

## Ecological observations on grass leaf mining flies in New Zealand

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### Abstract

Grass leaf mining flies were reared from two sites in Auckland city, at Oakley Creek walkway (over 2 years) and at Mount Albert Research Centre (in the second year only), from grasses collected monthly from October to February (year 1) and August to February (year 2). *Hydrellia tritici* (Ephydriidae) was uncommon at both sites, whereas *Ceradontha angustipennis* (Agromyzidae) was the most abundant fly at Oakley Creek except in mid-summer when *C. australis* was most numerous. The latter tended to be more numerous all year at Mount Albert. The flies were most numerous in late spring to early summer. Although apparently suitable hosts were available in summer, leaf mines became difficult to find in February. Flies were also reared from grasses in indigenous, secondary growth forest in the Waitakere Ranges, West Auckland, and the first host plant was found for *Hydrellia velutinifrons*. New host plants were found for each fly species: the number of host species for *C. angustipennis* increases from one to eight; for *C. australis* from five to 10; and for *H. tritici* from three to five. No indigenous host has been found for *C. angustipennis*.

**Keywords:** Grass, Leaf mining, Ephydriidae, Agromyzidae, Ecology, New Zealand

### Introduction

In New Zealand, three species of flies, *Ceradontha angustipennis* Harrison, 1959, *C. australis* Malloch, 1925 (= *C. denticornis*) (Agromyzidae) and *Hydrellia tritici* Coquillett, 1903 (Ephydriidae), have larvae that make mines in grass leaves (Harrison 1959). *Ceradontha australis* is the commonest agromyzid in the country (Spencer 1976), and *H. tritici* is the commonest species of that genus in pastures (Harrison 1959). These two species are also present in Australia. *Ceradontha angustipennis* is endemic and less common,

though widespread (Spencer 1976). *Ceradontha angustipennis* has been reared from Yorkshire fog (*Holcus lanatus* L.), and *C. australis* has been reared from barley, wheat, cocksfoot (*Dactylis glomerata* L.), rye grass (*Lolium perene* L.), and *Poa anceps* Forst., an endemic grass (Spencer 1976). *Hydrellia tritici* has been reared from wheat (Bock 1990), *Poa annua* and *P. trivialis* (May 1960). A qualitative survey of dipterous leaf miner parasitoids in New Zealand was conducted as a first step towards collecting data for a quantitative tritrophic food web of the host plants, leaf mining flies and their parasitoids, e.g. (Valladares *et al.* 2001). As part of this preliminary survey regular samples of grass leaf mines were collected in 2002-2003.

Further grass samples were collected in 2003-2004 to confirm the relative seasonal abundance of the three species found in the previous year. In 2006, grasses in native forest were sampled at three sites after a chance find of the host of an indigenous *Hydrellia* species. This paper reports new plant hosts of the four species of flies, and the relative seasonal abundance of three species in two Auckland city habitats.

### Materials and methods

In 2002-2003, grass leaf mines were collected on seven occasions from October to February from Oakley Creek Walkway near Mount Albert, Auckland City. At five or more sites along the walkway, up to 13 stems with leaf mines were picked from any single grass species in flower (to aid identification). In the laboratory, fly puparia were put on damp filter paper in plastic petri dishes. Larvae within leaves were inspected three times a week until they pupated. After dissection from the leaf, the pupae were transferred into a small plastic petri dish lined with damp filter paper and with a tight fitting lid. All specimens were reared at 15°C and a 16 h photoperiod. Emerged flies and

parasitoids were transferred to 75% ethanol three times a week. Fly puparia were identified to genus, but most unemerged flies were not identified.

In 2003-2004, quantitative samples of grasses were taken on seven occasions from August to February from two sites, Oakley Creek Walkway and Mount Albert Research Centre. Five sites were selected along Oakley Creek Walkway from each of which five plants of *Poa annua* with mines were dug up (in August, September, October), from three sites (November), or five stems of *Holcus lanatus* plants with some mines visible, at two sites (November) or five sites (December, January, February). At Mount Albert Research Centre, five *P. annua* plants that appeared to have leaf mines were dug up in each of August, September, October and November; five tillers of *H. lanatus* were collected from five sites in each of December and January; and six to 10 tillers were collected from five sites in February. Fly pupae and larvae were reared as in 2002-2003. All fly puparia were identified to genus, and where possible the unemerged flies were identified to species.

In 2006, grasses with leaf mines were collected from three sites in indigenous forest (cutover, second growth) in the Waitakere Ranges, West Auckland; Fairy Falls track (7 & 27 January), McElwains loop track (30 January) and Aritaki nature trail (11 February). At each site, grasses along tracks were sought, stems with leaf mines

collected, and larvae or pupae reared as above and identified to genus.

## Results

Flies were reared from 10 grass species in 2002-2003 (Table 1). In addition, *C. australis* and *H. tritici* were reared from *P. annua* in 2003-2004. Leaf mines were particularly abundant on tall oat grass and Yorkshire fog. The relative suitability of summer grasses such as Veld grass for leaf mining flies is hard to assess from these data, because of the small fly populations in mid to late summer.

In 2006, larvae and pupae of both *Ceradontha* and *Hydrellia* were found in leaf mines on grasses in indigenous forest. *Ceradontha angustipennis* was found on the exotic grass, *Entolasia marginata* (R. Br.) Hughes, at two sites – the Aritaki nature trail (three pupae) and McElwains loop track (seven pupae). *Hydrellia* larvae and pupae were found on *E. marginata* at McElwains loop track (six pupae, one larva) and on the Fairy Falls track on *Microlaena avenaceae* (Raoul) Hook. f. (three pupae) and *Oplisnenus hirtellus* (L.) P.Beauv. (four pupae). Two adult *Hydrellia velutinifrons* Tonnoir & Malloch. were reared from pupae found in *M. avenaceae*. About half of the juvenile flies found in the Waitakere Ranges were parasitised.

Many flies and parasitoids were reared in spring and early summer of 2002, but few flies

**Table 1. Numbers of flies reared from grasses collected from Oakley Creek Walkway in 2002-2003.**

Grass species sampled	Grass common name	Number of collections	<i>H. tritici</i>	<i>C. australis</i>	<i>C. angustipennis</i>	Total flies
<i>Anthoxanthum odoratum</i> L.	Sweet vernal	3	2	0	6	8
<i>Arrhenatherum elatius</i> (L.) J. Presl et C. Presl	Tall oat grass	12	0	19	164	183
<i>Ehrharta erecta</i> Lam.	Veld grass	5	0	0	7	7
<i>Dactylus glomerata</i> L.	Cocksfoot	1	0	0	0	0
<i>Holcus lanatus</i> L.	Yorkshire fog	6	1	21	168	190
<i>Lolium perenne</i> L.	Rye grass	1	0	11	0	11
<i>Poa annua</i> L.	Annual poa	1	0	0	32	32
<i>Poa pratensis</i> L.	Kentucky blue grass	2	0	7	13	20
<i>Polypogon viridis</i> (Gouan) Breistr.	Water bent	1	0	2	6	8
<i>Piptatherum miliaceum</i> (L.) Coss.		1	0	1	0	1
Total			3	61	396	460

**Table 2. Number (%) of flies of each species identified as eclosed adults or in puparia collected from Oakley Creek Walkway in 2002-2003.**

Date	Number of grass species sampled	Total number of flies	Number of flies (%)			
			<i>C. angustipennis</i>	<i>C. australis</i>	<i>H. tritici</i>	
4 Oct 02	6	74	73 (99)	0	1	(1)
17 Oct 02	5	161	158 (98)	2 (1)	1	(1)
31 Oct 02	5	41	35 (85)	5 (12)	1	(2)
21 Nov 02	4	72	53 (74)	19 (26)	0	
24 Dec 02	4	101	75 (74)	26 (26)	0	
21 Jan 03	4	3	2 (67)	1 (33)	0	
18 Feb 03	3	8	0	8 (100)	0	

**Table 3. Number of flies of each species identified as eclosed adults or in puparia collected from Oakley Creek Walkway and Mount Albert Research Centre in 2003-2004.**

Date	Total number of flies identified as eclosed adults or in puparia	Total <i>Ceradontha</i> pupae	Number of flies (% of <i>Ceradontha</i> pupae)			<i>H. tritici</i> Number (% of pupae)
			<i>C. angustipennis</i>	<i>C. australis</i>		
Oakley Creek Walkway						
26 Aug 03	5	12	5 (100)	0	0	
21 Sep 03	5	9	4 (80)	0	1	(10)
15 Oct 03	53	59	49 (92)	0	4	(6)
10 Nov 03	108	122	103 (95)	5 (5)	0	
9 Dec 03	110	155	104 (95)	3 (3)	3	(2)
7 Jan 04	33	89	21 (64)	11 (33)	1	(3)
17 Feb 04	1	1	0 (0)	1 (100)	0	
Mount Albert Research Centre						
26 Aug 03	4	12	0	4 (100)	0	
22 Sep 03	4	1	1 (25)	0	3	(75)
16 Oct 03	7	6	4 (57)	2 (29)	1	(14)
11 Nov 03	24	28	8 (33)	15 (63)	1	(3)
11 Dec 03	28	40	7 (25)	20 (71)	1	(2)
8 Jan 04	2	3	1 (50)	1 (50)	0	
19 Feb 04	0	0	0	0	0	

were successfully reared in January and February 2003 (Table 2). In February the low numbers of flies reared reflected the scarcity of leaf mines. *Hydrellia tritici* was the least common species, and only three were reared, whereas *C. angustipennis* was the most common species up to January. Many

of the parasitoids reared are awaiting identification, but preliminary results show that larval and larval-pupal parasitoids were present and that they belong to four families, Braconidae, Diapriidae, Eulophidae and Pteromalidae. Of the species identified, some have been found only or mainly

associated with grass leaf miners, whereas other species have been also commonly reared from leaf miners of herbs and shrubs. These latter could contribute to the control of invasive *Liriomyza* (Agromyzidae).

The trend of relative abundance of fly species found in 2002-2003 at Oakley Creek Walkway was confirmed in 2003-2004 (Table 3). At Mount Albert Research Centre, leaf mining flies were uncommon in January and February, but *C. angustipennis* did not dominate the fly population as it did along Oakley Creek Walkway. The numbers of leaf mines and juvenile flies present per sample were very variable for the same grass species on the same date, e.g. 0 to 70 flies in samples of 5 stems of Yorkshire fog from Oakley Creek Walkway in December 2003.

## Discussion

In Auckland city, leaf mines caused by flies in grasses were most numerous in samples collected in late spring and early summer (October to December) in both surveys (Tables 2 & 3). Mines were easy to find during this period and when present numbers of mines per tiller were high. A similar pattern of abundance of *C. australis* and *H. tritici* was found in sweep net samples from a Nelson pasture (Martin 1983). Such seasonal abundance of the flies may be linked to both the suitability of the host plants and the seasonal abundance of parasitoids. In Auckland, grasses grow all year. Several species grow throughout the winter (e.g. annual poa) while other species grow throughout the summer along creeks and elsewhere, even during dry summers. Mines were found in some of these summer grasses. All three species of fly, *C. angustipennis*, *C. australis* and *H. tritici*, appear to be multi-voltine and larvae have been seen in late winter, indicating that there is no winter diapause in the Auckland region. The availability of suitable host plants does not appear to limit the numbers of leaf mining flies, so it is likely that parasitoids have a major influence on the annual cycle of grass leaf mining flies.

The data on parasitoids was collected to provide qualitative information on the species associated with grass leaf mining flies in preparation for future quantitative samples which will provide

information on the impact of parasitism on the annual cycle of the flies. The variability in abundance of leaf mines between samples of grass stems and plants will influence the sampling protocol, as well as the need to spread sampling throughout the year.

The study provided insights into the ecology of two native leaf mining flies. *Ceradontha angustipennis* is widely but locally distributed in New Zealand (Cumber & Harrison 1959; Spencer 1976). These 2 years of data show that Oakley Creek is a favoured habitat, and the data from the Waitakere Ranges suggest that *C. angustipennis* may favour grasses in forest clearings. *Ceradontha angustipennis* is regarded as an indigenous species (Spencer 1976) and has now been found in indigenous forest, but it has not yet been reared from a native grass.

*Hydrellia velutinifrons*, an indigenous species, was reared for the first time from grasses in indigenous forest. It has now has one confirmed host plant, *Microlaena avenaceae*, and may have two others – *Oplisnenus hirtellus*, which was growing near *M. avenaceae*, and *E. marginata*.

Based on present data, the relative host preferences of the flies cannot be determined, but casual observation indicates that some species of grass do not or only rarely have leaf mines, while others are often attacked. Data from this study increase the number of host species for *C. angustipennis* from one to eight, *C. australis* from five to 10, *H. tritici* from three to five and *H. velutinifrons* from zero to one.

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