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INSECTS (DIPTERA, COLEOPTERA, LEPIDOPTERA) REARED FROM WETLAND MONOCOTS (CYPERACEAE, POACEAE, TYPHACEAE) IN SOUTHERN QUEBEC

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Abstract.—Information about feeding habits and host-plants is given for 24 species of insects reared from the stem or leaves of wetland herbaceous monocots, primarily *Carex lacustris* Willd. and *Phalaris arundinacea* L., in southern Quebec. Nineteen species of Diptera in eight families (1 Dolichopodidae, 2 Otitidae, 1 Anthomyzidae, 1 Agromyzidae, 1 Chamaemyiidae, 1 Sphaeroceridae, 11 Chloropidae, 1 Scathophagidae), three Lepidoptera in the families Cosmopterigidae, Elachistidae, and Noctuidae, and two weevils (Coleoptera: Curculionidae) were reared from four species of host plants. Seven species are phytophagous primary invaders, thirteen are secondary invaders (mostly saprophagous) inside the burrows of primary invaders, two are predators of aphids and other invertebrates living on the leaves of the plants, and two have unknown feeding habits.

Key Words: Diptera, Coleoptera, Lepidoptera, ecology, stem-borers, secondary invaders, host plants, wetlands, *Carex, Phalaris*

Emergent wetland plants provide a microhabitat and food source for many insects, especially Diptera (Gaevskaya 1969, Ferrar 1987). The higher Diptera fauna in wetlands is diverse and many species, particularly in the family Chloropidae, are associated with emergent plants such as sedges (Cyperaceae), rushes (Juncaceae) and grasses (Poaceae) (Davis and Gray 1966, Todd and Foote 1987a, 1987b, Pollet 1992). Although there have been several studies on the biology of selected Diptera feeding on wetland monocots (e.g., Valley et al. 1969b, Rogers et al. 1991, Allen and Foote 1992, Wearsch and Foote 1994, Valley and Foote 1996), the host plants and feeding habits are unknown for many species.

Many flies associated with emergent plants are saprophagous secondary invaders of plant tissues damaged by other insects. In many cases, the feeding habits of primary invaders other than Diptera are also poorly known. This study provided the opportunity to obtain biological information on some species of phytophagous Lepidoptera and Coleoptera associated with wetland plants.

This paper documents the results of rearing studies on Diptera and other phytophagous insects associated with emergent wetland monocots in southern Quebec. Host records and ecological information are given for 19 species of Diptera, three species of Lepidoptera, and two species of weevils (Coleoptera: Curculionidae) reared from Cyperaceae, Poaceae and Typhaceae.

MATERIALS AND METHODS

Infested plants were collected from May–October 1999 in sedge meadows of the Lac St. François National Wildlife Area in southern Quebec, and May 2000 at Stoney-

Table 1. Insects reared from *Carex lacustris* and *Phalaris arundinacea* in southern Quebec. COL = Coleoptera; LEP = Lepidoptera; all other species are Diptera.

Trophic Group	*Carex lacustris*	*Phalaris arundinacea*
primary invaders	*Chlorops seminiger*	*Chromatomyia fuscula*
	Cosmopterix fernaldella (LEP)	*Apamea ophiogramma* (LEP)
	Elachista sp. (LEP)	
	Sphenophora costipennis (COL)	
secondary invaders	*Chaetopsis massyla*	*Chaetopsis ?fulvifrons*
	Lasiosina canadensis	*Conioscinella zetterstedti*
	Rhopalopterum atriceps	*Oscinisoma alienum*
	Orthacheta hirtipes	*Elachiptera penita*
		Elachiptera angustifrons
		Eribolus longulus
		Eribolus nana
		Eribolus nearcticus
predators	*Plunomia elegans*	
	Thaumatomyia obtusa	
unknown	*Medetera aberrans*	
	Anthomyza sp.	

croft Pond, adjacent to McGill University's Morgan Arboretum in Ste-Anne-de-Bellevue, Quebec. Infested stems of *Carex, Scirpus* (Cyperaceae) and *Typha latifolia* L. (Typhaceae) were identified by the presence of curled, decumbent, yellowish-brown inner leaves, contrasting with green, straight, healthy outer leaves (Neff and Wallace 1969). Infested stems of *Phalaris arundinacea* L. (Poaceae) were detected by the presence of yellowish terminal leaves and shorter shoots than intact plants. Infested leaves were distinguishable by the presence of mines visible on the leaf surface.

Infested plants were transported to the lab in plastic bags and either examined immediately or refrigerated for later examination. Stems were dissected to locate larvae and any observed feeding behavior was noted. The lower end of each infested leaf was placed in a 1 cm × 5 cm vial filled with water. The vials containing leaves, or small cut sections of stems containing larvae, were placed in a plastic container 4.5 cm in diameter and 7.5 cm deep, covered with fine mesh. These were kept at 22°C in a sealed plastic bag containing moist paper towel in order to keep humidity high. Containers were inspected every 2–3 days for emerged adults. Plants collected late in the season (late August to October) were put in an incubator at 4°C for 1–2 months before dissection to simulate overwintering for the larvae.

Additional collecting in the field using sweep nets and pan traps around host plants provided data on the adult activity of some insect species. All specimens collected and reared are deposited in the Lyman Entomological Museum, McGill University, Ste-Anne-de-Bellevue, QC, except Microlepidoptera, which are in the Canadian National Collection of Insects, Ottawa, ON.

Results

Infested plants were mostly *Carex lacustris,* collected in the Lac St. François National Wildlife Area, and *Phalaris arundinacea,* collected at Stoneycroft Pond. Insects reared from these host plants are listed in Table 1. Species are classified as phytophagous primary invaders, secondary invaders (saprophages and/or facultative predators), and predators of other insects feeding externally on the plant. Ecological observations and previous records of reared species are included in the annotated list below.

Diptera

Medetera aberrans Wheeler (Dolichopodidae).—Two adults were reared from larvae found on the inner leaves of two shoots of *C. lacustris* at a height of 17 and 20 cm from the culm base (Lac St. François, 18.ix.1999, emerged 04.i.2000 (1); same except 01.x.1999, emerged 02.i.2000 (1)). A narrow, brown feeding trail was observed on two leaves of one of the shoots, but no other arthropods were found in association with the *M. aberrans* larvae. The larvae of several *Medetera* species live under tree bark, and are predators of soft-bodied arthropods (Bickel 1985). However, Bickel (1985) noted that *M. aberrans* and related species are more closely related to *Thrypticus* Gerstäcker (a phytophagous genus) and *Dolichophorus* Lichtwardt than they are to *Medetera sensu stricto* and suggested that the larvae of *M. aberrans* may be associated with wetland plants. Although the presence of a feeding trail and the absence of other arthropods might suggest that *M. aberrans* larvae are phytophagous, the evidence is not conclusive and the larval habits remain unknown.

Chaetopsis ?fulvifrons Macquart (Otitidae).—Three adults were reared from two stems of *P. arundinacea* attacked by *Apamea ophiogramma* (Noctuidae) (Stoneycroft Pond, 31.v.2000, emerged 27.vi.2000). Valley et al. (1969a) considered *C. fulvifrons* a secondary invader in the heads of *Echinochloa crusgalli* (L.) (Poaceae) attacked by the phytophagous otitid *Eumetopiella rufipes* (Macquart). Johnson (1921) stated that *C. fulvifrons* injures corn, sugar-cane and onions, but did not indicate whether he considered the larvae phytophagous or saprophagous.

Chaetopsis massyla (Walker) (Otitidae).—Adults were reared from three species of host plants. Most specimens were reared from multiple stems of *Typha latifolia,* usually following primary infestation by a moth or weevil (Lac St. François, 23.vii.1999, emerged 11.viii.1999 (2), 12.viii.1999 (3) and 13.viii.1999 (1); same except 7.viii.1999, emerged 16.viii.1999 (1); same except 12.viii.1999, emerged 17.viii.1999 (1) and 30.viii.1999 (1)); one adult was reared from *C. lacustris* (Lac St. François, 16.vii.1999, emerged 05.viii.1999); three adults emerged from a rotting shoot of *Scirpus fluviatilis* (Torr.) Gray (Cyperaceae) along with an adult of *Pullimosina pullula* (Zetterstedt) (Sphaeroceridae) (Lac St. François, 7.viii.1999, emerged 7.ix.1999). Adults were abundant on *C. lacustris* at Lac St-François. This species was previously reared as a secondary invader from *T. latifolia, C. lacustris* and *Scirpus microcarpus* Presl. (Valley et al. 1969b, Allen and Foote 1992). This is the first record of *C. massyla* from *S. fluviatilis.*

Plunomia elegans Curran (Chamaemyiidae).—Several adults were reared from puparia found between the leaves of *C. lacustris* (Lac St. François, 05.vii.1999, emerged 11.vii.1999 (1); same except 12.vii.1999, found dead 22.xi.1999 (1); same except 23.vii.1999, emerged 02.viii.1999 (1); same except 01.x.1999, emerged 14.ii.2000 (1); same except 27.x.1999, emerged 14.ii.2000 (1)). There are no previous records of the ecology of *Plunomia* spp., but given that all Chamaemyiidae whose feeding habits are known are predators of Aphidoidea and Coccoidea (Ferrar 1987), the larvae probably prey on one of these taxa. Specimens of *Thripsaphis ballii* (Gillette) (Drepanosiphidae) were abundant on *C. lacustris* at the study site and are the likely prey of *P. elegans.* Adults of *P. elegans* were abundant in stands of *C. lacustris* and *C. aquatilis* Wahlenb. by 14 May 1999, peaked in July, and persisted until early September. Unpublished collection data on specimens in the Canadian National Collection of Insects indicate that *P. elegans* lives in wet habitats such as grassy marshes, sedge meadows and bogs.

Chromatomyia fuscula (Zetterstedt) (Agromyzidae).—Four adults were reared from leaf mines in individual leaves of *P. arundinacea* (Stoneycroft Pond, 31.v.2000, emerged 11.vi.2000).This species has been reared from several cereals and wild grass-

es, including *P. arundinacea,* in Europe (Griffiths 1980); this is the first North American record from this host. Previous Nearctic records were from the grasses *Beckmannia erucaeformis* L. and *Cinna latifolia* (Trev.) Griseb. in western North America (Griffiths 1980).

Anthomyza sp. (Anthomyzidae).—One adult was reared from a larva that was found 10–15 cm from the culm base of *C. lacustris* (Lac St. François, 19.x.1999, emerged 09.ii.2000).The shoot had signs of internal feeding damage but no exit holes or larvae of other species were seen; this suggests that the anthomyzid larva was a primary invader, although this is not certain. The larval feeding habits of the Anthomyzidae are practically unknown (Foote 1991). Some *Anthomyza* spp. have been found between the sheathing leaves of grasses, *Juncus* and *Typha* (Nye 1958, Uffen and Chandler 1978, Ferrar 1987), but it is not known whether the larvae were phytophagous or saprophagous. This specimen was not identified to species because most Nearctic species of *Anthomyza* are undescribed and there is no key to species.

Chlorops seminiger Becker (Chloropidae).—This species was reared as a primary invader from ten *C. lacustris* stems (Lac St. François, 01.x.1999, emerged 28.xii.1999 (1); same except emerged 02.i.2000 (1); same except 19.x.1999, emerged 31.xii.1999 (1); same except emerged 24.i.2000 (1); same except emerged 29.i.2000 (1); same except 27.x.1999, emerged 24.i.2000 (5 from 4 stems); same except emerged 29.i.2000 (1)). Emerging adults were always solitary, except in one case where two flies emerged from the same stem. The mature larvae were deep in the culm, very close to the base. Adults were collected at the study site from mid-May to late June. Sedges from which the adults were reared were collected in October 1999; the larvae are more mature late in the season and damage to *Carex* stems is more evident. The flies probably overwinter as second- or third-instar larvae because larvae collected in October were large (over 0.6 cm long) and because most other chloropid stem-borers of Cyperaceae whose life cycle is known overwinter as second or third instars (Rogers et al. 1991, Wearsch and Foote 1994). This is the first host-plant record for *C. seminiger. Chlorops certimus* Adams and *C. frontosa* Meigen have been reared from *Carex* species (Nye 1958, Rogers et al. 1991) and *Chlorops obscuricornis* Loew is a primary invader of stems of *Eleocharis* (Cyperaceae) (Wearsch and Foote 1994). Most other rearing records of *Chlorops* species are from grasses (Nye 1958, Ferrar 1987).

Conioscinella zetterstedti Andersson (Chloropidae).—Two brachypterous adults emerged from one stem of *P. arundinacea* infested by *Apamea ophiogramma,* along with *Eribolus nearcticus* and *Oscinisoma alienum* (Stoneycroft Pond, *P. arundinacea,* 31.v.2000, emerged 05.vii.2000). This is the first host-plant record for *C. zetterstedti. Conioscinella zetterstedti* occurs in a range of habitats including peatlands, sedge meadows, shoreline debris, among grass roots and leaf litter and in seashore dune grasses (Wheeler 1994), suggesting that it is a generalist scavenger on plant material. Other *Conioscinella* species have a wide range of habits but many are apparently saprophagous (Ferrar 1987).

Seven species of Chloropidae (*C. zetterstedti, Elachiptera angustifrons, Elachiptera penita, Eribolus longulus, Eribolus nana, Eribolus nearcticus, Oscinisoma alienum*) were reared from a total of four stems of *P. arundinacea* infested by *A. ophiogramma.* The chloropid larvae were mostly in the lower part of the burrow excavated by the noctuid larvae, which was usually higher in the burrow.

Elachiptera angustifrons Sabrosky (Chloropidae).—One adult emerged from one stem of *P. arundinacea* infested by *Apamea ophiogramma,* along with an adult of *E. penita* and *Eribolus* spp (Stoneycroft Pond, 31.v.2000, emerged 21.vi.2000). This is the first host-plant record for *E. angustifrons.* Species of *Elachiptera* are usually considered secondary invaders of grasses

and plant scavengers in general, usually in wet habitats (Valley et al. 1969b, Ferrar 1987).

Elachiptera penita (Adams) (Chloropidae).—One adult emerged from one stem of *P. arundinacea* infested by *Apamea ophiogramma,* along with an adult of *E. angustifrons* and *Eribolus* spp (Stoneycroft Pond, 31.v.2000, emerged 21.vi.2000). This is the first host-plant record for *Elachiptera penita.*

Eribolus longulus (Loew) (Chloropidae).—Adults emerged from two stems of *P. arundinacea* infested by *Apamea ophiogramma,* along with *E. nana* and *E. nearcticus* (Stoneycroft Pond, 31.v.2000, emerged 17.vi.2000 (3) and 19.vi.2000 (1)).This is the first record of this species from *Phalaris.* Three other larvae and 18 pupae, probably *Eribolus* species, died before emergence in one of the stems. Like *Elachiptera,* species of *Eribolus* are usually considered secondary invaders of grasses and other plant material in wet habitats (Ferrar 1987, Valley and Foote 1996) and *E. longulus* is apparently confined to wet open habitats dominated by sedges or grasses (Valley and Foote 1996). *Eribolus longulus* has been reared from damaged stems of *Carex* and *Scirpus,* developing flowers of *Iris,* and several genera of grasses (*Avena, Echinochloa, Glyceria, Triticum*) (Valley et al. 1969b, Valley and Foote 1996).

Eribolus nana (Zetterstedt) (Chloropidae).—Adults emerged from two stems of *P. arundinacea* infested by *Apamea ophiogramma,* along with *E. longulus* and *E. nearcticus* (Stoneycroft Pond, 31.v.2000, emerged 17.vi.2000 (1), 19.vi.2000 (1), 21.vi.2000 (1), 22.vi.2000 (1), 27.vi.2000 (1) and 30.vi.2000 (1)). This is the first record of this species from *Phalaris. Eribolus nana* has been reared from *Carex, Scirpus* and *Sparganium* L. (Sparganiaceae) (Valley et al. 1969b, Uffen and Chandler 1978).

Eribolus nearcticus Sabrosky (Chloropidae).—Adults emerged from three stems of *P. arundinacea* infested by *Apamea ophiogramma,* along with *E. longulus* and *E. nana* (in two stems), and with *Oscinisoma alienum* and *Conioscinella zetterstedti* (in a third stem) (Stoneycroft Pond, 31.v.2000, emerged 17.vi.2000 (1), 19.vi.2000 (6), 21.vi.2000 (3), 27.vi.2000 (1) and 30.vi.2000 (1)). This is the first host-plant record for *E. nearcticus.*

Lasiosina canadensis Aldrich (Chloropidae).—Two adults were reared from a culm of *C. lacustris* (Lac St. François, 16.vii.1999, emerged 17.viii.1999). Adults were swept from stands of *C. lacustris,* and of *C. aquatilis-Calamagrostis canadensis* (Michx.) Beauv. from mid-May to late October. Its relatively high abundance in October may indicate multivoltinism. This species has been reported as a secondary invader of *Carex interior, C. hystricina* Muhl. and *Scirpus cyperinus* (L.) Kunth, feeding on the decaying tissue damaged by the primary invader (Valley et al. 1969b).

Oscinisoma alienum (Becker) (Chloropidae).—One adult emerged from a stem of *P. arundinacea* infested by *Apamea ophiogramma,* along with *Conioscinella zetterstedti* and *Eribolus nearcticus* (Stoneycroft Pond, 31.v.2000, emerged 05.vii.2000). This is the first record from *Phalaris*; this species has been reared as a secondary invader from *Scirpus microcarpus* Presl. (Valley et al. 1969b).

Rhopalopterum atriceps (Loew) (Chloropidae).—Adults were reared on two occasions from *C. lacustris* (Lac St. François, 09.vii.1999, emerged 28.vii.1999 (1); same except 18.ix.1999, emerged 04.i.2000 (6), and 10.i.2000 (1)). In one case, seven adults emerged from the same stem but ten larvae were previously observed feeding deep in the culm within 5 cm of the base on rotting tissues previously attacked by a phytophagous invader. This is the first record of this species from *C. lacustris.* This species was reported feeding in shoots of *Carex comosa* Boott infested by the scathophagid *Cordilura varipes* (Walker) (Valley et al. 1969b). Most specimens were collected in June. Its higher abundance in *Carex aquatilis–Calamagrostis canadensis* stands suggest that

one or both of these plants is also a host for *R. atriceps*. Rearing records of *Rhopalopterum* spp. suggest that they are all secondary invaders of herbaceous plants (Valley et al. 1969b, Armstrong et al. 1996).

Thaumatomyia obtusa (Malloch) (Chloropidae).—One adult was reared from a *C. lacustris* shoot (Lac St. François, 01.x.1999, emerged 04.i.2000). The single larva was found under the second leaf sheath 6 cm above the roots. Feeding damage possibly caused by a leaf-mining moth such as *Elachista* sp. was observed on the inner leaves and frass was present inside two of the leaves. At least three species of *Thaumatomyia* are predators of Aphidoidea (Harper 1963, Alleyne and Morrison 1977, Raspi 1996) and, despite the apparent leaf-miner damage near the *T. obtusa* larva, this species probably also preys on aphids, such as *Thripsaphis ballii,* which were abundant between the inner leaves of *Carex* at the study sites. No adults of *T. obtusa* were collected from *C. lacustris* stands.

Pullimosina pullula (Zetterstedt) (Sphaeroceridae).—One adult emerged from decaying shoots of *Scirpus fluviatilis* (Lac St. François, 07.viii.1999, emerged 01.ix.1999). Although in this case the specimen was a secondary invader and emerged along with adults of *Chaetopsis massyla* (Otitidae) from a previously attacked plant, larvae of *P. pullula* probably feed on various types of decaying vegetation. *Pullimosina pullula* is found in many types of wet decaying plant matter (Marshall 1986).

Orthacheta hirtipes Johnson (Scathophagidae).—One adult was reared from a stem of *C. lacustris* that was previously invaded, possibly by *Cordilura* sp. (Scathophagidae) or by a weevil (Lac St. François, 07.viii.1999, emerged 24.i.2000). *Orthacheta hirtipes* has been reported as a facultative predator of five *Cordilura* species, which are stem-borers of *Carex* species (Neff and Wallace 1969). This is the first record of this species from *C. lacustris.*

Coleoptera

Sphenophora costipennis (Horn) (Curculionidae).—Three adults were reared from *C. lacustris* (Lac St. François, 12.vii.1999, emerged 01.x.1999 (1); same except 23.viii.1999, emerged 08.x.1999 (1); same except 11.ix.1999 (1)). Several larvae were found in July and a few in August, within the base of the culm. Burrows examined were usually 6–7.5 cm long (rarely up to 13 cm). Numerous stems of *C. lacustris* were observed during these months with empty burrows and large exit holes close to the base, probably caused by *S. costipennis*; this species may contribute most to feeding injury of *C. lacustris* at Lac St. François and may play an important role in the colonization of Diptera secondary invaders in such sedge meadows. Previous records of this species are from *Carex comosa* F. Boott and *Scirpus validus* Vahl. (Vaurie 1951).

Sphenophora australis (Vaurie) (Curculionidae). One adult was reared from a stem of *Typha latifolia* (Lac St. François, 21.viii.1999, emerged viii.x.1999). This stem-boring species is widespread in North America. Vaurie (1951) cited *T. latifolia* as the preferred host, but also mentioned *Sparganium eurycarpum* Engelm. as a host.

Lepidoptera

Cosmopterix fernaldella Walsingham (Cosmopterigidae).—Five adults were reared from several mined leaves of *C. lacustris* (Lac St. François, 27.x.1999, emerged 09.ii.2000). Leaf-mines were conspicuous and abundant from August to October 1999. Usually several leaves on the same host plant were mined, which suggests that a single female lays eggs on many leaves of the same shoot. The larvae were sometimes observed outside of the mine, probably feeding externally on the leaves. Hodges (1978) reported that *C. fernaldella* feeds on *Carex* but did not specify a host species. *Cosmopterix clemensella* Stainton also mines the leaves of *Carex* (Hodges 1978) and an unidentified *Cos-*

mopterix sp. was reared from *Carex vesicaria* L. (Frohne 1938).

Elachista sp. (Elachistidae).—Adults were reared from leaf mines on *C. lacustris* (Lac St. François, 19.x.1999, emerged 14.iii.2000 (1); same except 27.x.1999, emerged 21.iii.2000 (1)). Infested sedges were most commonly seen in October, when larval feeding damage was more advanced. Only the basal parts of the innermost leaves were attacked, in contrast to *Cosmopterix fernaldella* and Agromyzidae that attack the upper parts of the leaves. The mines of mature larvae were usually 15–20 cm in length, usually starting within 1 cm of the culm base. The first few centimeters of the mine were narrow, brown and zigzag shaped. The upper portion was filled with white frass with the caterpillar always at the upper end of the mine. Occasionally, two mines were found in the same *Carex* stem, but on different leaves; and other shoots were simultaneously attacked by *Chlorops seminiger*. In the lab pupation occurred outside the mine in a cocoon attached to the mesh cover or bottom of the container. The immature stages and food plant are unknown for many species of *Elachista* (Braun 1948). A similar leaf mine was described for a species attacking *Diarrhena americana* Beauv. (Poaceae); that species was said to undergo a long resting period during which the early mine turns brown (Braun 1948). At least three species are known to mine *Carex*, but our biological observations indicate that the reared species is distinct from those species. Many *Elachista* species start feeding in fall; some start in spring, are dormant for the summer and resume feeding in fall; others have continuous development throughout the season (Braun 1948). The species we reared is probably of the dormant type, with two separate feeding periods.

Apamea ophiogramma (Esper) (Noctuidae).—Two adults emerged from two stems of *P. arundinacea* (Stoneycroft Pond, 31.v.2000, emerged 28.vi.2000). Larvae or pupae were seen in six shoots and several others had similar damage but were empty. Infested shoots were shorter than intact ones, with yellowish terminal leaves. Infested shoots had an entry hole 2–3 mm in diameter and 2–11 cm above the base. On two occasions, two holes were observed on the same shoot with a mass of green frass just above each hole, indicating that two caterpillars attacked the same shoot. Numerous Diptera larvae were found feeding on frass and decaying plant tissues in the six *A. ophiogramma* burrows examined; several of these were reared to adults (see above). This is the first North American rearing record of *A. ophiogramma* (J. D. Lafontaine, pers. comm.). This introduced Palearctic species was first recorded in British Columbia in 1992 (Troubridge et al. 1992) and is now also established in southern Quebec (Handfield 1999). Our specimens belong to the dark form of the species. The larvae are stem-borers of *P. arundinacea, Glyceria maxima* Hartm., *Phragmites communis* Trin. (Poaceae) and *Iris pseudacornis* L. (Iridaceae).

Discussion

This study established 15 new host-plants for three phytophagous species and 12 secondary invaders, including the first host records for five chloropid species. This reflects the current lack of knowledge on the feeding habits of Diptera, particularly Chloropidae, associated with Poaceae and Cyperaceae (Ferrar 1987). Other than the rearing survey of Valley et al. (1969b) and a few studies on the life-cycle and immature stages of selected species (e.g., Rogers et al. 1991, Wearsch and Foote 1994, Valley and Foote 1996), the biology of Nearctic Chloropidae is largely unknown.

Based on rearing data and observations of infested plants, the four primary invaders recorded on *C. lacustris* (Table 1) all seem to be well established on this host. This is probably also true for *Chromatomyia fuscula* and *Apamea ophiogramma* on *P. arundinacea*; both species were repeatedly reared or observed from a sample of the

host plant taken from one small stand on a single date.

There were at least three species of chloropids in each of the four stems of *P. arundinacea* examined, apparently feeding on the decaying matter inside *A. ophiogramma* burrows. This diversity of chloropid secondary invaders was unexpected and suggests that these flies may frequently be present in mixed infestations, competing for ephemeral food resources in a limited space. A similar situation probably occurs in a wide range of host plants.

One of the reasons that so little biological information is available for larval Brachycera is that emergence rates are often low when rearing flies. Many Diptera breeding in sedges and grasses probably overwinter as third-instar larva or pupa within young shoots (Nye 1958, Wallace and Neff 1971, Rogers et al. 1991). Our success in rearing flies was higher when the insects were collected in the field as a mature larva or pupa near the beginning of the warm season or at the end of it. The search for infested plants should be concentrated during these periods to increase the probability of successful rearing.

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