Proceedings of the

Entomological Society of Manitoba

VOLUME 63

2007

T.D. Galloway
Editor

Winnipeg, Manitoba

Contents

A new record for *Uranotaenia sapphirina* (Diptera: Culicidae) in Manitoba, Canada

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ABSTRACT

Uranotaenia sapphirina (Osten Sacken) was identified for the first time in Manitoba in September, 2005. This observation increases the known northern geographic range of *Ur*. *sapphirina* to Winnipeg, Manitoba, Canada (97º15´N; 49º86´W). The specimen, one adult female, was captured in a New Jersey Light Trap (NJLT) during routine adult mosquito collections performed as part of the City of Winnipeg mosquito control programme. This observation increases the total number of mosquito species in Manitoba and the City of Winnipeg to 47 from 46 and from 38 to 39, respectively.

Uranotaenia sapphirina (Osten Sacken) is found from southeastern Canada to Florida along the eastern seaboard of the United States. Its current known range extends into the central states, west to North Dakota and south into Mexico (Darsie and Ward 2005; Wood *et al*. 1979). *Uranotaenia sapphirina* larvae are generally found in primarily sunlit semi-permanent and permanent water bodies with floating and emergent vegetation such as *Spirogyra* or *Lemna* spp. They are sometimes confused with *Anopheles* species larvae, as they rest parallel to the water surface (Carpenter and LaCasse 1955; Dyar 1928). Like many of the *Culex* species, adult females of *Ur. sapphirina* enter hibernation after they have been inseminated in the fall, pass the winter in diapause and emerge in late spring to produce several egg batches over the course of the summer (Wood *et al*. 1979).

The City of Winnipeg maintains a network of 25 NJLT's and 16 CDC traps to monitor adult mosquito populations throughout the urbanized and non-urbanized areas in and around Winnipeg. On 12 September, 2005, the first presumptive specimen of *Ur.*

sapphirina was captured in one of the NJLT's. The female specimen was captured in a subdivision of St. Vital in Winnipeg, Manitoba. The NJLT was located near several permanent and semi-permanent water bodies. Confirmation of the presumptive identification was completed by comparing the field collected sample to voucher specimens from the Department of Entomology - North Dakota State University of Agriculture and Applied Science.

Additional adults or larvae of *Ur. sapphirina* were not detected at the original site of collection nor at others in the St. Vital area during 2006 and 2007; this collection may represent only a temporary establishment or incursion of this species into Manitoba. However, monitoring for this species, including examination of preferred overwintering habitats and active sampling for adults and larvae will continue to determine whether populations of *Ur. sapphirina* have become established in Winnipeg. This report increases the total number of mosquito species in Manitoba and the City of Winnipeg to 47 and 39, respectively (Wood *et al*. 1979).

West Nile virus (WNV) has been detected in field collected adults of *Ur. sapphirina* and this species was implicated as a potential vector of WNV in 2001 (CDC 2005). The vector competence of this species to acquire and transmit WNV under laboratory conditions has also been demonstrated (Shapiro *et al*. 2004). Because the preferred hosts of *Ur. sapphirina* are amphibians and reptiles, this species is considered an enzootic amplifier of WNV. Breeland *et al*. (1961) and Carpenter and LaCasse (1955) reported that *Ur*. *sapphirina* will land on humans but generally will not bite. As a result, spillover of WNV into the human population would have to be facilitated by polyphagous mosquitoes such as *Culex tarsalis* (Coquillett).

Though established populations of *Ur. sapphirina* have not been confirmed in Manitoba, the detection of *Ur. sapphirina* in Winnipeg may serve as an indicator that other mosquito species may be present but unreported in Manitoba. For example, *Culex pipiens* (Linnaeus) is established in parts of central Minnesota (Darsie and Ward 2005; Wood *et al.* 1979) and this important vector species may also incur and establish in Manitoba. It is important to continue mosquito surveillance activities in Manitoba and elsewhere in Canada to monitor the possible range expansion of mosquito species capable of transmitting arboviruses and other mosquito-borne pathogens.

ACKNOWLEDGEMENTS

Thanks to North Dakota State University of Agriculture and Applied Science – Department of Entomology for supplying voucher specimens. Rob Rekruit (City of Winnipeg) identified the blue sapphire scales of *Ur*. *sapphirina* and Robbin Lindsay (National Microbiology Laboratory) provided useful comments on this paper.

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The effect of seeding date on the development of Hessian fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae), on spring wheat (Poaceae) in southern Manitoba[1]

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ABSTRACT

The Hessian fly *Mayetiola destructor* (Say) has both univoltine and bivoltine generations on spring wheat in Manitoba. The first generation attacks seedlings of spring wheat in June and mostly completes its development at the crown of plants in July. Adults of the second generation emerge in mid–July to early August and oviposit primarily on late-seeded plants. The second generation larvae form puparia in late July and August and remain dormant over the winter in the straw under stem sheaths. The seeding date of spring wheat affects whether first or second generation larvae develop on the crop, and the severity of stem breakage by the Hessian fly. Wheat sown in mid- to late May is attacked mostly by the first generation, and only suffers minor damage. Crop damage is highest when spring wheat is sown in the first two weeks of June and is caused by the feeding of second generation larvae. In most years, about 70% of the Hessian flies in southern Manitoba are bivoltine. The puparia of univoltine flies remain quiescent for the remainder of the summer and overwinter at the base or crown of wheat plants. In the four year field study survival of first generation puparia was >65%, compared to <10% for second generation puparia.

INTRODUCTION

The Hessian fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae), is a serious pest of wheat *Triticum aestivum* L. in most major wheat growing areas (Barnes 1956; Berzonsky *et al*. 2003). The pest was introduced into North America in the 18th century (Osborn 1898), and is now throughout the United States and Canada (Buntin and Chapin 1990; Ratcliffe *et al*. 2000; Whistlecraft and Deakin 1992). In the many areas of the United

States, resistant winter wheat cultivars have provided the most reliable and economical control of the Hessian fly (Ratcliffe and Hatchett 1997), but no spring wheat cultivars grown in western Canada are known to be resistant, although one cultivar, 'Superb', is less susceptible to damage (Wise *et al*. 2006).

In western Canada, outbreaks of the Hessian fly are infrequent (McCullough 1987; Harris 1991) and the extent of its damage to spring wheat is not well documented. Turnock and Timlick (1990) found 5% of stems of 'Biggar' spring wheat from 11 fields in Manitoba were infested by Hessian fly.

In the northern winter wheat areas of the United States and in eastern Canada, the Hessian fly is bivoltine (Ratcliffe and Hatchett 1997), and in the southern United States it may produce three to six generations per year (Hoelscher and Turney 1985; Buntin and Chapin 1990). The Hessian fly in western Canada, where most wheat is sown in spring, has been observed to complete one full and a partial second generation per year (Criddle 1915).

The Hessian fly mainly damages spring wheat in western Canada by attacking stems during stem elongation which weakens the stem at the feeding site of the larvae. Yield losses occur when infested stems break (Criddle 1915; Mitchener 1923) or from reductions in seed number and size in spikes on infested unbroken stems (Wise *et al.* 2006). Damage to seedlings in western Canada has not been documented to cause yield losses as opposed to winter wheat in the United States where attack by multiple broods can cause additional yield losses in the autumn by killing seedlings or vegetative tillers (Hill and Smith 1925; Byers and Gallun 1972; Buntin 1999).

A delay in the seeding of winter wheat to escape fall infestation can prevent or reduce Hessian fly damage in many winter wheat areas of North America (Flint and Larrimer, 1928; Buntin *et al*. 1990). It is known that seeding date of spring wheat in western Canada may affect damage by the Hessian fly (Wise *et al*. 2006), but the differences in yield loss have not been documented. The effects of seeding date on the development of the Hessian fly on spring wheat in western Canada and on associated crop losses by this insect pest were the objectives of this study.

MATERIALS AND METHODS

The spring wheat cv. 'AC Barrie' was seeded in 2003 to 2005 and in 2007 at a rate of 80 - 100 kg/ha by hand or with a double disc press drill at the Agriculture and Agri-Food Canada Research Farm, Glenlea, Manitoba, Canada (49º38′N, 97º09′W). Seeding was done by hand when excess surface moisture prevented mechanized seeding. 'AC Barrie' was selected because it is susceptible to the Hessian fly (Wise *et al*. 2006) and was the most commonly grown cultivar in western Canada during the study (Canadian Wheat Board 2003, 2004, 2005). The plots were located in the fallow portion of a field with a wheat:fallow annual crop rotation. Plots were 10 m^2 to 16 m^2 and were sown on four dates at similar intervals each year between 16 May and 19 June (Tables 2, 3). The seeding dates were replicated four times and plots were arranged in a randomized complete block design. The fallowed areas around the plots were sown to 'Roblin' spring wheat on the last day of seeding, except in 2005 because of wet conditions.

Adult emergence next to the plots was monitored with galvanized metal cone traps. Five traps on 4 June 2004 and eight on 31 May 2005 were pushed 2-3 cm into the soil over wheat stubble infested with Hessian fly. The traps enclosed an area of 0.10 m^2. Two screened holes on the side provided ventilation and a plastic vial over an opening at the top collected adults.

Sampling consisted of 15 to 25 plants (Foster and Taylor 1974) randomly selected in each plot weekly from early June to August in 2003 to 2005 (growth stages 11 to 80, Tottman and Makepeace 1979). Plants were unearthed by a hand trowel and soil was removed from the roots. Samples were placed into a separate plastic bag for each plot and stored within a few hours. Eggs or larvae on young plants were assessed within four days after storage at 5°C, but older plants (growth stages 70 to 80) collected in August were stored at 10°C for up to three weeks.

The number of eggs on leaves, and larvae and puparia at nodes or at the base of plants (growth stages 11 to 29) were counted, using a dissecting microscope, and plants were assessed for feeding damage by larvae. Plants with elongated stems (growth stages 30 and above) were cut immediately above the first node without adventitious roots. A 'base' count of larvae and puparia was taken at and below this node, and a 'stem' count of eggs, larvae and puparia was taken from above the node. Larvae and puparia were exposed by pulling back the leaf or stem sheathes at the base or nodes. The puparia with broken exuviae or exit holes were examined for the presence of parasitoid remains (Hill and Pinckney 1940). Exuviae without any remains were recorded as being exited by an adult Hessian fly.

The mean numbers of larvae and puparia at the base or on the stems were calculated from collections (80-100 plants per plot) taken from mid-July to August. The number of first generation adults was estimated by counting puparia with adult fly emergence holes from samples collected in August (50-70 plants per plot). In 2007 puparia and adult fly emergence were estimated from a single collection (20-25 plants per plot) in early October. Plants with puparia were assessed for plant or tiller death. Assessments to determine the proportion of plants infested at the base or on the stems were taken from the mid-July to August or October collections.

At plant maturity in September or October, stem breakage by Hessian fly was estimated by counting the numbers of broken and unbroken stems in each plot from two 0.25-m^2 areas that were representative of the entire plot. In 2007, the stems of all plants in plots of the two last sowings that had been damaged by rains just after seeding, were examined for stem breakage. Yield losses were calculated from the percentage of stems that had broken and fallen to the ground.

Puparial survival. Plants were collected in September or October in all years to determine the emergence of adults (%) and mortality of puparia. The plants were cut, as for earlier collections, and all samples were stored at 2.0°±1°C, 0:24 L:D within 24 h in sealed plastic containers for at least 13 weeks (Harris and Rose 1989). Immediately after storage, five puparia from the base or stems were placed on a 5-7 mm layer of moistened sand in separate 10-ml glass vials. The vials were kept at room temperature, and adult Hessian flies and parasitoids were counted and removed from vials as they emerged. Puparia that did not eclose after five weeks were examined for immature or dead Hessian flies.

In 2004, puparia at the base of plants in the two earliest sowings were collected on 21 and 28 July and were tested as above, except puparia were kept at room temperature and were not moved to cold storage until after eclosion had ceased for five weeks.

Plants also were collected at crop maturity from late maturing commercial fields at La-Salle (49°38´N, 97°12´W), Rosenhoff (49°25´N, 97°25´W), and Otterburne (49°30´N, 97°03´W) in the Red River Valley of Manitoba on 9 September 2005. The fields were about 15 to 35 km from the Glenlea site. Broken stems were severed at the crown and overwintered, as for the plot studies. After overwintering, puparia were placed onto moist sand in separate glass vials and exuviae from empty puparia were counted. Hessian fly and adult parasitoids were counted as they emerged in the vials. Puparia that did not eclose were dissected to determine if they had been parasitized.

The proportion of plants infested by first and second generation Hessian flies and stem breakage for the four seeding dates each year were analyzed by ANOVA and Tukey's Multiple Range test (P>0.05) to determine differences among seeding dates.

RESULTS

Weather data and crop growth. Mean temperatures at Glenlea from May to August in 2003, 2005, and 2007 were about 1°C above 30 year means of 16.8°C (Environment Canada 2008). In 2004, mean temperatures were 1°C to 5°C below normal for all four months. Moisture levels during these months were within 10% of 30 year means (293.2 mm) in 2003 and 2007, 38% above in 2004, and more than 50% above in 2005. May and August of 2004 and June and July of 2005 had about double the normal rainfall levels.

Plants in most plots each year produced 3-5 tillers per plant. The low temperatures in 2004 delayed germination and crop growth by a week to 10 days. Heavy rainfall killed many newly emerging plants in the second seeding of 2004, and in the last seeding of 2005 and 2007. Plants which survived in the damaged plots in 2004 were of normal height and many produced more than twice as many tillers as plants in other plots. In the damaged plots only five tillers per plant, which equaled the mean found in the other plots, were assessed. Plants damaged in 2005 and 2007 were very short and had only one to three tillers per plant.

Number of generations. All immature stages and eclosed puparia of Hessian flies were collected on spring wheat. Two peaks of egg and larval development were identified, corresponding to two generations (Fig. 1).

First generation. Adult Hessian flies were captured in cone traps and eggs were found on seedlings in the first week of June. Egg densities on seedlings in all years were highest in the second week of June, ranging from 0.6 to 3.0 eggs per plant each year. Oviposition lasted for about three weeks in 2003 and 2005 and for about four weeks in 2004 (Fig. 1).

Larvae were first collected on 9-10 June (Fig. 1). In 2003 and 2004, about 5% were already third instars, indicating some oviposition had occurred more than one week earlier. Larvae were most abundant from late June (2003) to the second week of July (2004). The first puparia were found during the period of peak larval abundance, and empty exuviae began to appear about two weeks later. By early August, adult Hessian flies had exited from nearly 60% of the puparia in 2003 and 50% in 2005, but less than 20% in 2004 (Fig. 2). At crop maturity, adults had emerged from 40% to 64% of first brood puparia in 2003 to 2005 (Table 1).

After an overwintering period, adults emerged from 12% to 30% of the puparia for a total emergence of 67% to 77% from puparia in the late collections (Table 1). The post-overwintering emergence represented 17% to 42% of all first generation adult emergence. Hymenopterous parasitoids killed 18% to 28% of the puparia, and 4% to 8% died from unknown causes.

Second generation. A second population of eggs was laid during the second or third week of July (Fig. 1) on leaves of plants in the later seeded plots. Larvae were found at the stem nodes soon thereafter, and densities were highest during the last week of July or the first week of August (Fig. 1). Puparia began to form by the end of July in 2003 and 2005 but not until 11 August in 2004 (Fig. 2). A few empty puparia were found each year. All these puparia contained the remains of a parasitoid.

Survival of second generation puparia never exceeded 12.5% in any collection (Table 1). At all sites and years, puparia were killed mainly by chalcidoid parasitoids (Wise 2007), and an average of 17% died from unknown causes. In the latter cases, the dead larvae were either desiccated and covered with mycelia or liquefied by a bacterial infection.

Seeding dates. Crops were attacked by overwintering adults as the first or second leaf unfolded (growth stage 11 and 12). In all years, Hessian fly infestations by first brood populations were lowest in plots sown on or after 9 June (Table 2). In two of the four years, June sowings had fewer (P<0.05) infested plants than those sown 2-3 weeks earlier (Table 2).

No plants collected in 2003 and 2004 were killed by the feeding of first generation larvae, and <10% of infested plants had one or two dead tillers. In 2005, no dead plants were found, but 72% (n=54) of infested plants in the first seeding, 67% (n=30) in the second, and 80% (n=25) in the third had at least one tiller that was killed by first generation larvae.

A higher percentage of adults emerged without an overwintering period in the earliest sowings in 2003 ($F_{3,9}$=5.0, P=0.026, n=1098) and in 2005 ($F_{3,9}$=9.72, P=0.035, n=218) than in the last sowings. In both years, 64-65% of adults in the first seeding emerged without diapause versus 38-39% in the last seeding. Adult emergence without diapause in the first seeding (33%) was also higher than the last seeding (17%) in 2004 (33%), but results were not significant (P>0.05).

Although densities varied greatly among years, second generation populations increased the later the crops were sown (Table 3). Crops sown in the first or second week of June had higher second generation infestations than crops sown three to four weeks earlier (P<0.05), except in 2007 when populations were higher for sowings in the first week but not in the third week of June (P>0.05) (Table 3).

Stem breakage largely reflected infestation levels of the second generation. Breakage was higher ($P<0.05$) for the last versus the earliest seeding date (Table 4) except for the last seeding date in 2007. Many infested plants in the earliest sowings had few broken stems. These plants were mostly infested by first brood larvae which concentrated their feeding at the base of the plants.

DISCUSSION

While the Hessian fly is widespread throughout southern Manitoba, it is not known to cause serious yield losses in the province. In this study, seeding dates used by most growers contributed to the low incidence of damage. Growers are recommended to seed wheat early in the growing season, *i.e.*, before 1 June, to maximize yields (Wolfe *et al*. 1978; Manitoba Agriculture 1998). Crops sown by 22 May in this study had up to 7-fold less stem breakage than crops sown two to three weeks later.

Hessian flies use chemical and visual cues (Harris *et al*. 1993) and wheat plants of suitable size and maturity (Hill *et al*. 1943; Morrill 1982) to locate oviposition sites. Plants sown in this study by 22 May were mostly too mature to attract females or for second generation larvae to develop. Very few main shoots or early tillers on these plants were found to be infested. Since the main shoot and first two tillers of spring wheat in western Canada contribute two-thirds or more to the total yield (Hucl and Baker 1989a, b), second generation larvae mostly attack the least productive tillers in early seeded crops.

Crops are more susceptible to damage if sown in the first week to 10 days of June. In most years, these crops attract first brood females, and second generation larvae feed mostly at the upper nodes of the main shoot or first tillers of these crops. Feeding at these nodes maximizes the likelihood of stem breakage and the potential for further yield losses from seed shrinkage and fewer seeds forming in spikes of infested standing stems (Wise *et al*. 2006). These symptoms were characteristic of the damage to susceptible spring wheat cultivars by the Hessian fly in Oregon (Smiley *et al.* 2004).

Plants sown after 10 June, particularly sowings just before the 20 June cut-off date for crop insurance in western Canada, are readily attacked by second generation larvae but are less prone to stem breakage than plants sown in early June. The lower breakage in late sowings can be attributed to plants more likely being stunted and having smaller spikes which places less stress on damaged areas of the stems.

Plants infested as seedlings by first generation larvae did not show damage symptoms common to winter wheat seedlings (Anderson and Harris 2006). Dead or severely damaged shoots were found on some infested seedlings in 2003 and 2004, but these plants continued to produce new shoots and outgrew the damage. Young plants those years were frequently infested by another insect pest of wheat, the frit fly, *Oscinella frit* (L.). This insect is a serious pest of wheat in eastern Europe (Lauva and Shutele 1977), but it is not known to cause economic yield losses to spring wheat in North America. Frit fly larvae fed mostly on newly developing secondary shoots, masticating the tissue and killing the shoot. First generation Hessian fly larvae, conversely, fed mostly at the elongated internodes of large primary tillers at the crown of the plant.

In 2005 when growing conditions were less suitable than the previous two years, 67-80% of all infested plants had at least one dead tiller. Plants that year had few tillers, and first generation larvae were found more frequently on small secondary shoots than in previous years, causing their death. Plants in 2005 were less able to compensate for early tiller loss than in 2003 and 2004 because of poor growing conditions. Thus, damage to seedlings may contribute to lower yields in years of poor plant growth and, if some compensatory growth does occur, to a delay in wheat maturation.

Many first generation adults emerge after spring wheat fields are suitable for oviposition and for larvae to develop. Late-appearing females can produce a second generation in southern Manitoba if they find an alternate host since there are 4-6 weeks of temperatures suitable for larval development. Perennial grasses known to support Hessian fly reproduction, such as *Hordeum jubatum* L. and *Elytrigia repens* (Zeiss *et al*. 1993), are abundant in southern Manitoba, but it is not known if flies will seek these plants this late in the season.

Hessian flies are both univoltine and bivoltine on spring wheat in southern Manitoba each year. Adults emerge in late May to late June, depending on the weather, and females lay eggs on newly emerged wheat. The larvae feed at internodal areas of the plant crown for two to three weeks, and either first brood adults emerge about two weeks later or puparia aestivate during the summer and then overwinter. The presence of univoltinism and multivoltism in Hessian fly populations has also been found in Kansas, Germany and England (Barnes 1958), albeit at lower prevalence than in these studies.

No second generation adults were observed in any year of the study. Empty casings of second generation puparia were found, but all had been exited by a parasitoid. This bivoltine life cycle is similar to populations in the eastern and northern United States (Flint and Larrimer 1928, Ratcliffe and Hatchett 1997), except puparia of bivoltine flies in Manitoba do not have a summer dormancy.

In southern Manitoba, bivoltinism is the dominant condition, varying from 58% to 84% of the annual population in the studies. As seen in 2004, cool weather in the summer may reduce the frequency of bivoltinism. Puparia exposed to warmer conditions in July and August before overwintering that year had 14% higher adult emergence, or 18% higher incidence of bivoltinism, than puparia in the field (Table 1). Thus, emergence by first generation adult Hessian flies in southern Manitoba can be affected by climatic conditions, and, for many flies, univoltism is facultative.

Hessian fly populations can greatly increase in areas with multiple generations (Buntin and Chapin 1990). In southern Manitoba, population increases by bivoltine flies are reduced largely by seeding dates and puparial mortality. In the four years of the study, over 90% of all spring wheat fields in Manitoba were sown on dates in May that are unsuitable or less favourable for second generation development (Manitoba Agriculture and Food, 2002-2005). When second generation populations do develop, they are subject to >90% puparial mortality, primarily by parasitoids (Table 1).

In conclusion, the seeding of spring wheat before June in Manitoba can greatly reduce damage by the Hessian fly. The effect was four-fold; fewer stems are infested by second generation larvae, first generation larvae concentrate feeding at the crown of primary tillers where feeding is more tolerated, plants in good growing conditions can compensate for early season damage, and lower yielding late tillers are more likely to be attacked.

ACKNOWLEDGEMENTS

I wish to thank Sheila Wolfe, Tesfu Araia, and Thelma Czarnecki for technical support, Denis Green and Otto Gruenke for field maintenance and preparation, and Robert Lamb for research advice.

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Table 1. Percentage of adults from first and second brood puparia of *Mayetiola destructor* that emerged without (ND) or after diapause (AD) in southern Manitoba 2003-05, and mortality of Hessian flies by hymenopterous parasitoids or by an unknown cause.

Sampling data				Adult emergence (%)			% Mortality[1]	
Year	Site	Date	n	ND	AD	Total	Parasitism	Unknown
First generation								
2003	Glenlea	9 Sep	900	63.9	12.6	76.5	19.9	3.6
2004	Glenlea	5 Oct	497	39.6	29.1	68.7	27.7	3.6
		21-28 Jul	703	53.5	16.8	70.3	23.0	6.7
2005	Glenlea	11 Aug-15 Sep	344	52.6	21.5	74.1	18.3	7.6
2007	Glenlea	2 Oct	80	44.8	22.5	67.3	26.3	7.5
Second generation								
2003	Glenlea	9 Sep	800	0	0.4	0.4	73.8	25.8
2004	Glenlea	5Oct	433	0	12.0	12.9	78.8	9.2
2005	Glenlea	15 Sep	48	0	10.4	10.4	72.9	16.7
	LaSalle	9 Sep	200	0	12.5	12.5	68.0	19.5
	Otterburne	9 Sep	62	0	3.2	3.2	85.5	11.3
	Rosenhoff	9 Sep	365	0	7.9	7.9	73.4	18.9
2007	Glenlea	2 Oct	79	0	6.3	6.3	75.9	17.7

[1]Mortality assessed at puparial stage of Hessian fly.

Table 2. The proportion of spring wheat plants infested by first generation *Mayetiola destructor* when sown on four seeding dates per year in southern Manitoba, 2003-2005 and 2007.

	Proportion of infested plants			
Seeding date	2003	2004	2005	2007
16-22 May	0.73±0.04a*	0.67±0.02a	0.28±0.02a	0.07±0.02a
28-31 May	0.47±0.05b	0.62±0.05a	0.14±0.01b	0.17±0.03a
03-05 June	0.35±0.02b	0.61±0.05a		0.18±0.08a
09-10 June	0.35±0.02b	0.55±0.02a	0.11±0.02bc	
17-19 June			0.03±0.02c	0.04±0.02a
$F_{3,9}$	30.52	1.50	26.18	2.66
P>F	<0.0001	0.28	<0.0001	0.11

*Means in each column followed by the same letter are not significantly different according to Tukey's Multiple Range test (P>0.05).

Table 3. The proportion of spring wheat plants infested by second generation *Mayetiola destructor* when sown on four seeding dates per year in southern Manitoba, 2003-2005 and 2007.

	Proportion of infested plants			
Seeding date	2003	2004	2005	2007
16-22 May	0.23±0.06c*	0.45±0.03b	0.04±0.01b	0.17±0.03a
28-31 May	0.68±0.06b	0.64±0.08a	0.03±0.01b	0.16±0.06a
3-5 June	0.87±0.03a	0.80±0.04a		0.25±0.03a
9-10 June	0.96±0.02a	0.79±0.02a	0.09±0.01b	
17-19 June			0.27±0.05a	0.13±0.01a
$F_{3,9}$	121.1	17.4	32.4	3.31
P>F	<0.0001	0.0004	<0.0001	0.071

*Means in each row followed by the same letter are not significantly different according to Tukey's Multiple Range test (P>0.05).

Table 4. Stem breakage (%) by *Mayetiola destuctor* to spring wheat sown on four seeding dates per year in southern Manitoba, 2003-2005 and 2007.

Seeding date	2003	2004	2005	2007
16-22 May	11.1±2.7c	4.1±0.8b	0b	1.9±0.3ab
28-31 May	18.3±2.9c	16.2±4.6ab	0.6±0.6b	3.5±0.7ab
3-5 June	38.7±5.7b	14.0±4.6ab		4.7±1.3a
9-10 June	86.5±3.2a	25.8±5.2a	0.6±0.6b	
17-19 June			3.7±1.5a	0.7±0.4b
$F_{3,9}$	177.6	4.85	6.13	5.41
P>F	<0.0001	0.028	0.015	0.021

Fig. 1. The timing of egg deposition and larval development of *Mayetiola destructor* on spring wheat at Gleanlea, Manitoba, 2003-2005.

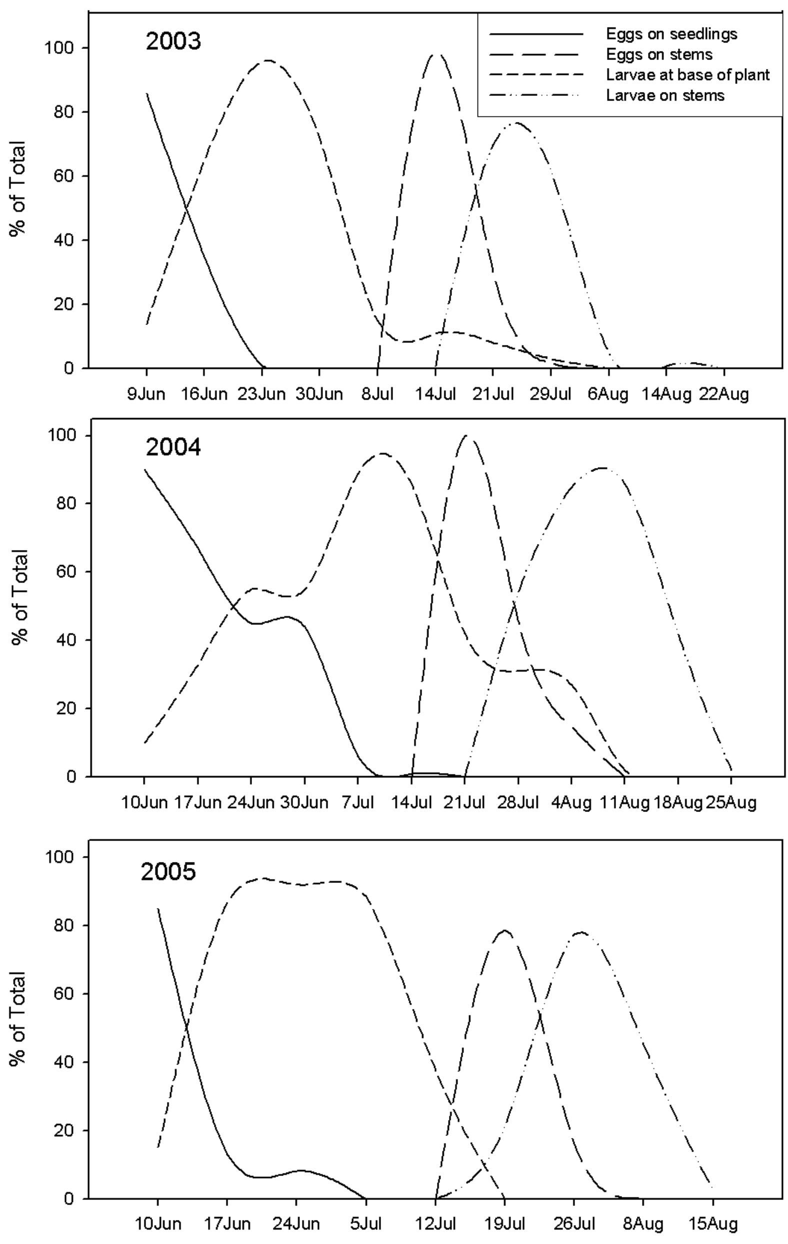
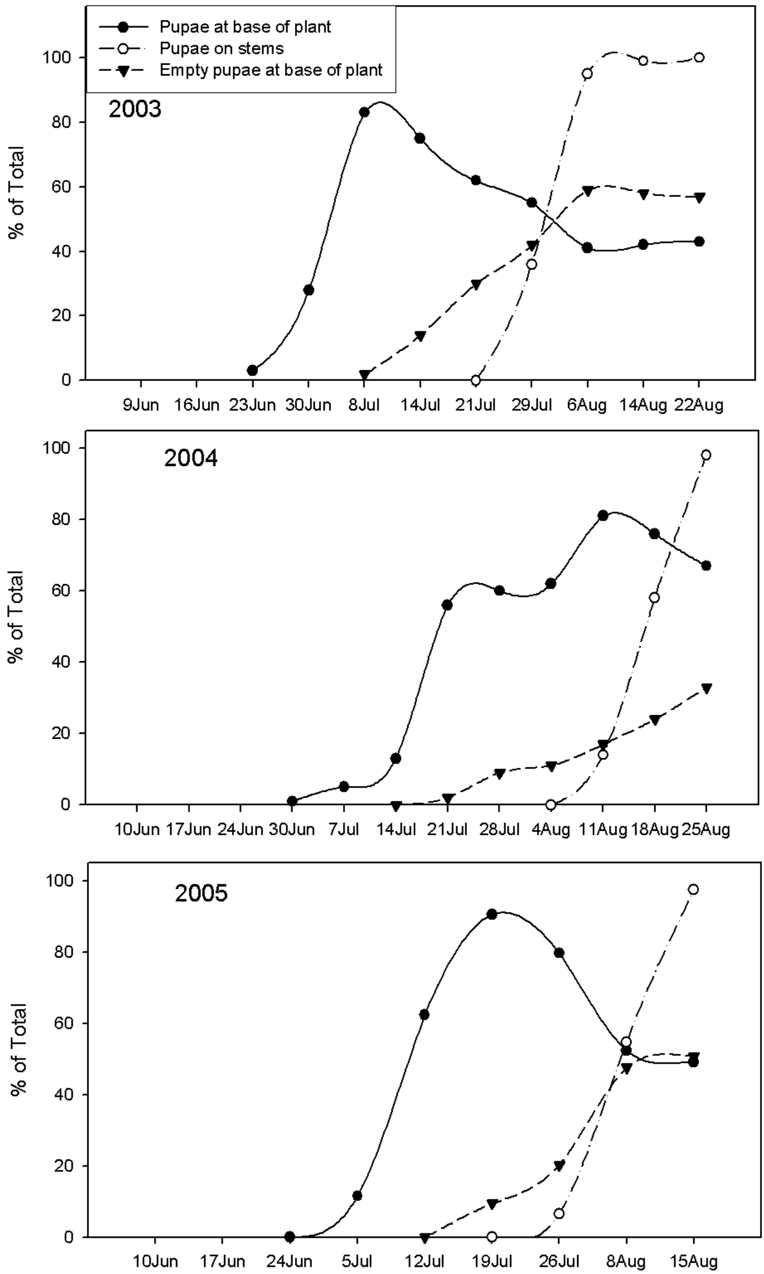


Fig. 2. The timing of puparial development and emergence of first generation adults of *Mayetiola destructor* on spring wheat at Glenlea, Manitoba, 2003-2005.



Parasitism of the Hessian fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae), on Spring Wheat (Poaceae) in Southern Manitoba

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ABSTRACT

Six species of Hymenoptera were found as parasitoids of the Hessian fly, *Mayetiola destructor* (Say), in the Red River Valley of Manitoba in 2003-2005. These parasitoids were the main cause of pupal mortality. *Platygaster hiemalis* Forbes and a *Homoporus* spp. mostly parasitized only first generation Hessian flies. *Pediobius eubius* (Walker), *Aprostocetus zosimus* (Walker), *Trichomalopsis americana* (Gahan), and *Panstenon poaphilum* Heydon mostly attacked second generation flies. All parasitoid species appeared to be univoltine on the Hessian fly. In 2003-2005, 18-28% of first generation flies and 73-79% of the second generation were parasitized in experimental plots. Parasitism of second generation flies in commercial fields in 2005 was 68-85%. *Platygaster hiemalis* was the most abundant parasitoid of the first generation and *P. eubius* of second generation flies. The prevalence of *P. eubius* was greater than the total of all other parasitoid species at all sites in all years. About 25% of adult parasitoids emerged in August after completing one generation in Hessian flies. This late season emergence occurred for all six species, but was least likely for *P. hiemalis*. A further 15-35% of all parasitoids died as larvae or pupae. This study is the first documented record of *P. eubius* attacking the Hessian fly in Canada, of *A. zosimus* in Manitoba, and of *P. poaphilum* parasitizing the Hessian fly. Ten species of Hymenoptera are now known to parasitize the Hessian fly in Manitoba.

INTRODUCTION

The Hessian fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae), is a pest mainly of spring wheat *Triticum aestivum* L. (Poaceae) in western Canada (Criddle 1915; Mitchener 1923). In southern Manitoba, the Hessian fly completes one or two generations per year (Criddle 1915; Wise 2007) and its feeding either causes stems to break or reduces seed production on infested unbroken stems (Wise *et al*. 2006).

Many hymenopterous parasitoids attack the Hessian fly in North America (Hill *et al*. 1939; Hill 1953). Gahan (1933) documented 31 species of chalcidoid and 4 species of proctotrupoid parasitoids of Hessian fly from North America. More recent world-wide records identify the Hessian fly as a host for at least 51 species of Chalcidoidea (Natural History Museum 2004). Many of these chalcidoids are solitary parasitoids of widely disparate host species. The few species attacking Hessian fly in the superfamily Proctotrupoidea include solitary and gregarious parasitoids in the genus *Platygaster*. These species are only known from *Mayetiola* spp.

Parasitism is a frequent cause of Hessian fly mortality in North America (Pike *et al*. 1983; Schuster and Lidell 1990). In the United States, prior to the introduction of winter wheat cultivars with resistant genes to the Hessian fly (Ratcliffe *et al*. 2000), 62% of puparia in eastern states (Hill and Smith 1928) and 74% in north-central states (Hill 1953) were killed by parasitoids. In western Canada, wheat is sown mostly in the spring and no cultivars have known genes for resistance (Patterson *et al*. 1992). The extent to which the Hessian fly populations in western Canada are reduced by parasitoids is not known.

Six chalcidoids and one proctotrupoid parasitoid of the Hessian fly have been found in Manitoba (Gahan 1933; Peck 1963; Heydon and Boucek 1992; Gibson and Floate 2001). Since many of these species are polyphagous, the primary objectives of this study were to determine which species are important parasitoids of Hessian fly in Manitoba, if parasitism is an important cause of Hessian fly mortality in southern Manitoba, what is the relative abundance of parasitoid species in first and second generation Hessian flies, and if any parasitoid of Hessian fly has more than one generation per year.

MATERIALS AND METHODS

Parasitoid identification. The spring wheat cultivar 'AC Barrie' was seeded at 80 kg/ha with a double disc press drill on 4 June, 2002 at the Cereal Research Centre's Experimental Farm, Glenlea, Manitoba (49°38'N, 97°09'W). Spring wheat stems broken by the Hessian fly were collected by cutting the stems at their base in September 2002. The stems were placed in sealed plastic tubs and immediately stored at 2.5°C for four months. Samples were then moved to 20°C, lightly moistened, and placed in four-litre containers that were covered with clear plastic tops. Adult parasitoids were captured, preserved in 95% alcohol as they emerged, and sent to the Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, Ottawa, Ontario for their identification to species.

Research plots. Spring wheat cv. 'AC Barrie' was seeded every one to two weeks from the third week of May on four dates at Glenlea in 2003 to 2005 and 2007 to provide suitable plants for oviposition by first and second generation Hessian flies. The wheat was sown in 10-16 m2 randomized strips in four separate blocks on each seeding date.

Adult parasitoids in 2004 and 2005 were monitored with galvanized metal cone traps and yellow sticky cards (7.5 cm x 12.5 cm). Six cards were placed in wheat stubble next to the plots in late May to early June when the earliest seeded plants were in the one to two-leaf crop stage. The cards were stapled to wooden stakes, placed at a height of 15-20 cm, and replaced weekly until mid-August. Six cone traps were pushed about three cm into the soil on 4 June over wheat stubble near the sticky cards. The traps had a base diameter of 36 cm, two circular screened holes in the side for ventilation, and covered an area of 0.10 m^2. A plastic vial was fitted over an opening at the top to collect parasitoids.

Parasitism of first generation Hessian fly. Puparia of first generation Hessian fly were collected from the plots in late July or August, and in September or October at plant maturity. Samples of whole plants (20-25 per plot) were unearthed by a hand trowel, excess soil on the roots was removed, and stems were cut just above the first node that had no adventitious roots. The lower part of the plants, including the crown where first generation larvae mostly feed (Wise 2007), was placed into a separate plastic bag for each plot. All collections were stored at 2.5°C within a few hrs of sampling, in sealed plastic containers for at least 13 weeks.

Immediately after being moved to room temperature (20-25°C), puparia were extracted from plant material and examined for adult emergence. Empty puparia were examined for parasite remains (Hill and Pinckney 1940). Five puparia with larvae were placed on a five to eight mm layer of moistened fine quartz sand in a ten-ml glass vial and kept at room temperature.

Adults of Hessian flies and parasitoids in the vials were counted and removed as they emerged, exuviae was removed, and the parasitoids were identified to species. Three weeks after emergence had ceased the remaining puparia were examined for parasites or other mortality factors. Parasitoids still inside the puparia were identified to species, where possible.

Parasitism of second generation Hessian fly. Puparia of second generation Hessian flies were collected in September or October from mature plants in the last two seeded plots (2003 and 2004), when densities of puparia were high, or from all plots (2005) when densities were low. Plants were sampled as for previous collections, except the stems, where second generation larvae mostly feed, were retained and stored within 24 hrs in sealed containers at 2.5°C as for first generation collections.

Immediately after cold storage, puparia were extracted from the stems, examined for emergence of adults, and, if empty, for parasitoid remains (Hill and Pinckney 1940). Larvae within puparia were added to glass vials, and results were recorded as for those of the first generation flies.

Emergence of second generation parasitoids. To determine if any parasitoid species produced more than one generation per year, first generation puparia were collected early in their development in 2004. Puparia were extracted from plants within 48 hrs, examined for adult emergence, and added to vials, as for previous assays. The vials were examined for adult parasitoids for up to three weeks after emergence of the last adult.

For a second collection, spring wheat cv. 'AC Barrie' was seeded on 28 May and 4 June, 2007 in single blocks of 30 m^2 at the Cereal Research Station in Winnipeg (49°49'N, 97°08'W) and on 6 June at Glenlea in multiple blocks of 50 m^2. Broken wheat stems were collected on 13 and 14 August, and puparia were examined for parasitoid emergence. Infested stems were cut 1-2 cm above and below the infested node, and were moistened and kept at room temperature in sealed containers for five weeks. Adult parasitoids were collected and identified to species as they emerged. Another collection on 2 October was made at Glenlea from blocks not sampled earlier, and puparia were examined for the emergence of parasitoids.

Field site collections. Broken stems of spring wheat were collected 9 September, 2005 from late maturing commercial fields at LaSalle (49°38'N, 97°12'W), Rosenhoff (49°25'N, 97°25'W), and Otterburne (49°30'N, 97°03'W) in the Red River Valley of Manitoba. Stems were cut just below the node of the break and were overwintered as for those from field plots. Puparia were extracted from the stems and analyzed for parasitism. Those with larvae were placed onto moist sand in separate glass vials, as for earlier assays, and parasitoid species and Hessian flies were identified and counted as they emerged in the vials. When adults did not emerge, puparia were examined for the cause of their mortality.

RESULTS

Six species of hymenopterous parasitoids emerged from Hessian fly collected at Glenlea, Manitoba in 2002 from spring wheat: *Platygaster hiemalis* Forbes (Platygasteridae), *Pediobius eubius* (Walker) (Eulophidae), *Aprostocetus zosimus* (Walker) (Eulophidae), *Trichomalopsis americana* (Gahan) (Pteromalidae), *Homoporus* spp. (Pteromalidae), and *Panstenon poaphilum* Heydon (Pteromalidae). Voucher specimens of all species were deposited in the J. B. Wallis Museum, University of Manitoba, Winnipeg, Manitoba.

Parasitoid species of first generation. Only *Homoporus* spp. and *P. hiemalis* emerged from overwintered first generation Hessian flies in 2003, 2005 and 2007 (Table 1). These species comprised 98% of all parasitoids that emerged from this generation in 2004. Two *P*. *eubius* and one *P*. *poaphilum* also emerged from first generation puparia in 2004 (n = 138). *Homoporus* spp. were more abundant than *P*. *hiemalis* in 2003 and 2007 but less abundant than *P*. *hiemalis* in 2004 and 2005 (Table 1). In all years an average of six *P. hiemalis* adults emerged from each parasitized puparia.

Parasitoid species of second generation. *Pediobius eubius* was the dominant parasitoid species each year at all sites, greatly exceeding the combined abundance of all other species. The chalcidoid, *A*. *zosimus*, was the second most abundant species at all sites and years. Two other species, *T. americana* and *P. poaphilum*, were of lesser abundance (Table 2), and were found in all years at Glenlea but in only one commercial field. The two first generation brood parasitoids, *Homoporus* spp. and *P. hiemalis*, also were found on second generation flies. *Homoporus* spp. were collected every year in low numbers at all sites, while *P. hiemalis* was found at very low levels every year at Glenlea but at only one commercial site (Table 2).

Prevelence of Parasitoids. Parasitoids were found in18% to 28% of first generation puparia collected in 2003 to 2005 at Glenlea (Table 1). Parasitoids reduced survival of second generation puparia by 73% to 79% at Glenlea in 2003 to 2005 (Table 2) and by 68% to 86% in three commercial fields in the Red River Valley in 2005 (Table 2).

Emergence of first generation adult parasitoids. No adult remains of a parasitoid, to indicate a parasitoid species produced a second generation, were found in exuviae of first generation flies in 2003 to 2005. Many first generation adults of *Homoporus* spp. and *P*. *hiemalis* did emerge in the same year from first generation puparia in 2004 when placed in moistened vials at room temperature (Table 1).

Adult parasitoids from second generation puparia emerged in August each year. Emergence ranged from 2% in 2004 to 20% to 28% at all sites in 2003 and 2005 (Table 2). In 2007, 96 adult parasitoids were collected at Glenlea and Winnipeg from first and second generation puparia in the same year of development. *Homoporus* spp. at 47% was the most abundant, followed by *P. eubius* (16%), *A. zosimus* (15%), *T. americana* (13%), *P. hiemalis* (6%) and *P. poaphilum* (4%).

Parasitoid mortality. Larval or pupal mortality of parasitoids in second generation Hessian fly puparia at all sites ranged from 15% in 2004 to 35% at LaSalle in 2005 (Table 2). In all years, severe decomposition of immature parasitoids at plant maturity prevented species identification.

Adult parasitoids captured on the sticky traps were too damaged by blown soil or plant debris to be identified to species. Maintaining the integrity of the parasitoids was necessary in order to differentiate these species from many others captured on the traps. Cone traps in 2004 were more selective, capturing one adult of *Homoporus* spp. on 17 June and 7 July, one *P. eubius* on 17 June and 21 July, and one *T. americana* on 21 July.

DISCUSSION

Hymenopterous parasitoids are the main cause of puparial mortality of first and second generation Hessian flies in southern Manitoba. Parasitism was highest in second generation puparia. Its prevalence of about 75% in this study was similar to levels at many sites from the spring generation in the Atlantic states (Hill *et al*. 1939), the north-central states of Illinois, Indiana, Michigan, and Ohio (Hill 1953), and in the eastern states of Pennsylvania, Maryland, and Virginia (Hill and Smith 1928) before resistant cultivars were introduced. Combined with other mortality factors, fewer than 13% of second generation puparia in Manitoba emerge as adult Hessian flies the following spring. At sites of exceptionally high parasitism, mortality of second generation puparia can exceed 99%.

By comparison, parasitism had less impact on the survival of first generation Hessian flies. Puparial mortality by parasitism reduced first generation populations during the three years by about 22%. First generation flies include univoltine and bivoltine populations (Wise 2007), and since the first generation phenology of these two populations do not differ, it is likely the early season parasitoids do not discriminate between univoltine and bivoltine flies. Thus, the impact of parasitism on reducing Hessian fly populations in Manitoba is mainly against bivoltine populations.

Parasitoid emergence and mortality. There was no evidence from the exuviae that adult parasitoids emerged in the field from first generation Hessian fly puparia in the same year of larval development. Adult emergence in the same year, though, from second generation puparia was consistently between 20% and 28% at all sites and years, except in 2004. Weather conditions that year were much colder throughout the growing season than during the two other years of the study (Wise 2007).

All four parasitoid species common to second generation populations emerged in the same year of their development (Table 3). The number of adult parasitoids collected was insufficient to provide an accurate assessment on whether this emergence impacts the relative abundance of these parasitoid species in second generation Hessian fly, but *A. zosimus* and *T. americana* may have a higher tendency than *P. eubius* or *P. poaphilum* to emerge in the same year. All Hessian flies at this time would be too far developed to be a suitable host for all these parasitoids, and, thus, adults would need to find an alternate host species to complete a second generation.

The combination of late season adult emergence and mortality can reduce parasitoid emergence from Hessian flies in the spring by over 60%. Most dead parasitoids found in host larvae were larvae, as opposed to pupae, and had been attacked by either fungi or bacteria. In all cases, the host larvae had also died and showed similar symptoms.

Parasitism by species. The highest cause of puparial mortality of the Hessian fly in Manitoba and by far the most dominant parasitoid species of Hessian fly in southern Manitoba was *P. eubius*. Its discovery on Hessian fly is a first for Canada. Previous reports of *P. eubius* in Canada and the United States from cereal pests were from the wheat stem sawfly, *Cephus cinctus* (Thompson 1955; Peck 1963; Peterson *et al*. 1968; Herting 1977; Burks 1979). Boucek and Askew (1968) reported *P. eubius* from the Hessian fly in Europe and Asia. *Pediobius eubius* is the fourth species of this genus to be identified as a parasitoid of the Hessian fly in Canada. The Hessian fly is known to be attacked by *P. nigritarsis* (Thomson) in Saskatchewan and Alberta (Peck 1963) and by two closely related species, *P. metallicus* (Nees) and *P. epigonus* (Walker), in Ontario and further east (Thompson 1955; Peck 1963). In the United States, *P. epigonus* is the dominant Hessian fly parasitoid species of this genus. It is one of three important parasitoid species of Hessian fly in Idaho (Bullock *et al*. 2004) and is found in Washington (Pike *et al*. 1983; Clement *et al*. 2003) and throughout the north-central and Atlantic states (Hill *et al*. 1939; Hill 1953). The prevalence of *P. epigonus* on the Hessian fly in all areas of the United States is below one-tenth that for *P. eubius* on second generation Hessian flies in Manitoba.

The presence of small numbers of *P. eubius* from first generation puparia in 2004 came during a year of unseasonably cool temperatures that delayed first generation Hessian fly development (Wise 2007). This delay could have allowed an opportunity for early emerging *P. eubius* to attack immature first generation flies. The capture in June of an adult of *P. eubius* in 2004, and the absence of this parasitoid in first generation flies in other years indicates *P. eubius* can emerge early enough to attack this generation of Hessian flies but its frequency is rare.

Platygaster hiemalis was the most common parasitoid of first generation puparia and the second most important parasitoid of Hessian fly in southern Manitoba. This species occurs throughout the wheat growing areas of Canada and the United States (Muesebeck 1979). It is considered the most important parasitoid of Hessian fly in North America (Gahan 1933) and is the only parasitoid to attack the fall generation on winter wheat. Its prevalence of 10% to 24% in Manitoba is lower than in Atlantic states (Hill 1926), about equal to that in Idaho (Bullock *et al*. 2004), and mostly higher than in north central states (Hill 1953).

This parasitoid does attack the second generation in Manitoba but at far lower frequencies than in the spring. In the early season collection of 2004, adult *P. hiemalis* emerged without overwintering, indicating this species in Manitoba does not have an obligatory diapause. Thus *P. hiemalis* in southern Manitoba may have a partial second generation. In Oregon, *P. hiemalis* is reported to have two generations per year (Gahan 1933). However, none of nearly 1150 first generation exuviae in 2003 and 2004 showed signs of parasitism by *P. hiemalis*. Parasitism of second generation flies by this species was likely from late emerging overwintered adults attacking the eggs of early ovipositing second generation female Hessian flies. Hill (1926) found *P. hiemalis* throughout the eastern states to have only one generation per year.

The second most common parasitoid of second generation flies was the eulophid, *A. zosimus*. This is the first documented evidence of its presence in Manitoba. It previously had been reported in Canada on Hessian fly from Ontario (Peck 1963). Burks (1979) reported it as being generally distributed in wheat growing areas of Canada and the United States. In most of its range in the United States, parasitism by *A. zosimus* is <1% (Hill *et al*. 1939; Hill 1953). The only reports of *A. zosimus* parasitism comparable to or higher than our 2003 or commercial field results were from unpublished notes by P. M. Myers (Gahan 1933) in Indiana (12%) and from a collection of 100 puparia in 1932 (34%) at Mannsville, New York (Hill *et al*. 1939). Adults of *A. zosimus* may emerge from Hessian fly in late summer but it is unknown if this species produces a second generation on a different host.

The pteromalid, *Homoporus* sp., collected in our studies is likely *H. destructor*, which is already known from Manitoba. A second species in this genus, *H. febriculosus*, has not been recorded from Manitoba but is found in Saskatchewan (Peck 1963). *Homoporus destructor* is found throughout the United States in many areas at a higher prevalence than in our studies (Hill *et al*. 1939; Hill 1953; Bullock *et al*. 2004). It is the most abundant parasitoid of late brood Hessian fly in Texas (Schuster and Lidell 1990), and a *Homoporus* sp. in Washington, likely *H. destructor* (Clement *et al*. 2003), was the dominant parasitoid of the Hessian fly (Pike *et al*. 1983).

The two *Homoporus* spp. known from western Canada oviposit directly into puparia (Gahan 1933). The presence of *Homoporus* sp. in first and second generation flies in all years and at all sites is consistent with the capture of an adult in cone traps in 2004 in mid-June and early July. The latter time coincides with the usual onset of second generation puparial development of the Hessian fly (Wise 2007). *Homoporus* sp. does not require an overwintering period to complete its development in Manitoba, but there is no evidence from examinations of exuviae of first generation Hessian flies that *Homoporus* sp., as for *P. hiemalis*, have more than one generation in Manitoba.

The two parasitoid species of the Hessian fly of least abundance in our studies, *T. americana* and *P. poaphilum*, greatly differ in their presence in North America. *Trichomalopsis americana* is a common Palaearctic pteromalid parasitoid of Diptera in Canada and the United States (Gibson and Floate 2001). When found on Hessian fly, it is always at very low populations (Hill 1953; Bullock *et al*. 2004). The Nearctic pteromalid, *Panstenon poaphilum,* has been found in Alberta and Manitoba in Canada and in six American states (Heydon and Boucek 1992), but this is the first record of this species parasitizing the Hessian fly. The only *Panstenon* sp. previously known to parasitize the Hessian fly is the Eurasian species, *P. oxylus* (Walker) (Herting 1978, Xiao and Huang 2000). This species is not known to occur in North America.

The addition of *P. eubius*, *A. zosimus*, and *P. poaphilum* increases the number of documented chalcidoid parasitoids of the Hessian fly in Manitoba to nine species. Three other species, *Chrysocharis pentheus* Walker (Hansson 1987), *Eupelmus allynii* French (Peck 1963; Burks 1979), and *Trichomalopsis viridescens* (Walsh) (Gibson and Floate 2001) are known from Manitoba but were not found in this study. At least four other species, including *Eupelmus vesicularis* (Retzius) and *Eurytoma atripes* Gahan, because of their presence to the west in Saskatchewan and to the south in North Dakota (Peck 1963), which have similar Hessian fly habitats, may also be present in Manitoba.

ACKNOWLEDGEMENTS

I thank Drs. G.A.P. Gibson, J.T. Huber, and L. Masner of the Agriculture and Agri-Food Canada, Ottawa, Ontario for the identification of the parasite species, and S. Wolfe, T. Araia, and T. Czarnecki for technical assistance.

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Table 1. Parasitism by species of first generation *Mayetiola destructor* (Say) on spring wheat at Glenlea, Manitoba in 2003-2005 and 2007.

Year	Sampling Date	Puparia (n)	Parasitism (%) Total	*Platygaster hiemalis*	*Homoporus* sp.	*Pediobius eubius*	*Panstenon poaphilum*
2003	Late*	900	19.9	9.4	10.5	0	0
2004	Early†	703	23.0	21.0	2.0	0	0
	Late	497	27.7	24.2	2.9	0.4	0.2
2005	Late	344	18.3	12.2	6.1	0	0
2007	Late	80	26.3	12.5	13.8	0	0

*Puparia collected at plant maturity in September or October.
†Puparia collected in July and/or August and not overwintered.

Table 2. Parasitism of second generation *Mayetiola destructor* (Say) by species, and parasitoid losses by autumn emergence of adults and mortality of larvae and in southern Manitoba, 2003-2005.

	Glenlea			LaSalle	Otterburne	Rosenhoff
Year	2003	2004	2005	2005	2005	2005
Puparia (n)	800	433	48	200	62	365
Parasitism (%)	73.9	78.8	72.9	68.0	85.5	73.4
Platygaster hiemalis	0.9	3.5	6.3	0	0	3.0
Homoporus sp.	3.5	0.7	8.3	1.4	3.2	2.5
Pediobius eubius	52.4	69.7	41.7	58.6	59.7	49.6
Panstenon poaphilum	2.6	1.4	4.2	0	0	1.9
Aprostocetus zosimus	8.8	3.0	8.3	8.0	22.6	14.8
Trichomalopsis americana	5.6	0.5	4.2	0	0	1.4
Parasitoid Losses (%)	50.7	17.0	48.6	62.5	54.7	38.4
Early emergence*	25.7	2.0	22.9	27.9	26.4	20.5
Mortality†	25.0	15.0	25.7	34.6	28.3	17.9

*Percentage of adults that emerged without completing an overwintering diapause.
†Percentage of parasites that died as larvae or pupae in Hessian fly puparia.

63rd Annual Meeting Entomological Society of Manitoba

Friday November 2, 2007
Freshwater Institute
501 University Crescent
and
Saturday November 3, 2007
Room 219 Animal Science/Entomology Building
University of Manitoba

ABSTRACTS

Symposium: *Arthropod vectors of plant & animal pathogens*

INSECT VECTORED TREE DISEASES IN MANITOBA. Michael Allen, Consulting Urban Forester and Certified I.S.A. Arborist Owner, Viburnum Tree Experts, Winnipeg, Manitoba.

Manitoba has had one of the most serious vectored tree diseases in North America – Dutch elm disease – for 32 years. To date there has not been any other tree species in Manitoba infected with a disease borne by an insect or any other organism. The presentation will first look at the complex relationship among the Dutch elm disease, its prime vector – the native elm bark beetle, and its tree host – the American elm. This relationship will focus on the life cycle of the native elm bark beetle as it affects the American elm and Dutch elm disease. A brief history of the control strategy for Dutch elm disease will be given. There is a potential for the spread into Manitoba of two other insect vectored tree diseases from adjacent border states. Ash Yellows disease affects mature native green ash, other green ash cultivated varieties, and other species of ash. The other disease is called Elm Phloem Necrosis which affects American elms. Both diseases are primarily vectored by leaf hoppers. Are Manitoba's ash and elm trees at risk? A discussion of these diseases will pursue the potential for serious infection on local tree species. Finally I want to explore a traditionally non-vectored disease, ash anthracnose and its relationship with *Lecanium* scales. This common ash leaf disease seems to be producing disease lesions on the twigs of ash species that have been fed upon by *Lecanium* scales. Is there a possibility that a vectored disease relationship is happening?

ECOLOGICAL FACTORS IN THE 2003 AND 2007 OUTBREAKS OF WEST NILE VIRUS IN THE PRAIRIE PROVINCES. Philip Curry, West Nile Virus Coordinator and Entomologist (Saskatchewan Health) & lead consulting entomologist (Manitoba Health), Saskatchewan Health, Population Health, 3475 Albert Street, Regina, SK S4S 6X6.

VECTOR-BORNE DISEASE AND CLIMATE CHANGE: THE EXAMPLE OF LYME DISEASE IN CANADA. Nick H. Ogden, Foodborne, Waterborne & Zoonotic Infections Division, Public Health Agency of Canada.

Climate change is anticipated to cause global changes in the risk from vector-borne diseases. Here we discuss the ways that climate change can impact on vector-borne disease occurrence and risk, and focus on Lyme disease as a pertinent example. The USA has suffered an epidemic of Lyme disease, which began in the late 1970s and peaked in 2002 when over 21000 cases were reported. In Canada, Lyme disease is an emerging infection due to recent expansion of the range of the tick vector, *Ixodes scapularis*, which may in part be due to a warming climate. A comprehensive understanding of the ecology of *I. scapularis*, its hosts and the pathogens it transmits, has allowed us to predict the scope and direction of potential range expansion of Lyme disease with projected climate change. This knowledge has also allowed us to raise model-based hypotheses for how climate change may affect evolutionary processes of *I. scapularis*-borne microparasites and drive pathogen emergence. Together, these studies will allow us to limit the public health impact of Lyme disease and other zoonoses by prediction and early warning of tick-borne pathogen risk. However, we pose the question as to what extent the ecological approach used here for *I. scapularis*-borne zoonoses can be applied as a general model for public health purposes.

APPLICATION OF VECTOR ECOLOGY IN MANAGEMENT OF PVY AND PLRV IN SEED POTATO. David W. Ragsdale, Professor of Entomology, 219 Hodson Hall, 1980 Folwell Ave., University of Minnesota, St. Paul, MN 55108.

To control the spread of aphid-transmitted viruses in seed potato takes a complex set of regulatory guidelines along with application vector ecology to reduce incidence of disease effectively. We typically think of a disease cycle as the classical triad of susceptible host, viable inoculum, and favourable environment. With an insect-vectored pathogen, the disease cycle is far more complex since the aphid must acquire and transmit the pathogen to enable progression of the disease. For most potato growers and their pest management advisors, the vector is the least understood component of this “disease tetrahedron.” Disease is observed in the field, tolerances for disease are set by state (provincial) or federal statute and little thought is given to how disease transmission can be interrupted by focusing on the behaviour of the vector. Indeed, we have much to learn about most pathosystems but it takes a multi-tactic approach to limit virus spread and to achieve seed potato quality necessary to meet phytosanitary standards. Here we will review the biology and ecology of aphid vectors of potato viruses and discuss application of this knowledge in management of potato viruses in the context of a seed potato production programme.

SUBMITTED PAPERS

VARIATION IN POST-DIAPAUSE DEVELOPMENT OF CABBAGE MAGGOTS. L.D. Andreassen[1,2], U. Kuhlmann[2], P.G. Mason[3], and N.J. Holliday[1], [1]University of Manitoba Department of Entomology, [2]CABI – Europe, Switzerland, [3]Agriculture and Agri-Food Canada, Eastern Cereal and Oilseed Research Centre.

The cabbage maggot, *Delia radicum* (L.) (Diptera: Anthomyiidae), is being evaluated as a target for classical biological control through the introduction of natural enemies from Europe. Larvae of *D. radicum* feed on roots of brassicaceous plants, including canola, and the aim of the biological control is to improve control in this crop. Post-diapause development of populations of *D. radicum* from canola (Shellbrook SK, Carman and Fort Whyte MB) was compared with that of a population from Brassica vegetables (London ON). Experiments were conducted over two years in the laboratory at a range of constant temperatures, and rate of development was related to temperature using a nonlinear regression model. Each population had both an early- and late-emerging phenotype. Prairie populations from canola crops had the same breakpoint to separate the two phenotypes (280 day degrees above 4°C), the same model parameters for both phenotypes, and high proportions of the late-developing phenotype. In contrast, the population from Ontario had a lower breakpoint (224 DDC4), different model parameters for both phenotypes than prairie phenotypes, and high proportions of the early-emerging phenotype. The differences in response of developmental rate to temperature may be due to selection pressure on the prairies to time emergence to coincide with the preferred growth stage of canola for *D. radicum* oviposition, whereas in Brassica vegetables selection pressure may act to encourage earlier emergence and therefore more generations completed each season. The implications of these results for classical biological control of *D. radicum* are discussed.

LARGE AND SMALL-SCALE OXALIC ACID FUMIGATION OF HONEY BEE PACKAGES FOR THE CONTROL OF *VARROA DESTRUCTOR*. Paul Kozak and Rob Currie, Department of Entomology, University of Manitoba, Winnipeg, MB Canada R3T 2N2.

Each spring, thousands of honey bee packages are shipped all over North America to replenish the supply of colonies that have perished over the winter. Often arriving with these packages are parasitic varroa mites. With widespread resistance to the standard chemical acaricides it is increasingly difficult to control this serious parasite, even at the stage of establishing colonies. This has renewed interest in examining different approaches to use organic acids, such as oxalic acid, for mite control because they provide effective treatments of varroa infestations in honey bee colonies.

The efficacy of oxalic acid fumigation for the control of *Varroa destructor* in individual honey bee packages was examined. Individual packages were fumigated with two different doses of oxalic acid or left untreated, mite infestation levels were sampled before fumigation, 6, 24 and 48 hours after. The three treatment groups of packages were hived and colonies sampled to assess worker population, brood level and queen

supersedure. Large-scale fumigations of honey bee packages with oxalic acid were also performed in outdoor fumigation chambers stocked with multiple packages and the efficacy of these treatments and bee mortality was assessed.

EFFECT OF TIME OF TREE REMOVAL ON POTENTIAL OF *HYLURGOPINUS RUFIPES* (EICHHOFF) TO TRANSMIT DUTCH ELM DISEASE PATHOGENS FROM NEWLY-DIAGNOSED AMERICAN ELM TREES IN MANITOBA. S. Oghiakhe and N.J. Holliday, Department of Entomology, University of Manitoba, Winnipeg, MB, Canada R3T 2N2.

In Manitoba, *Hylurgopinus rufipes* is the vector of Dutch elm disease, and trees showing symptoms in summer are removed either immediately or the following winter, to prevent disease transmission. Effect of removal time on potential for transmission was studied by removing trees at intervals after symptom appearance, enumerating beetles in brood galleries and estimating the proportion of beetles carrying spores. In 2006, adult spore-carrying beetles emerged from newly-symptomatic trees before winter.

THE EFFECTS OF BACTERIAL AND JASMONIC ACID TREATMENTS ON INSECTS OF CANOLA. Kate Bergen, W.G. Dilantha Fernando, and Neil J. Holliday, Department of Entomology, University of Manitoba, Winnipeg, MB, Canada R3T 2N2.

Strains of some plant growth promoting rhizobacteria (PGPR) can inhibit plant pathogens. Two PGPR strains, *Pseudomonas chlororaphis* (PA23) and *Bacillus amyloliquifaciens* (BS6) have been shown to control some fungal diseases of canola, including *Sclerotinia sclerotiorum*. One way that PGPR control pathogens is through induced systemic resistance (ISR), which is initiated by the signalling molecule jasmonic acid, and can protect plants against multiple pest threats by activating and enhancing naturally occurring defence mechanisms in the plant. Direct application of jasmonic acid has been shown to activate defensive compounds and influence insect herbivory in canola. We have conducted laboratory and field experiments to determine the effects of the two bacterial strains and jasmonic acid on insects of canola. Our laboratory experiments on canola have shown that jasmonic acid significantly affects oviposition and larval feeding in the diamondback moth (*Plutella xylostella*). Jasmonic acid also significantly affects development time of the turnip aphid (*Lipaphis erysimi*). Changes in plant chemistry associated with ISR that can control pests were also investigated. Analyses of several compounds including glucosinolate and peroxidase were performed, as changes in the levels of these compounds may affect insect herbivores. The result of the laboratory experiments and the potential role of chemical induction in insect control will be discussed.

THE EFFECT OF QUEEN STATUS AND BEE GENETICS ON GROOMING SUCCESS AGAINST THE VARROA MITE (*VARROA DESTRUCTOR* A. & T.) IN HONE YBEE COLONIES UNDER SIMULATED WINTER CONDITIONS.
R. Bahreini and R.W. Currie, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Honey bees (*Apis mellifera* L.) may perform grooming behaviour in order to remove parasitic varroa mites (*Varroa destructor* A. & T.) from their body. Grooming behaviour could reduce the susceptibility of honey bee colonies to varroa mite infestation. An experiment was carried out at the University of Manitoba in summer of 2007 under simulated winter conditions on two groups of colonies, selected (from Manitoba queen breeders) and unselected. Small colonies (n=25) containing 220 g worker bees and 75 varroa mites were kept at 5 °C and queen status was altered to create three treatment groups of broodless colonies with either caged mated queens, queen pheromone lures or queenless. Overall, selected colonies had higher average daily mite mortality (2.07 ± 0.48) than unselected ones (0.97± 0.16). Small colonies with queen lures had slightly higher average daily mite mortality (1.68 ± 0.32) than caged queens (1.55±0.60) or queenless (1.33±0.54) treatments, while average daily bee mortality was slightly lower in colonies treated with queen lures (31.13±7.82) than caged queens (33.50±10.48) or queenless (35.63±10.51) treatments.

THE POTENTIAL FOR THE PROPORTION OF A SUSCEPTIBLE REFUGE IN MIDGE-RESISTANT WHEAT TO DRIFT OVER TIME. M.A.H. Smith, S.L. Fox, and I.L. Wise, Cereal Research Centre, Agriculture & Agri-Food Canada, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9.

Spring wheat carrying a gene conferring antibiosis resistance against wheat midge will soon be available commercially. Plans are underway to include an interspersed refuge of 10% susceptible wheat in the resistant wheat, to delay the development of virulence by the wheat midge. At this percentage the refuge will reduce selection of virulence alleles in the wheat midge population, while maintaining grain grade and minimizing yield losses during years of high wheat midge populations. There is concern that the proportion of refuge could drift from the initial 10%, so field studies were initiated in 2005 at Glenlea, MB. There were four treatments, each a blend using different wheat lines. Drift due to wheat midge seed damage was not a factor in 2005 because there was no midge infestation, but drift due to other factors was observed. Seed harvested from the 2005 experiment was used to initiate the 2006 experiment which was seeded at Glenlea and Brandon, then seed from each respective location was used to seed the 2007 experiment again at the two locations. The overall proportion of susceptible refuge in the wheat at maturity in 2006 was 9.4% at Glenlea and 9.7% at Brandon, and in 2007 was 6.9% at Glenlea and 6.3% at Brandon.

METHYL BROMIDE ALTERNATIVES IN CANADIAN FLOUR MILLS. Paul Fields,Cereal Research Centre, AAFC, 195 Dafoe Road, Winnipeg, MB, Canada R3T 2M9.

There is a pressing need to find alternatives to methyl bromide fumigation in flour mills, due to the phase-out of methyl bromide in Canada and other countries. The Canadian National Millers Association collaborated with Agriculture and Agri-Food Canada to test alternatives to methyl bromide in 2005 and 2006, and to compare these alternative treatments to standard methyl bromide treatments. There were two trials with propane-fired heaters and one trial with portable steam heaters, four trials with sulfuryl fluoride (ProFume®), two trials with phosphine (ECO2FUME®), heat and carbon dioxide combination treatment and six trials with methyl bromide.

The efficacy of treatments was estimated in three ways: 1. Just before the treatments, bioassays, adults and eggs of the red flour beetle (*Tribolium castaneum* (Herbst)) were placed throughout the mill to determine efficacy. Almost all treatments were effective in killing 100% of adult red flour beetles put out as bioassays. There was more survival of the eggs. In the sulfuryl fluoride treatments, egg mortality ranged from 35 to 99.6%. The other treatments had egg mortalities over 98%, 2. Insect populations in the mill were estimated using pheromone for 6 weeks pre-treatment and at least 16 weeks post-treatment. In methyl bromide treatments, the rebound of insect populations to pre-treatment levels occurred in as little as 3 weeks to never within the 30 week sampling period. For sulfuryl fluoride the rebound took from as little as 1 week to never rebounding within the 18 week study. Phosphine combination treatment saw populations rebound within 7 to 29 weeks. In all three heat treatments, none of the populations returned to the original levels by 19 weeks post-treatment, 3. Adult and larva flour beetles were monitoring in the tailings from rebolt sifters. The data for the rebolt sifter tailings is available for only about half the mills that we conducted trials. For the most of the mills, there is a good correlation between insects found in the pheromone traps and insects found in the rebolt sifter tailings. However, on several occasions pheromone traps were not a good predictor of insect numbers in the rebolt sifter tailings. In methyl bromide treatments, the rebound of insect populations to pre-treatment levels occurred in as little as 15 weeks to never within the 31 week sampling period. For sulfuryl fluoride the rebound took from as little as 9 weeks to never rebounding within the 18 week study. Phosphine combination treatment saw populations rebound within 1 to 33 weeks. In all three heat treatments, the mills either did not sample rebolt sifter tailings or there were never insects in the tailings. There are limitations to this study, limited replication with regard to the mills, treatments done at different times and at different locations. Despite these limitations, this project has provided Canadian flour millers and pest control operators with many opportunities to test alternatives to methyl bromide in their facilities. Sulfuryl fluoride, heat and phosphine combination treatment (phosphine, heat and carbon dioxide) can control insect populations in flour mills for over 18 weeks.

INSECTS ON FIELD CROPS IN MANITOBA IN 2007 – AN EXTENSION UPDATE. John Gavloski, Crops Branch, Manitoba Agriculture, Food and Rural Initiatives, Box 1149, Carman, Manitoba R0G 0J0.

In cereal crops, wheat midge populations were high in some areas in the western part of the province, resulting in some spraying of insecticides. Wireworms were at high levels in some fields near Teulon. White heads caused by wheat stem maggot were quite noticeable in many fields. In canola, bertha armyworm populations were high in some areas of the province, resulting in some insecticide applications, however levels were not as high as expected based on trapping of adults earlier in the year. Cutworm populations were high in some areas, resulting in spraying and reseeding of crops. Aster yellows was more noticeable in canola this year than is normal. Levels of lygus bug (*Lygus* spp.) were high in many sunflower fields during the flowering period, resulting in control in many fields of confection sunflowers. Green cloverworm was quite noticeable in many fields of dry beans and soybeans, resulting in some insecticides being applied. Pea aphid levels were high in many fields of field peas. Alfalfa weevil was a concern in many alfalfa hay and seed fields. A more detailed summary of Insects on field crops in Manitoba in 2007 will be presented at the Western Forum on Pest Management and posted on the Manitoba Agriculture, Food and Rural Initiatives website at: http://www.gov.mb.ca/agriculture/crops/insects/index.html.

THE OCCURRENCE AND HABITAT OF THE ENDANGERED WHITE FLOWER MOTH (*SCHINIA BIMATRIS*) IN MANITOBA. Richard Westwood and Chris Friesen, Department of Biology, University of Winnipeg, Winnipeg, Manitoba R3B 2E9.

The only known Canadian population of the endangered white flower moth (*Schinia bimatris*) occurs in the sand dune area of Spruce Woods Provincial Park, though little is known about its biology and ecology. This dune area was surveyed for the white flower moth during the summer of 2007 using light traps and visual searching techniques. Fourteen individuals were caught in light traps and several were observed during the day. This is the first record of diurnal activity of *S. bimatris* in Manitoba. The habitat used by the moth in Manitoba is also described.

IDENTIFICATION OF *CULEX* SPECIES USING SPECIES-SPECIFIC PCR PRIMERS AND ITS APPLICATION IN WNV SURVEILLANCE PROGRAM IN CANADA. M. Iranpour[1], R. Lindsay[2], and A. Dibernardo[2], [1]International Centre for Infectious Diseases (ICID), Winnipeg, Manitoba; [2]Zoonotic Disease and Special Pathogens, Public Health Agency of Canada, Winnipeg Manitoba R2E 3R2.

In 2002, more than 17,000 mosquito pools collected in Canada (Quebec, Ontario and Manitoba), were tested at the National Microbiology Laboratory in Winnipeg, Manitoba for infection with West Nile virus (WNV). Using real time RT-PCR, 558 mosquito pools (86% *Culex* species and 14% other species) had evidence of infection with WNV. However, only 30% of the *Culex* specimens were identified to the species level. In this study, *Culex* species-specific PCR primers were designed to identify individual mosquitoes and mixed pools of *Culex* mosquitoes to species. In addition, pools of non-*Culex* mosquitoes that tested positive for WNV were also screened for *Culex* DNA to determine the frequency of cross contamination among mosquitoes of different species. DNA extracts from 121 *Culex* and 51 non-*Culex* pools, previously positive for WNV, were screened and *Culex* DNA was detected in approximately 6% of non-*Culex* pools. This study demonstrates that contamination among mosquito species can occur and emphasizes that precautions should be taken to minimize this potentially confounding effect.

CHEWING LICE (PHTHIRAPTERA: MENOPONIDAE AND PHILOPTERIDAE) ON DOVES (COLUMBIFORMES) IN MANITOBA, WITH THE DISCOVERY OF *COLOCERAS TOVORNIKAE* (PHILOPTERIDAE), A SPECIES NEW TO NORTH AMERICA. Terry D. Galloway[1] and R. L. Palma[2], [1]Department of Entomology, University of Manitoba, Winnipeg, MB Canada R3T 2N2; [2]Museum of New Zealand Te Papa Tongarewa, P.O. Box 467, Wellington, New Zealand.

An extensive survey of chewing lice from two species of Columbiformes (rock pigeon, *Columba livia* Gmelin and mourning dove, *Zenaida macroura* (Linnaeus)) carried out from 1994 to 2000, and 2003 to 2006 in Manitoba, Canada, has produced the following new records: *Coloceras tovornikae* (Tendeiro) for North America; *Columbicola macrourae* (Wilson), *Hohorstiella lata* (Piaget), *H. paladinella* Hill and Tuff and *Physconelloides zenaidurae* (McGregor) for Canada; *Bonomiella columbae* Emerson, *Campanulotes compar* (Burmeister), *Columbicola baculoides* (Paine), and *C. columbae* (Linnaeus) for Manitoba. We collected 25,418 lice of four species (*Campanulotes compar*, *Columbicola columbae*, *H. lata* and *C. tovornikae*) on rock pigeons. Overall prevalence was 78.9%, 52.5% and 23.3% for *C. compar*, *C. columbae* and *H. lata*, respectively. *Coloceras tovornikae* was not discovered until 2003, after which its prevalence was 39.9% on 114 pigeons. We collected 1,116 lice of five species (*P. zenaidurae*, *C. baculoides*, *Columbicola macroura*, *H. paladinella*, and *B. columbae*) from 114 mourning doves. *Physconelloides zenaidurae* was encountered most often (prevalence = 36.7%), while the prevalence of infestation for the other four species was 26.3%, 18.4%, 3.5% and 2.6%, respectively.

POSTER PRESENTATIONS

A BIODIVERSITY STUDY OF ARCTIC DIPTERA: MUSCIDAE AND FANNIIDAE (DIPTERA: MUSCOIDEA) OF CHURCHILL (MB). Anaïs Renaud[1], Rob Roughley[1], and Jade Savage[2], [1] Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2; [2] Department of Biological Sciences, Bishop's University, Sherbrooke, Québec, Canada J1M OC8.

The Muscidae and Fanniidae of Churchill are inventoried to determine if the species composition has changed in this northern region since the publication of Huckett's memoir (1965). Material collected in 2006-2007 will be compared with published records and collection specimens going back to the beginning of the last century to detect recent modifications to the geographical range and changes in the relative abundance of species over the last decades.

Huckett, H.C. 1965. The Muscidae of Northern Canada, Alaska, and Greenland (Diptera). Memoirs of the Entomological Society of Canada 42.

The Entomological Society of Manitoba gratefully acknowledges the following organizations which provided financial support for the 63rd Annual Meeting

Canadian Centre for Mosquito Management

Canadian Grain Commission

Canola Council of Canada

City of Winnipeg Insect Control Branch

Louisiana-Pacific Canada Limited

Metro Pest Control

Monarch Pest Control

North South Consultants

Orkin PCO Services

Poulin's Pest Control

Province of Manitoba-Conservation

Viceroy Distributors

The Entomological Society of Manitoba 63rd Annual Business Meeting

3 November 2007

Department of Entomology, University of Manitoba

Attendance

President	Rhéal Lafrenière (for Blaine Timlick)
Secretary	David Ostermann
President-Elect	Désirée Vanderwel
Treasurer	Ian Wise
Regional Director to ESC	Pat MacKay

Brent Elliott	John Gavloski
Paul Fields	Kristin Hynes
Noel White	Kate Bergen
Bob Wrigley	Rob Roughley
Lars Andreassen	Marj Smith
Bob Lamb	Taz Stuart
Neil Holliday	Robbin Lindsay
Terry Galloway	Mahmood Iranpour
Richard Westwood	

1. **Acceptance of Agenda**.
   Motion: Galloway/MacKay – to accept the Agenda (**Appendix A**) Carried
2. **Acceptance of the Minutes**

   Motion: Holliday/Elliott – to accept previous Minutes of the 62nd Business Meeting (16 November 2006) .... Carried
3. **Business Arising from the Minutes** - None
4. **Reports - Executive**

   Motion: MacKay/Wise - to receive reports.. Carried

Appendix B - President

Appendix C – Treasurer

Fields noted that a letter should be sent to the ESA/NCB as thanks for the joint meeting.

Appendix D - Regional Director to the ESC
Lafrenière commended Pat for her commitment as Regional Director.

Appendix E – Editor of the Proceedings

Appendix F – Endowment Fund Board

5. **Reports** - Committees

Appendix G – Finance

Appendix H - Publicity / Newsletter

Appendix I - Social

Appendix J - Youth Encouragement

The Youth Encouragement committee was praised for their fund-raising, involvement and hard work with tours and presentations.

Holliday noted that the Department of Entomology was nominated for the Michael Smith Award ($10,000) which is looking at a number of aspects of the Department, including youth encouragement activities.

Appendix K - Archives

Appendix L - Scholarships and Awards

Appendix M – Fund-raising

Appendix N - Scientific Programme

Appendix O - Membership

Appendix P - Web Page

Motion: Gavloski/Galloway – to accept the reports as given................... Carried

6. **Election results**

President Elect ....Richard Westwood

Member-at-Large ....Taz Stuart

Motion: Holliday/Lamb - to destroy the ballots...................................... Carried

7. **New Business**

Elliott suggested having Wise do the financials for the meeting in 2009
Motion: Holliday/MacKay – to have Ian Wise to handle the financials when the ESC is hosted in 2009

Lafrenière noted the difficulty in finding people to fill the Society's Executive positions and suggested there may be a benefit of extending terms. Due to the sequence of positions related to President, and the limited period that graduate students are at the University, it was felt that terms could not be extended. Executive terms to remain unchanged at 1 year.

8. **Transfer of Presidential Office** - Blaine Timlick to Désirée Vanderwel

9. **Reappointment of Auditor**
Motion: Wise/Lamb – Nicholson Rawluk LLP as auditor to the ESM.... Carried

10. **Adjournment**. 3:15 p.m.
Motion: Holliday/MacKay – to adjourn the meeting............................... Carried

APPENDIX A

The Entomological Society of Manitoba, Inc.
Agenda of the Entomological Society of Manitoba
63rd Annual Business Meeting

3 November 2007

1. Acceptance of Agenda
2. Acceptance of the Minutes of the last Annual Meeting (16 November 2006)
3. Business arising from the Minutes
4. Reports – Executive
   President – Blain Timlick
   Treasurer – Ian Wise
   Regional Director to the ESC – Patricia MacKay
   Editor of the Proceedings – Terry Galloway
   Endowment Fund Board – Marjorie Smith
5. Reports – Committees
   Finance – Marjorie Smith
   Publicity/Newsletter – Mahmood Iranpour, Patricia MacKay
   Social – Brent Elliott, Sheila Wolfe
   Youth Encouragement/Public Education – Kristin Hynes
   Archives – Rob Roughley
   Scholarship and Awards – Richard Westwood
   Fund-raising – Joel Gosselin
   Scientific Programme – Robbin Lindsay
   Membership – Desiree Vanderwel
   Web Page – Rob Currie
6. Election results – Scrutineer, Colin Demianyk
7. New business
8. Transfer of Office
9. Reappointment of Auditor
10. Other business
11. Adjournment

APPENDIX B

Entomological Society of Manitoba

Report of the President – 2006 – 2007

The executive committee of the ESM met twice between November, 2006 and October, 2007. The first meeting took place March 9, 2007 and the focus of the meeting was many of the details associated with budgeting and general direction for the year. Most of the meeting was focused on the ESM – NCB/ESA meeting that was held in Winnipeg March 25-28, 2007.

The joint ESM – NCB/ESA meeting that occurred in March was very successful and the Society members who participated in the local arrangements, scientific program, fundraising and audio visual are to be congratulated. The president received a number of mailings congratulating our Society on a successful and enjoyable event.

The second executive meeting took place on June 27, 2007 and details regarding the upcoming 2007-2008 63rd Annual meeting of the Society were discussed. It was determined that the theme for the meeting was to be 'Arthropod vectors of plant and animal pathogens.' Other updates included using T-bill monies and maturing GIC's to top up the endowment fund and discussions on membership numbers.

As president, I express my sincere thanks to all those who have chaired committees and participated in the executive. It is all of this work that makes the society what it is today.

Blaine Timlick
President

Appendix C

Entomological Society of Manitoba, Inc.
Financial Statements
August 31, 2007

NICHOLSON RAWLUK LLP
Certified General Accountants

REVIEW ENGAGEMENT REPORT

To the Members of the
Entomological Society of Manitoba Inc.

We have reviewed the statement of financial position of **Entomological Society of Manitoba Inc.** as at **August 31, 2007** and the statement of revenues, expenditures, and surplus for the year then ended. Our review was made in accordance with Canadian generally accepted standards for review engagements and accordingly consisted primarily of enquiry, analytical procedures, and discussion related to information supplied to us by the company.

A review does not constitute an audit and consequently we do not express an audit opinion on these financial statements.

These financial statements have been prepared using the cash basis of accounting as further described in note 2. The effects of this departure from Canadian generally accepted accounting principles on the unaudited financial statements have not been determined.

Based on our review, except as noted in the preceding paragraph, nothing has come to our attention that causes us to believe that these financial statements are not, in all material respects, in accordance with Canadian generally accepted accounting principles.

Nicholson Rawluk LLP

Winnipeg, Canada
September 28th, 2007

Nicholson Rawluk LLP
Certified General Accountants

Entomological Society of Manitoba Inc.
Statement of Financial Position
(Unaudited - Se Review Engagement Report)
August 31, 2007

ASSETS

	2007	2006
CURRENT		
Cash in bank	$ 2,268	$ 1,413
Canadian T-Bill fund (note 3)	13,149	7,483
Investment certificates (note 2, 4)	33,135	35,935
	48,552	**44,831**

LIABILITIES

LIABILITIES	nil	nil

SURPLUS

SURPLUS	48,552	44,831
	$ 48,552	**$ 44,831**

APPROVED BY THE BOARD:

____________________ President ____________________Treasurer

The accompanying notes form an integral part of these financial statements

Entomological Society of Manitoba Inc.
Statement of Financial Position
(Unaudited - Se Review Engagement Report)
August 31, 2007

	2007	2006
REVENUE		
Annual meeting	$ 615	$ 1,632
Donations	1,650	1,715
Interest income	1,464	1,059
Members fees	1,549	1,715
Miscellaneous	2,670	133
Proceedings	277	49
Social committee	-	278
Youth encouragement & public education	766	76
	8,991	**6,657**
EXPENDITURES		
Awards and scholarships	1,500	1,500
Donations	-	50
General	725	1,507
Meetings	1,504	3,347
Newsletter	313	387
Proceedings	1,068	546
Social committee	-	236
Youth encouragement & public education	160	168
	5,270	**7,741**
EXCESS OF REVENUES OVER EXPENDITURES	**3,721**	**(1,084)**
Add: Surplus, beginning of the year	44,831	45,915
SURPLUS, END OF THE YEAR	**$ 48,552**	**$ 44,831**

The accompanying notes form an integral part of these financial statements

Entomological Society of Manitoba Inc.
Statement of Financial Position
(Unaudited - Se Review Engagement Report)
August 31, 2007

	2007
REVENUE	
Registration fees	$ 27,947
Sponsorships & funding	30,516
	58,463
GENERAL EXPENDITURES	
Administrative	4,603
Awards	749
Facility rental	26,982
Souvenir purchases	2,076
Speaker & special guests	6,600
Student assistance	315
Travel	8,394
	49,719
EXCESS OF REVENUES OVER EXPENDITURES	**8,744**
Payment to Entomological Society of America - North Central Branch	**$ 8,744**

The accompanying notes form an integral part of these financial statements

APPENDIX D

Entomological Society of Manitoba
Report of the ESC Regional Director

Over the past year, the second year of my second term as Regional Director for the Entomological Society of Manitoba on the Governing Board of the Entomological Society of Canada, and since the last ESM Annual Business Meeting on 16 November 2006, I have carried out several duties. As Regional Director I have served on the ESC Membership Committee and the ESC Science Policy and Education Committee. In addition I reported on ESM activities at the 2006 Joint Annual Meeting of the Entomological Societies of Canada and Quebec in Montreal from 18-22 November 2006, and the 2007 Joint Annual Meeting of the Entomological Society of Canada and the Entomological Society of Saskatchewan in Saskatoon, from 29 September to 03 October 2007. In both cases, I attended the two scheduled Board Meetings and the Annual Business Meeting of ESC. I also submitted a report on ESM activities to the Interim Meeting of the ESC Executive Council in Ottawa in April 2007. These reports are available as attachments to the minutes of the next ESM Executive Meeting following the report.

At the most recent ESC meeting in Saskatoon, Dan Quiring, a forest ecologist from UNB stepped down as Past President and left the ESC Board. Peggy Dixon, AAFC, Newfoundland became Past President, and Terry Shore, CFS, Victoria B.C. became President. ESM member Paul Fields became 1st Vice-President, and Maya Evenden from Biological Sciences at U of A became 2nd Vice-President. ESM member Rob Roughley finished his third and final year as Director-at-Large on the Board of ESC.

The next ESC Annual Meeting is a joint meeting with the Entomological Society of Ontario in Ottawa, 18-22 October 2008. According to the traditional pattern of annual meetings, ESM is scheduled to host the joint annual meeting again in 2009.

Recent noteworthy events in the ESC include changes to the editorships of both the Society's publications. Richard Ring stepped down as Editor of the Canadian Entomologist, and was replaced by Robb Bennett from the British Columbia Provincial Government. ESM member Paul Fields stepped down as Editor of the ESC Bulletin, to be replaced by Kevin Floate, AAFC Lethbridge. ESM member Marj Smith continued as Assistant Editor of the Bulletin, but will step down as of the end of 2007. The ESC continues to struggle with the issues around the trend towards electronic publication and how to increase accessibility of information.

Until recently, membership in the ESC had been in decline for some years, down to a low of 475 in 2004, However over the last two to three years, the number of members has increased and seems to have stabilized currently standing at 504. On behalf of ESC, I encourage all ESM members who are not already ESC members to seriously consider joining ESC. Without a strong national society, the ESM will become a much weaker organization. ESC plays a critical role in Entomology in Canada which benefits all entomologists in the country, whether they are members of the national society or not. The health and strength of ESC is critical to all of us.

Finally, my second three year term as Regional Director will end in the fall of 2008, and Regional Director should be on the ballot for the next ESM election, to be held in the summer of 2008. I thank the membership for giving me the opportunity to serve on the Executive of ESM and the Board of ESC.

Patricia A. MacKay
Regional Director for ESM on the ESC Board
November 2007

APPENDIX E

Entomological Society of Manitoba
Report of the *Proceedings* Editor

Volume 62 (2006) of the *Proceedings of the Entomological Society of Manitoba* went to press on 1 November, 2007, and unfortunately, is not available for the annual meeting this year. The *Proceedings* is once again being printed by Warren Schuetz in the University of Winnipeg printshop. Minutes from the *Proceedings* were copied and distributed to the members who attended the business meeting. Volume 62 contains 36 pages, the abstracts from the Annual Meeting held in the Animal Science/Entomology Building on 14 October, 2006 and the Minutes of the 62nd Annual Business Meeting of the Entomological Society of Manitoba held on 16 November at the Manitoba Agriculture and Animal Industry Complex. Cost of production will be presented to the ESM Executive at its next meeting.

I thank Noel White who provided electronic copies of the components of the *Proceedings*. This greatly facilitates the process.

I specifically want to draw attention of the members to the absence of scientific papers in Volume 62. I did not receive one submission last year. I encourage those of you out there who have manuscripts that are specifically of relevance to entomology in Manitoba to consider submitting your manuscript to the *Proceedings*. If you know of amateur entomologists that have important information on distribution, occurrence or taxonomy of insects in Manitoba, please ask them to consider publishing their results in the *Proceedings*. All manuscripts are peer-reviewed; all published papers are available as PDF's on the web and are fully accessible using on-line search engines.

Proceedings Editor, T.D. Galloway
3 November, 2007

APPENDIX F

Entomological Society of Manitoba
Report of the Endowment Fund Board for 2006-2007

The Endowment Fund provides a basis for funding the publication of the Proceedings and other Society activities. In the past the Fund provided full support for these commitments, but income generated declined each year as maturing GIC's were reinvested at lower interest rates. The Endowment Fund cap is $40,000, approved at the Annual Business Meeting in 1998, and in 2005 a plan to increase the Endowment Fund to this cap was approved. This past February, GIC no. 960006276-0010 matured, and the principal amount of $3,800 was held in the Treasury Bill account until 31 October 2007, when it was combined with GIC no. 960006276-0005 (principal amount of $3,135). Prior to reinvestment of the total principal of $6,935, the Endowment Fund Board received approval from the ESM Executive to increase the principal to $8000, bringing the Endowment Fund to a current total of $38,000.

Summaries of investments and projected interest income for the current fiscal year and the 2008-2009 fiscal year are attached (Tables 1 and 2). Next September, GIC no. 960006276-0008 will mature, and the principal amount of $4,000 will be held in the Treasury Bill account until 11 December 2008, when it will be combined with GIC no. 960006276-0004, and the total principal of $7,000 reinvested. Prior to this reinvestment, the Endowment Fund Board will seek approval from the ESM Executive to increase the principal to $8,000, bringing the Endowment Fund up to $39,000.

Marjorie Smith, Chair
Ian Wise
Pat MacKay
Endowment Fund Guaranteed Investment Certificates

Table 1: Account information as of August 31, 2007. Interest generated during the 2007-2008 fiscal year.

Certificate No.	Principle	Interest Rate (%)	Maturity Date	Annual Interest
900055611-0009	$8,000.00	4.00	Nov 16, 2011	$320.00
900055611-0010	$8,000.00	3.20	Nov.16, 2010	$256.00
960006276-0004	$3,000.00	3.00	Dec 11, 2008	$90.00
960006276-0005	$3,135.00	4.55	Oct 31, 2007	$142.64
960006276-0008	$4,000.00	3.30	Sept 16, 2008	$132.00
960006276-0009	$7,000.00	2.75	Feb 10, 2009	$192.50
960006276-0010	$3,800.00	Held in Treasury Bill account until 31 October 2007		
Total	**$36,935.00**			**$1,133.14**

Table 2: Projected account information as of August 31, 2008. Interest generated during the 2008-2009 fiscal year.

Certificate No.	Principle	Interest Rate (%)	Maturity Date	Annual Interest
900055611-0009	$8,000.00	4.00	Nov 16, 2011	$320.00
900055611-0010	$8,000.00	3.20	Nov.16, 2010	$256.00
960006276-0004	$3,000.00	3.00	Dec 11, 2008	$90.00
960006276-	$8,000.00	3.85	Oct 31, 2012	$308.00
960006276-0008	$4,000.00	3.30	Sept 16, 2008	$132.00
960006276-0009	7,000.00	2.75	Feb 10, 2009	$192.50
Total	**$38,000.00**			**$1,298.50**

APPENDIX G

Entomological Society of Manitoba
Report of the Finance Committee for 2006-2007

The Finance Committee met on 30 October 2007, to review the 2006-2007 financial statement and the budget for the current fiscal year. The Society continues to be in very good financial shape, as reflected in our available cash at the end of the fiscal year (31 August 2007) of $11,617 in the Treasury Bill account and chequing account. The Joint Meeting of the North Central Branch of the ESA and the ESM was a great success all round, including financially. We were able to receive reimbursement of $2,554 for expenses from previous years: $2,054 incurred in 2003 to send Paul Fields and Brent Elliott to the NCB meeting that year, and $500 incurred last year as a deposit on the hotel booking. The substantial surplus of $3,721 is due in large part to these reimbursed expenses.

For the current fiscal year, General Expenses are larger than usual because of Auditor's review of our accounts included the accounts for the Joint Meeting held in March 2007. This increase will be offset by $500 received from the NCB Joint Meeting surplus to cover the auditor's fee. Expenses for the Proceedings in the past fiscal year was larger than usual because of payment of publication costs for one issue plus postage costs, which were included in General Expenses in previous years. For the coming fiscal year, some budgets, particularly Proceedings and Newsletter, have been increased to include postage costs these committees incur. In the past, postage costs of committees have sometimes incorrectly been included under General Expenses.

Marjorie Smith, Chair
Ian Wise
Pat MacKay

APPENDIX H

Entomological Society of Manitoba
Report of the ESM Newsletter Committee

In 2007, we have so far produced the last issue of Volume 33 and two of the three issues of Volume 34 of the ESM Newsletter. The fall issue of Volume 33, Volume 33.3, should have been out in October 2006 but was not distributed until 22 January 2007. With Volume 34, the production dates of the three issues were modified to fit more easily with the schedule of one of the co-editors. Those target dates are now April/May, August/September and December/January. The spring/summer issue, Volume 34.1 was distributed on 14 June 2007 and the fall issue Volume 34.2 was distributed on 17 September 2007, along with the announcement and call for papers for the 2007 Annual Meeting. The winter issue is planned for late December 2007. The above three issues contained 10, 14 and 11 pages of text and photographs and notices respectively. The costs of the first three issues of the Newsletter distributed so far in 2007 were $52.89, $157.49, and $139.73; the budgeted amount was $150. Volume 33.3 was unusually inexpensive because it was mailed out with the Proceedings and paid for under that budget line. Envelopes were purchased at a cost of $30.35; for supplies, $50.00 was budgeted. The costs of printing and postage continue to push the budgeted limit and steps may need to be taken to reduce costs. As long as the size of the Newsletter is maintained at 9 or fewer sheets, or 18 pages and postage does not rise significantly, current costs can probably be maintained. If we restrict the size of a Newsletter to no more than 5 sheets, or 10 pages, this would reduce costs significantly by dropping Canadian postage from $.89 to $.51. This could be accomplished by publishing fewer or shorter articles, or by reducing the font size of some or all of the items.

Patricia MacKay
Mahmood Iranpour
Co-editors, ESM Newsletter
November 2007

APPENDIX I

Entomological Society of Manitoba
2007 Social Committee Report

- no activity in 2007
- new members social and similar events routinely have very low turnout so none scheduled
- luncheons were attempted to be arranged but suitable timing could not be satisfied for all parties

- no banquet associated with annual meeting due to shortened meeting in 2006 and due to general decline in interest for 2007 (refer to 2005 meeting)

B. Elliott, R. Lafrenière, S. Wolfe (maternity leave)

APPENDIX J

Entomological Society of Manitoba
Youth Encouragement Committee Report

The youth encouragement program continues to provide age appropriate education of the life and times of insects to schools, daycares and the general public. Presentations or department tours involve a slide show, as well as pinned and live insects – the live insects always being a crowd pleaser. This program is well received by the children and is made possible through volunteers within the Department of Entomology.

In the past year the program has provided 7 department tours and 17 presentations, reaching a total of 818 children; a monthly breakdown of activities is presented in Table 1. With hectic schedules it is difficult to accommodate all requested presentations when working within a volunteer program; the program is largely run by a handful of enthusiasts within the department. To save these few students time in their busy schedules as well as accommodate more requests it would be beneficial if more people were able to volunteer their time.

Amazing Agriculture is another forum from which our volunteers educate young and old on the joys of entomology. The three day event held in fall had a great public response and has over 2000 students in attendance per year. Students in the department ran an insect relay and assisted Marg Smith at her observation bee hive.

I would like to thank everyone who helped out with youth encouragement activities this past year; this program would not be running without you.

Volunteers:
Taryn Dickson; Andrea Patenaude; Christie Borkowsky; Jonathan Veilleux; Kate Bergen; Katrina Froese; Lars Andreassen; John Gavlowski; Sheila Wolfe-Campbell; Dr. Rob Currie; Dr. Pat MacKay; Dr. Bob Lamb.

Kristin Hynes, Chair, Youth Encouragement Committee

Table 1. Youth encouragement activities by month; November, 2006 – October, 2007.

Month received	# of Department tours	# of Presentations	# of children	Donations
November, 2006	0	4	150	
December, 2006	1	1	14	
January, 2007	0	0	0	
February, 2007	1	0	23	
March, 2007	0	1	30	$50.00
April, 2007	0	2	49	$25.00
May, 2007	2	0	70	$90.00
June, 2007	2	1	143	$50.00
July, 2007	0	3	180	$70.00
August, 2007	1	4	129	$70.00
September, 2007	0	0	0	
October, 2007	0	1	30	
TOTAL:	7	17	818	$355.00

APPENDIX K

Entomological Society of Manitoba
Report of the Archivist

No report.

APPENDIX L

Entomological Society of Manitoba
Report of the ESM Student Awards and ESM Scholarship Committee

Student Achievement Award:

Awarded to a student who is in a Bachelor's degree program or recently completed a program. This award recognizes students who have shown exceptional interest in entomology as evidenced by their insect collections, insect photography, published articles of entomological interest, insect experiments and/or outstanding contributions during summer employment.

This year's winner is Ms. Laura Woloshyn. Laura is completing her last year of an undergraduate program in the Agroecology program in the Faculty of Agriculture and

Food Sciences at the University of Manitoba. Laura has completed two entomology courses and is currently enrolled in five more and when finished will have qualified for a minor in Entomology. Laura is also completing an undergraduate thesis project examining leafcutter bee biology under the supervision of Dr. R. Currie in the Dept. of Entomology. Laura impressed the scholarship selection committee with her interest in entomology in the classroom and the field, her keen work ethic and academic proficiency.

Orkin/Swat Student Award:

This award is designed to foster and encourage student interest in general Entomology including natural methods of insect pest control and the proper use of insecticides. Candidates must have a demonstrated interest in entomology, superior scholastic ability, high research potential, originality and industriousness in their university courses and/or summer work.

This year's winner is Mr. Jonathan Veilleux. Jonathan completed a degree in fine arts from the University of Quebec and is in his third year in the Agroecology program in the Faculty of Agriculture and Food Sciences at the University of Manitoba, with a minor in Entomology. Jonathan intends to do an undergraduate thesis project examining the role of tree removal on the effectiveness of Dutch elm disease control in his final year. Jonathan has worked in the University of Manitoba, Department of Entomology for the last two summers and proved to be a very reliable and hard working field assistant. Jonathan was an undergraduate NSERC research award winner in 2007. Faculty of the Entomology dept. noted his excellent performance as a summer student employee, praising his research ability and conscientious approach to his work.

The ESM Graduate Scholarship:

This scholarship is awarded to a student in a M.Sc. or Ph.D. program in entomology at the University of Manitoba. Students must be enrolled in their graduate program for at least 12 months prior to Oct 1 of the award year. This award recognizes superior scholastic ability, high research potential as evidenced by industriousness, good judgment, originality, a conscientious attitude and organizational ability, and excellent communication skills.

This years winner is Mr. Lars Andreasson. Lars is enrolled as a Ph.D. candidate in the Dept. of Entomology at the University of Manitoba working under the supervision of Dr. N. Holliday. Lars received his B.Sc. in 2004 from Augustana University College and his M.Sc. in 2007 from University of Manitoba. Lars has received several awards since joining the department including a University of Manitoba Graduate Fellowship and an NSERC post graduate scholarship. Lars Andreasson's PhD project examines the biological control of the *Delia radicum* in canola.

Desiree Vanderwel
Joel Gosselin
Richard Westwood
November 3, 2007

APPENDIX M

Entomological Society of Manitoba
Fundraising Committee Report

The Fundraising Committee raised a total of $1,400.00 from 13 donors to cover the costs of bringing in the out of town speakers for the AGM.

The Committee acknowledges the support provided by the sponsors in helping to make this another very successful entomological event.

Joel Gosselin,
Chair, Fundraising Committee.

APPENDIX N

Entomological Society of Manitoba
Scientific Programme Committee

The 63rd annual meeting of the Entomological Society of Manitoba was held on the 2nd and 3rd of November at the Freshwater Institute and the Animal Sciences Building, Fort Garry Campus, University of Manitoba. The theme for this year's meeting was "Arthropod vectors of plant and animal pathogens". The invited speakers included: Nick Ogden, with the Public Health Agency of Canada who spoke on vector-borne diseases (such as Lyme disease) and the possible effects of climate change on the incidence and distribution of human infections; Mike Allen, former City Forester for Winnipeg, who provided a synopsis on relevant vector-borne forestry diseases including: Dutch Elm disease and Ash Yellow; Phil Curry, a medical entomologist for both Saskatchewan and Manitoba Health, described the ecological factors in the 2003 and 2007 that lead to human outbreaks of West Nile Virus in the Prairie provinces; and David Ragsdale from the University of Minnesota, who provided an overview of his work on soybean aphid and establishing economic thresholds for this new invasive pest.

Overall the meeting was well attended with approximately 50 attendees registering for the meeting. As in previous years, sponsors were very generous providing $1450 in donations and revenue was also provided through the meeting registration process (i.e., an additional $885). The total expenses for the meeting were only $1865.88 so there was a net profit of $469.12 from the 2007 meeting. Expenses were dramatically off-set this year because all of the invited speakers were either local (so virtually no cost in the case of Allen), traveled by car to the meeting (Ragsdale and Curry) or did not charge the society for any expenses (Ogden). In addition, the organizing committee did not plan a social event or banquet this year which in previous years was a considerable expense to the society. Based on all of the above, this year's meeting was a great success, which hopefully can be duplicated in the future.

Robbin Lindsay
Scientific Organizing Committee, Chair

APPENDIX O

Entomological Society of Manitoba
Report of the ESM Membership Committee

There are currently 106 members in the ESM, compared to 118 in November of last year (after the AGM): 2 members joined, while 14 members were dropped, to give the net loss of 12 members.

I would like to thank Ian Wise (Treasurer) for his careful record keeping of the membership.

Désirée Vanderwel, Chair.

APPENDIX P

Entomological Society of Manitoba
Web Page Report

The Entomological Society of Manitoba web page is currently hosted by the University of Manitoba thanks to the cooperation of Paul Fields. It contains pages with current and past versions of the Newsletter and Proceedings as well as lists of current meeting information, the name and contact information for members on the Executive and names of those chairing committees. There are sections on Committee Guidelines and Souvenirs. The site also has a section "For Kids" and links to other sites. Currently electronic copies of the proceedings (issues from 1997 to 2005) and newsletter have been posted and are up to date. Pdf reprints of papers published in the proceedings during the period from 1995 to 2005 are also available on the site. These papers are readily picked up by search engines such as Google Scholar and thus give great exposure to the author(s). Future issues will continue to be posted as soon as they become available. There has not been any development of new content on the site during the past year (with the exception of postings of newsletters, proceedings etc.) but information on meetings etc. has been updated regularly as soon as it has been made available to me. It would be useful if any persons visiting the site would take time to report any errors or omissions to the web site master so they can be rectified. If anyone has content they think would be of interest to members of the society or items appropriate for posting (on the for kids page, for example) please feel free to e-mail a request to the web site master.

Rob Currie