Meyer) Soják in California.

Scatella stagnalis (Fallén).—This was a relatively common species in the *Eleocharis* stand, with 10 specimens being recorded. The larvae are generalized consumers of algae and organic detritus (Zack and Foote 1978, Foote 1979).

Typopsilopa atra (Loew).—This was a common species, becoming particularly noticeable in mid-August. Its larvae are saprophagous, having been reared in laboratory cultures of decaying lettuce (Foote 1995). A related species, *T. nigra* (Williston), was found to be a secondary invader of the stems of California bulrush and cattail (*Typha* sp.) damaged by the feeding of larvae of the primary invader *Bellura obliqua gargantua* (Dyar) (Lepidoptera: Noctuidae) in southern California (Keiper et al. 2001).

Family Opomyzidae

Opomyza petrei Mesnil.—Although this was an abundant species in the *Eleocharis* stand, occurring throughout the collecting season, it was not directly associated with the sedge, Its larvae are known to be stem borers of grasses (Nye 1958) which were abundant on either side of the *Eleocharis* stand. This is a common, non-native species in the eastern states.

Family Otitidae

Chaetopsis massyla (Walker).—This was a relatively uncommon species within the *Eleocharis* stand. It appeared to be multivoltine, as adults were taken throughout the summer. The larvae are secondary invaders of the stems of wetland plants (Allen and Foote 1992), but no larvae were found in the stems of *Eleocharis*.

Family Sciomyzidae

Atrichomelina pubera (Loew).—This species was regularly encountered in the *Eleocharis* stand, and appeared to be

multivoltine. Its larvae are generalized predators of aquatic pulmonate snails that have been stranded by dropping water levels (Foote et al. 1960).

Pherbellia nana (Fallén).—This was a fairly common species, occurring in low numbers throughout the summer months. Like those of *A. pubera*, its larvae prey on stranded aquatic snails (Bratt et al. 1969).

Dictya expansa Steyskal, *D. sabroskyi* Steyskal, and *D. steyskali* Valley.—Adults of these *Dictya* spp were taken in low numbers throughout the summer. They are known to be multivoltine, and their larvae are generalized predators of aquatic pulmonate snails (Valley and Berg 1977).

Sepedon armipes Loew, S. fuscipennis Loew, and *S. tenuicornis* Cresson.—These *Sepedon* spp. were uncommon to abundant within the stand of *Eleocharis*. Larvae of all three prey on aquatic pulmonate snails (Neff and Berg 1966).

Family Sepsidae

Enicomira minor (Haliday), *Sepsis puncta* (Fabricius).—Both of these species were minor components of the fly community, occurring in low numbers throughout the summer. Larvae of both are saprophagous on decaying plant material and feces (Ferrar 1987).

Family Sphaeroceridae

Leptocera spp..—Although numerous adults of this genus were swept from the stand, no larvae were found. Ferrar (1987) reported that larvae are saprophagous, coprophagous, and necrophagous.

Family Muscidae

Coenosia tigrina (Fabricius).—This was a common species, occurring throughout the summer. Larvae are predators of the stem-boring chloropid larvae in sedges (Kuehne 1991). Larvae also prey on earthworms and other soft-bodied invertebrates in moist to sodden soils (Ferrar 1987).

Lispe sp.—Adults of this species were found throughout the summer. The larvae are known to be general predators of soft-bodied invertebrates (Skidmore 1985).

Schoenomyza chrysostoma Loew, and *S. dorsalis* Loew.—Both *Schoenomyza* spp. were commonly taken in the stand, being particularly abundant in June. Larvae are stem borers of wetland monocots (Skidmore 1985, Ferrar 1987).

Discussion

There was obvious partitioning of food resources within the stand of *Eleocharis*, and eight trophic guilds were recognized (Table 1). A large guild consisting of 11 species fed as generalized scavengers of decaying organic matter. The guild of secondary invaders consisted of six species whose larvae fed as scavengers on stem tissues previously damaged by phytophagous species. The phytophagous community consisted of 11 species of stem borers, three species of leaf miners, two species of seed predators, and one species that fed on blue-green algae (Cyanobacteria). Predacious species consisted of a snail-killing guild that contained 11 species and a insect-attacking guild that contained two species. The larval feeding habits of four species remain unknown. Only six of the 50 species (12%) encountered within the stand fed directly on tissues of *E. palustris*, although another four species fed as secondary invaders of *Eleocharis* stems that had been damaged by truly phytophagous insects.

The family containing the greatest number of species within the stand was Chloropidae with 15. The same family also produced the greatest number of individuals (n = 477). Over 65% of these belonged to two species of stem borers, *Chlorops obscuricornis* (n = 209) and

Diplotoxa inclinata (n = 112). The abundance of these two species suggests that larval infestations of the stems and rhizomes could be significant.

The degree of possible competition that exists among the six species that fed as larvae within the *Eleocharis* stems is unknown and warrants additional study. Interactions among the two species of seed predators, *E. debilis* and *P. approximatonervis*, and species of other insect families (Curculionidae, Cecidomyiidae, undetermined family of Lepidoptera) that were also encountered in the inflorescence need to be elucidated.

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