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Contents

Weather conditions and sphinx moth activity in relation to pollination of the endangered Western Prairie Fringed Orchid (*Platanthera praeclara*) in Manitoba

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Abstract – Weather conditions can influence flight activities of sphinx moths (Lepidoptera: Sphingidae), including floral visitation. The rare Western prairie fringed orchid, *Platanthera praeclara,* is exclusively pollinated by several species of nectar-feeding sphinx moths in Manitoba. The orchid is classified as endangered and threatened in Canada and the United States, respectively. We examined several meteorological factors which may influence sphinx moth visitation to *P. praeclara* in Manitoba. Sphinx moth visitation rates, as indicated by orchid seed capsule production and removal of pollinaria, varied between sites but there was no apparent relationship between sphinx moth activity and weather conditions during the flowering period of the Western prairie fringed orchid. We suggest that removal of pollinaria from orchids may be caused by other factors in addition to sphinx moth pollination, such as mechanical disturbance by wind, and that removal rates of pollinaria during the flowering period may not always be an accurate indicator of sphinx moth pollination rates. It is recommended that seed capsule production be used to estimate sphinx pollinator activity and to determine annual rates of orchid reproduction rather than estimates of pollinaria removal during the flowering period.

Introduction

The activity of adult Lepidoptera may be constrained by meteorological conditions, particularly temperature and wind speed (Eisikowitch and Galil 1971; Hardwick 1972; Cruden *et al.* 1976; McGeachie 1989; Holyoak *et al.* 1997; Butler *et al.* 1999; Bailey and Horn 2007). Adult Lepidoptera are active within a range of ambient temperatures, above or below which activity ceases (Daly *et al.* 1978). For nectar-seeking sphinx

moths, there is a positive relationship between ambient temperature within this range and the number of floral visits (Cruden 1973; Cruden *et al.*1976; del Rio and Búrquez 1986). In moderate to high winds, moth activity decreases dramatically (Douwes 1968; Eisikowitch and Galil 1971; Willmott and Búrquez 1996). This may be due to the presumably high energetic costs associated with flight in such conditions or because it is too difficult for a moth to maintain proper positioning in front of the flower while hovering during nectar feeding (Eisikowitch and Galil 1971).

The Western prairie fringed orchid (WPFO) (*Platanthera praeclara* Sheviak and Bowles) (Orchidaceae) is a perennial herb (United States Fish and Wildlife Service 1989). The WPFO is found in tall grass prairie habitats in the midwestern United States (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and Oklahoma), (United States Fish and Wildlife Service 2006), and southern Manitoba in Canada (Catling and Brownell 1987) preferring mesic to wet calcareous prairie swales (Sheviak and Bowles 1986; Smith 1993; Wolken *et al.* 2001). It is classified as endangered and threatened in Canada and the United States, respectively (Collicutt 1993; United States Fish and Wildlife Service 1989) and has been placed on the world list of endangered species (NatureServe 2006). The largest population, and only known Canadian population of this orchid occurs in and adjacent to the 2200 ha Tall Grass Prairie Preserve (TGPP) in southeastern Manitoba (Westwood and Borkowsky 2004). The rarity of the WPFO is often attributed to the conversion of its habitat to agricultural use (Sheviak and Bowles 1986; United States Fish and Wildlife Service 1989; Smith 1993; Hof *et al.* 1999).

In Manitoba, two nectar-feeding sphinx moth (Sphingidae) species, *Sphinx drupiferarum* J.E. Smith and *Hyles gallii* (Rottenburg), have been confirmed as pollinators of the WPFO (Westwood and Borkowsky 2004; Borkowsky *et al.* 2011). One other non-native sphinx moth species, *Hyles euphorbiae* L., has been confirmed as a pollinator of WPFO in North Dakota (Fox *et al.* 2013). This species has been observed in the vicinity of the TGPP (Borkowsky pers. comm. 2014, Westwood unpublished data) but has not been recorded as a pollinator of the WPFO in Manitoba.

A WPFO flower contains a pollinarium which is composed of three structures: the pollinium (the pollen mass), the caudicle (stalk), and the viscidium (which is adapted to cement itself to the head or eye of a pollinator) (Sheviak and Bowles 1986; Pleasants and Moe 1993; Johnson and Edwards 2000; Pacini and Hesse 2002). Each WFPO flower has two pollinaria (Sheviak and Bowles 1986). The mechanism of pollinarium removal from a WPFO flower by sphinx moths involves the adherence of the viscidium to the eye of the sphinx moth during the process of nectar removal from the flower (Sheviak and Bowles 1986; Cuthrell 1994; Westwood and Borkowsky 2004). The entire pollinarium is removed from the flower when the moth leaves (Sheviak and Bowles 1986; Westwood and Borkowsky 2004). The pollinium is located in a position protruding from the head of the moth such that when the moth visits the next orchid flower, the pollen mass touches the stigma and pollen is transferred. The number of pollinaria removed from orchid flowers has been used as a measure of pollinator visitation by a number of investigators (Montalvo and Ackerman 1987; Maad 2000; Murren 2002; Maad and Alexandersson 2004). The number of seed capsules produced by the orchids has also been used as a proxy measure of sphinx moth visitation (Cole and Firmage 1984; Patt *et al.*1989; Maad 2000; Lipow *et al.* 2002).

Platanthera praeclara reproduces only by seed (Bowles 1983; Sieg and King 1995; Hof *et al*. 1999), thus pollination is a critical step in its life history. Artificial self and cross-pollination resulted in similar levels of fruit production (Pleasants and Moe 1993) but the positioning of the pollinaria relative to the stigma makes it unlikely that self-pollination would occur commonly in nature (Fox *et al.* 2013). The WPFO is pollen limited, that is, a flowering WPFO fails to produce as many fruits as it has flowers because it lacks the pollen with which to fertilize ovules and stimulate fruit production (Janzen *et al.* 1980; Willson 1983; Calvo 1990; Bertness and Shumway 1992; Westwood and Borkowsky 2004; Darrault and Schlindwein 2005; Borkowsky 2006).

The objective of this study was to determine if meteorological conditions (temperature, relative humidity and wind speed) affected sphinx moth activity in the TGPP and influenced pollinia removal and seed capsule production in the WPFO during the bloom period.

Materials and Methods

Field sampling for this study was carried out in 2006 in the Tall Grass Prairie Preserve (TGPP) in southeastern Manitoba (49°09'N, 96°40'W). The climate is boreal continental with mean temperatures of -17.1°C and 19.8°C for January and July, respectively (Environment Canada 2004). The area receives an average of 382.4 mm of precipitation (86.7% of the annual precipitation) during the months of April through September (Environment Canada 2004). Drainage in the area is poor with soil composed of lacustrine parent material, sandy loam to clay loam upper horizons and a thin organic surface layer (Canada Soil Inventory 1989).

Four undisturbed areas within the TGPP with high densities of the WPFO (orchid beds) were selected to act as sites (sites one, two, three, and four) (Figure 1). Sites were separated by at least 800 m. The approximate radii of the sites were: site 1 – 80 m; site 2 – 40 m; site 3 – 50 m; site 4 – 35 m. As direct observation of the crepuscular and nocturnal pollinators of the WPFO is difficult due to their swift flight and the poor light conditions during their periods of activity (Sheviak and Bowles 1986; Pleasants and Moe 1993; Fox *et al*. 2013), two proxy measures were used to determine visitation rates: removal of pollinaria and seed capsule production.

During the study, we placed a flagged stake beside each flowering orchid at each site and assigned it a unique number. A census of the buds, flowers, and senesced flowers was conducted between 1800 and 2200 hrs five times during the bloom period (only four times for site 4). The number of pollinaria in the flowers on each orchid was counted during each census. The number of pollinaria in the flowers on each orchid was counted again between 800 and 1100 hrs on the morning following each census. The dates of the evening censuses were 27 and 28 June and 4, 5, and 6 July. The seed capsules produced by each orchid at each site were counted on 26 July.

A measure of general sphinx moth activity was also determined. Light trapping was conducted in the TGPP during 10 nights, five nights prior to (13/14, 15/16, 20/21, 21/22, and 22/23 June) and five nights during (27/28, and 28/29 June and 4/5, 5/6, and 6/7

July) the WPFO bloom period in 2006 (approximately 24 June through 8 July). A large white sheet was hung on two opposing sides of a small building at the TGPP field station. An eight watt fluorescent ultraviolet light, with four reflective baffles, from a Ward's All-Weather Insect Trap™ was suspended at a height of 1.5 m in front of each sheet. The lights were operated and monitored for two to four hours between 2200 and 0200 hrs on trapping nights. Sphinx moths which alighted on or near the sheet were caught with containers, which were placed in a cooler until the next morning. The moths were then identified to species, checked for WPFO pollinaria, and marked on the hind wing using a black felt-tipped marker. After identification, the moths were released. For all trapping nights during the WPFO bloom period, the lights were left on until 0430 hrs, at which time any sphinx moths on or near the sheet were captured and identified as described above. There were no WPFO within 500 m of the lights and light traps were not visible from WPFO research sites.

Hourly temperature, wind speed, and relative humidity data for the trapping nights were obtained from a weather station located adjacent to the TGPP field station.

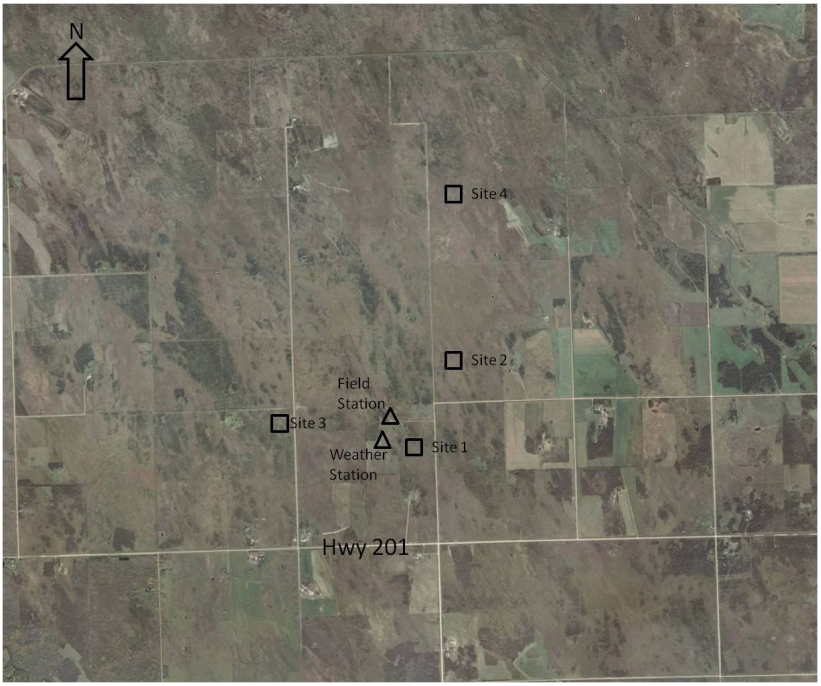

Figure 1. Layout of four orchid sites in relation to the field station (location of moth collection) in the Tall Grass Prairie Preserve in Manitoba (a four-square is one section – 1.6 x 1.6 km)

Statistical analyses

The plant and weather data were first tested for normality by graphing residuals from a general linear model estimate against the estimated values, and assessing the distribution pattern in the scattergram. Data were appropriately transformed (*i.e.,* log(X+1) or square-root-transformed) if heterogeneity of residuals was noted. Untransformed means are reported in the results and tables.

The mean number of flowers per plant per site was derived by dividing the number of flowers by the number of plants, using only the plants which were still intact at the time of the seed capsule survey. Capsules per flower for each plant were also calculated and between site differences examined using the Kruskal-Wallis ANOVA test (the data did not satisfy parametric assumptions after transformation). The percentage of pollinaria removed from the flowers (not including buds or senesced flowers) of each plant during each trapping night was calculated. The Kruskal-Wallis ANOVA test was used to examine the differences in percentage pollinaria removed between sites and between nights. Pearson correlation was used to examine the relationship between number of pollinaria removed and seed capsule production on an individual plant basis.

The mean hourly temperature, wind speed, and relative humidity were calculated during the periods that light traps were operated and observed, and also for the nights associated with pollinaria counts. Tukey's HSD test was used for comparison when differences between means were determined by ANOVA. Between evening and between night differences in these variables were examined using ANOVA during the flowering period. Pair-wise relationships between the weather variables, the number of moths caught and the pollinaria removal rate were analyzed using Pearson correlation over the flight period. Given that weather data from a single weather station were used for all sites, the assessment of pollinaria removal rate x weather variables utilized pooled pollinaria removal counts from all sites per night. A significance level of $\alpha = 0.05$ was used for analyses. All analyses were carried out using SPSS Version 19 (SPSS 2010).

Results

Mean inflorescence size ranged from 4.0 flowers per plant (site 4) to 7.2 flowers per plant (site 3) (Table 1). The number of capsules produced per flower did not vary significantly between sites (Table 1). There was no significant correlation between the number of flowers per plant and seed capsule production or seed capsules per flower and number of plants.

The percentage of available pollinaria removed did not differ significantly between sites (Table 2) or nights (Table 3). The highest single night removal rate (11.1%) and the highest overall removal rate occurred at site 3 (Tables 2 and 3). Pollinarium removal rate tended to increase over the bloom period (Table 3). Pollinarium removal was not correlated with the rate of seed capsule production ($r = -0.072$, $p = 0.928$).

Table 1. Comparison of seed capsule production by the Western prairie fringed orchid (mean ± SE) between four sites in the Tall Grass Prairie Preserve, Manitoba, 2006.

Site	No. Orchids	No. Flowers	Flowers Per Plant	No. Seed Capsules	Capules Per Flower
1	22	122	5.5	22	0.14 ± 0.07
2	39	247	6.3	13	0.05 ± 0.03
3	25	181	7.2	25	0.12 ± 0.06
4	11	44	4.0	14	0.37 ± 0.14
					X^2=6.332
					df=3
					p=0.097

Table 2. Comparison of percentages of Western prairie fringed orchi pollinaria removed from flowers (mean ± SE) between four sites in the Tall Grass Prairie Preserve, Manitoba, 2006.

Site	Night					Mean
	JN 27/28	JN 28/29	JL 4/5	JL 5/6	JL 6/7	
1	0.0	0.8	0.6	1.6	2.8	1.1 ± 0.5
2	0.0	2.7	1.0	0.4	1.1	1.0 ± 0.5
3	---	0.5	2.4	0.7	11.1	3.7 ± 2.5
4	0.0	0.0	1.1	3.0	3.6	1.5 ± 0.7
						$F_{3,15}$=1.018
						p = 0.412

Table 3. Comparison of percentages of Western praire fringed orchid pollinaria removed from flowers (mean ± SE) between five nights in the Tall Grass Prairie Preserve, Manitoba, 2006.

Night	Site				Mean
	1	2	3	4	
JN 27/28	0.0	0.0	---	0.0	0.0 ± 0.0
JN 28/29	0.8	2.7	0.5	0.0	1.0 ± 0.6
JL 4/5	0.6	1.0	2.4	1.1	1.3 ± 0.4
JL 5/6	1.6	0.4	0.7	3.0	1.4 ± 0.6
JL 6/7	2.8	1.1	11.1	3.6	4.6 ± 2.2
					$F_{4,14}$ = 2.362
					p = 0.103

All three weather variables – temperature, relative humidity, and wind speed – varied between trapping nights (Table 4) and between trapping nights during the WPFO bloom period (Table 5). The number of sphinx moths caught per night ranged from two to 17, with a mean of 6.7 (Table 4). Of the 67 sphinx moths caught over the ten nights, no specimens of *S. drupiferarum, H. gallii*, or any other likely pollinator were collected (Table 4). The most abundant and consistently caught sphinx moth was *Smerinthus jamaicensis* (Drury) (Table 4). None of the moths carried WPFO pollinaria or were re-captured on subsequent nights.

The number of moths caught per night was not significantly related to any of the weather variables (with temperature: $r = 0.339$, $p = 0.338$; with relative humidity: $r = -0.001$, $p = 0.997$; with wind speed: $r = 0.088$, $p = 0.808$) over ten nights. For the five trapping nights during the WPFO bloom period, the number of moths caught was not significantly correlated with per cent pollinaria removed ($r = -0.354$, $p = 0.138$). Per cent pollinaria removed was significantly positively correlated with temperature ($r = 0.577$, $p = 0.010$) and wind speed ($r = 0.620$, $p = 0.005$). However, the per cent pollinaria removed had a significant negative relationship with relative humidity ($r = -0.607$, $p = 0.006$). Temperature was positively associated with wind speed ($r = 0.794$, $p = 0.006$) and negatively correlated with relative humidity ($r = -0.705$, $p = 0.023$). Wind speed and relative humidity were negatively correlated ($r = -0.635$, $p = 0.049$).

Discussion

The rate of seed capsule production per flower varied (though not significantly) between sites. While not significant, the percentages of pollinaria removed from flowers varied during the bloom period both within and across sites. While a site effect was not detected in this study, Borkowsky (2006) found considerable differences in WPFO seed capsule production rates between sites in Manitoba. Pleasants and Moe (1993) showed that moth visitation rates to the WPFO increase during the bloom period, with the pollinaria removal rate roughly corresponding with the number of open flowers. Spatial variation in visitation rates has also been recorded for *Platanthera blephariglottis* (Willdenow) Lindley (Cole and Firmage 1984), *P. ciliaris* (L.) Lindley (Smith and Snow 1976), *P. metabifolia* F. Maekawa (Inoue 1986) and *P. okuboi* Makino (Inoue 1985). For these studies, several reasons for the variation were suggested, including differences in flower size (and therefore pollinator attraction) between populations (lnoue 1986), differences in the plant community between populations (Smith and Snow 1976; Inoue 1985), and fluctuating pollinator abundance between years (Cole and Finnage 1984). In the current study, perhaps the sample size was insufficient to show significant differences in pollinaria removal between sites or dates.

The number of seed capsules produced was not correlated with the rate of pollinaria removal. That no relationship was found between these two measures may be due to the different time scales of the measurements – seed capsules per flower were measured after the entire blooming period, while overall rates of pollinaria removal were averages of five nights during the bloom period. If the pollinaria removal rate for the entire bloom period had been calculated using only the plants present when seed capsules were counted, a different relationship between the two measures may

Table 4. Mean weather conditions and sphinx moth catches for ten evenings (2200 – 200 hrs) at the Tallgrass Prairie Preserve, Manitoba, 2006.

	Weather Conditions			Moth Catch			
Evening (no. hours)	Temperature (°C)	Relative Humidity	Windspeed (m/sec)	*Smerinthus jamaicensis*	*Smerinthus cerisyi*	*Pachysphinx modesta*	*Paonias myops*
JN 13/14 (5)	13.8 ± 0.9	95.7 ± 3.4	0.87 ± 0.14	2	0	0	0
JN 15/16 (5)	20.7 ± 0.2	91.6 ± 0.6	2.71 ± 0.21	13	3	0	0
JN 20/21 (4)	16.2 ± 1.0	82.6 ± 4.0	1.72 ± 0.21	5	1	1	0
JN 21/22 (4)	11.6 ± 0.8	91.1 ± 1.2	1.63 ± 0.53	2	0	0	0
JN 22/23 (4)	13.0 ± 1.1	97.7 ± 2.3	0.36 ± 0.10	1	0	1	0
JN 27/28 (4)[1]	11.3 ± 1.2	96.8 ± 3.1	0.20 ± 0.05	7	0	0	0
JN 28/29 (4)	15.8 ± 0.7	82.7 ± 2.1	0.65 ± 0.06	11	1	4	1
JL 4/5 (4)	13.2 ± 1.2	90.4 ± 5.7	0.34 ± 0.05	5	1	0	0
JL 5/6 (4)	17.2 ± 0.8	86.8 ± 1.7	0.83 ± 0.06	6	0	0	0
JL 6/7 (3)	21.5 ± 0.8	63.2 ± 2.7	2.94 ± 0.14	1	0	1	0

[1]June 27/28 to July 5/6 - denotes beginning of flowering period.

have been observed. Alternatively, pollinarium removal rates may not be a reliable measure of pollinator visitation (see below).

Table 5. Comparison of meteorological variables (mean ± SE) among five nights (2200 to 430 hrs) during the Western prairie fringed orchid bloom period at the Tallgrass Prairie Preserve, Manitoba, 2006.

Night	Temperature (°C)[1]	Relative Humidity	Windspeed (m/sec)
JN 27/28	9.2 ± 0.8a	98.6 ± 1.4d	0.19 ± 0.03a
JN 28/29	14.1 ± 0.6bc	84.5 ± 1.4b	0.79 ± 0.06bc
JL 4/5	11.5 ± 0.8ab	94.7 ± 2.7cd	0.50 ± 0.05ab
JL 5/6	15.9 ± 0.5c	89.1 ± 1.4bc	1.05 ± 0.09c
JL 6/7	20.9 ± 0.4d	66.4 ± 1.7a	3.34 ± 0.28d
$F_{4,40}$	45.817	47.756	84.104
p	<0.001	<0.001	<0.001

[1] Means followed by different letters are significantly different

The proportion of flowers producing seed capsules in the present study ranged from 5% to 37% (mean: 17%). These are considerably higher than most previously recorded rates for the WPFO in Manitoba, which ranged from 0.18% to 3.21% (Borkowsky 2006). Borkowsky (1997) recorded a seed capsule production rate of 22% for the WPFO in Manitoba, but this was based on a small sample size, so results must be interpreted with caution. Approximately 30% of flowers in a North Dakota WPFO population produced seed capsules (Pleasants and Moe 1993).

Neither of the known pollinator species of the WPFO in Manitoba was caught at the light traps in this study. There are several possible explanations for their absence. Both *H. gallii* and *S. drupiferarum* are uncommon in Manitoba in some years (Hodges 1971; Westwood and Borkowsky 2004; R. Westwood unpublished data), thus 2006 may have been a year in which populations of both species were low and as such, catching individual moths should have been a rare occurrence. Alternatively, the abundance of these species may not have been low in general, but only in the particular area where the lights were stationed. Potential reasons for low local abundance may include lack of food sources (no known alternate food sources of the adult moths, including *P. praeclara*, were located within 300 m of the lights) or high predator populations in the area.

At least 15 sphinx moth species have been collected in the vicinity of the TGPP during the WPFO bloom period (Westwood and Borkowsky 2004), though only four of these species were collected in this study. Of these four species, none have a proboscis of sufficient length to access the nectar in WPFO flowers (Westwood and Borkowsky 2004) and are thus unlikely to act as pollinators of the WPFO.

The activity of sphinx moths, including their pollination activity, is likely constrained by meteorological factors such as temperature (del Rio and Búrquez 1986; Butler *et al*. 1999; see Willmott and Búrquez 1996) and wind speed (Eisikowitch and Galil

1971; Willmott and Búrquez 1996). There was no significant relationship between the number of sphinx moths caught and three meteorological variables – temperature, relative humidity, and wind speed in our study. There are at least two explanations as to why the expected correlation between weather conditions, particularly temperature and wind speed, and moth abundance was not found. Traps were operated for only 10 nights. Many studies which specifically examine the relationship between light trap catches and weather conditions generally have much larger sample sizes over many more nights (Butler *et al*. 1999). A second potential reason the temperature and wind speed did not correlate with moth abundance in the present study involves the range of conditions in which sphinx moths are active. If the conditions during trapping periods were well within the thresholds of moth activity, a strong linear correlation between moth abundance and weather conditions may not be found (Danthanarayana 1976; Willmott and Búrquez 1996; see Cruden *et al*. 1976; del Rio and Búrquez 1986). Mean temperature during the trapping periods ranged from 11.3°C to 21.5°C and wind speed ranged from 0.20 m/sec to 2.94 m/sec. These values are within the range of conditions in which moths, including sphinx moths, may be active (Eisikowitch and Galil 1971; Cruden *et al*. 1976; Danthanarayana 1976; del Rio and Búrquez 1986; Butler *et al*. 1999). Consistent with previous research (Danthanarayana 1976; Willmott and Búrquez 1996), relative humidity did not have a noticeable effect on sphinx moth abundance, though the problem of a small sample size noted above may apply here as well.

Pleasants and Moe (1993) found 33% pollinaria removal from WPFO flowers in North Dakota. Borkowsky (2006) reported mean percentages of pollinaria removed ranging from 6% to l0% for the WPFO in Manitoba. The percentages of pollinarium removed in our study are more consistent with the findings of Borkowsky (2006) than with Pleasants and Moe (1993). However, the above studies measured removal rates over the entire bloom period rather than daily as in the present study, thus results are not directly comparable.

Percentage pollinaria removal was significantly correlated with all three weather variables (positively with temperature and wind speed, negatively with relative humidity), though the correlation coefficients did not suggest particularly strong relationships. The highest rates of pollinaria removal in the present study occurred when the wind speed was 2.94 m/sec. The upper wind speed threshold for sphinx moth activity is about three metres per second (Eisikowitch and Galil 1971; Danthanarayana 1976). The number of sphinx moths caught at lights, a more direct indicator of sphinx activity than pollinaria removal rates, did not correlate with the weather variables, including wind speed. These observations suggest that the removal of many pollinaria in this study may not have been the result of sphinx moth activity. The relationship between pollinaria removal rates and the weather variables may not have been mediated through sphinx moths but rather through some other feature(s) of the orchid's environment. Other workers have noted that surrounding vegetation, particularly tall grasses, contact the viscidia of WPFO flowers, which then adhere to the grass and are removed from the flower; such events are likely related to grasses swaying in the wind (Cuthrell 1994; Borkowsky 2006; R. Westwood unpublished data). This phenomenon was also noted in the course of the present study. The positive correlation between pollinaria removal and wind speed may be due to increased removal of pollinaria by

surrounding vegetation during windy periods rather than increased moth activity. This suggestion is consistent with the lack of correlation between wind speed and the number of sphinx moths caught at the lights. As in other studies (Cuthrell 1994; Borkowsky 2006; see Fox *et al*. 2013), our study corroborates the finding that the removal of pollinaria from WPFO flowers may not always be an accurate measure of pollinator visitation.

The rate of pollinator visitation to the WPFO in Manitoba, as measured by seed capsule production, did not statistically vary by site. Pleasants and Moe (1993) found a significant, but low ($r = 0.26$) positive correlation between inflorescence size (*i.e*., flowers per plant) and seed capsule production in a North Dakota WPFO population. In the present study, such a trend was not evident between sites. The size of a plant population (*i.e*., number of plants) may be positively related to rates of fruit production (Ågren 1996; Morgan 1999; Waites and Ågren 2004), though this does not appear to be the case for the WPFO (Pleasants and Moe 1993; the present study). There was no significant relationship between seed capsules per flower and the number of plants in the present study.

Four sites may not be a sufficient sample size to demonstrate relationships between pollinator visitation and the variables examined. Although the WPFO population at the TGPP is the largest remaining population in North America, in most years there are not many sites in the TGPP with adequate numbers of orchids for studies such as this. Even if more sites were available and had been used, the resources necessary to sample many additional sites sufficiently were not available for this study.

Temporal variation of pollinator visitation rate also warrants further study, particularly in regards to wind speed. Strong winds during the WPFO bloom period may not only reduce the pollinating activity of sphinx moths (Eisikowitch and Galil 1971; Willmott and Búrquez 1996), but also remove a considerable number of pollinaria from WPFO. The latter phenomenon may increase the incidence of nectar theft experienced by WPFO flowers as they may not have pollinaria to attach to visiting moths which can still access the nectar reward. Nectar theft may lead to lower pollination rates and reproductive implications for the orchid. Long term studies at the TGPP following orchid seed capsule production, meteorological conditions, and sphinx moth abundance may yield important insights into the factors influencing temporal variation in sphinx moth visitation to WPFO flowers in Manitoba.

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69th Annual Meeting
Entomological Society of Manitoba, Inc.

Friday November 1, 2013
Freshwater Institute
501 University Crescent
and
Saturday 2 November, 2013
Cereal Research Centre, AAFC
195 Dafoe Rd., University of Manitoba

ABSTRACTS

KEYNOTE ADDRESSES

EFFORTS TO MANAGE WHEAT MIDGE THROUGH HOST GENETICS.

Curt A. McCartney[1], Mulualem T. Kassa[1], Ian Wise[1], Marjorie Smith[1], Stephen Fox[2], Julian Thomas[1], Colin Hiebert[1], Mark Jordan[1], and Curtis Pozniak[3]. [1] Agriculture and Agri-Food Canada, Cereal Research Centre, Winnipeg, Manitoba, Canada R3T 2M9; [2] DL Seeds, Inc., Winnipeg, Manitoba, Canada R3T 6C5; [3] University of Saskatchewan, Crop Development Centre, Saskatoon, Saskatchewan, Canada S7N 5A8.

Wheat midge (*Sitodiplosis mosellana* Gehin) is among the most important pests of wheat in western Canada. Host genetics is an important tool for managing wheat midge. *Sm1* is the only described wheat midge resistance gene and is the foundation of efforts to manage this insect. Research will be presented outlining efforts to sequence *Sm1*. Unfortunately, the majority of wheat varieties with *Sm1* still suffer some kernel damage as a result of larval feeding on the developing grain. These damaged seeds are approximately the same seed weight as undamaged kernels but are distorted in shape and considered undesirable. The variety Shaw (*Sm1* carrier) is a notable exception, with very few damaged seeds relative to other *Sm1* wheats. The genetic basis of this improved midge resistance is being studied in the cross Shaw/Goodeve. Another avenue for managing wheat midge is oviposition deterrence where wheat lines with this trait have fewer eggs laid on their spikes. Reduced seed damage can also arise from aberrant egg laying behaviour, where eggs are laid on the rachis rather than the florets. Oviposition deterrence has been identified in common

wheat lines from the northern USA and wheat lines with northern USA parentage. Present and future research in this area will be discussed. The combined research of breeders, entomologists, and geneticists has led to the development of the first generation of wheat midge resistant varieties. The genetic research underway will assist in the development of succeeding generations of varieties with improved wheat midge resistance coupled with oviposition deterrence.

FIVE DECADES OF ENTOMOLOGY COME TO AN END AT THE CEREAL RESEARCH CENTRE.

Robert J. Lamb. Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Entomological research at the Research Station began in 1957 with 10 entomologists investigating stored-product and field-crop pests. In 1972 when the "Belleville" group arrived, the number of entomologists peaked at 18. In 1995, entomological research on canola was transferred to Saskatoon and the field-crop entomology programme was reduced to one Scientist and two Biologists. Stored-product entomology also declined to the current complement of two Scientists and one Biologist. During the 50 year period, internationally recognized research was completed on pest management in bulk grains, alternatives to ozone-depleting fumigants, pest management in canola and breeding wheat resistant to wheat midge. When the Cereal Research Centre closes in early 2014, a small stored-product entomology group will remain at the University of Manitoba, but no federal or provincial research on field-crop entomology will be available, leaving one position in the Entomology Department to continue research on field crops in Manitoba.

SYMPOSIUM

ENTOMOLOGY AT THE CEREAL RESERCH STATION: PAST, PRESENT AND FUTURE

PESTS OF STORED GRAIN AND GRAIN PRODUCTS (INSECTS, MITES, MOULDS): DETECTION AND CONTROL.

Noel White. Cereal Research Centre, Agriculture and Agri-Food Canada, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9.

The stored grain ecosystem is discussed. Stored grain is a true desert to which a few arthropod and fungal species have adapted. Management of this human-made ecosystem involves an integrated pest management approach including physical manipulation of the environment, chemical control, and biological control. Recent advances in the detection of pests and control tactics are outlined.

TRUST BUT VERIFY: A FIELD ECOLOGIST PONDERS THE POWER AND PITFALLS OF MOLECULAR METHODS.

K.D. Floate. Lethbridge Research Centre, Agriculture and Agri Food Canada, Lethbridge, Alberta, Canada TIJ 4B1.

Molecular tools offer a world of possibilities. They can identify species from leg fragments, disentangle cryptic species-complexes, clarify phylogenetic relationships, and shed new light on microbial-host interactions. And to someone like me, trained as a field ecologist with no formal training in molecular biology, they carry a certain aura of mystic and intimidation. About twelve years ago, our lab took the plunge and began using standard polymerase chain reaction (PCR) methods to study symbiont-host interactions. We since have used denaturing gradient gel electrophoresis, nested-PCR, qPCR and are beginning to use nextgeneration sequencing. Each technique has brought its own set of trials and tribulations and, if you learn from failure, we have learned a lot. Yes - molecular methods can be powerful, but their application takes a certain aptitude, a lot of patience, and a healthy dose of caution when interpreting results. I convey some of the lessons that I have learned in this layperson's presentation on the power and pitfalls of molecular methods.

WHEAT MIDGE IN WESTERN CANADA: A MULTIDISCIPLINARY APPROACH TO PEST MANAGEMENT.

M.A.H. Smith, R.J. Lamb, and I.L. Wise. Cereal Research Centre, Agriculture and Agri-Food Canada, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9.

The wheat midge, *Sitodiplosis mosellana* (Gehin) (Diptera: Cedidomyiidae), has been a key pest of spring wheat in western Canada since the mid-1980s, causing many millions in financial losses per year due to damaged and lost grain. In the early 1990's, scientists at the Cereal Research Centre discovered genetic resistance to the wheat midge in winter wheat varieties and transferred the gene into spring wheat. Today there are several registered midge-resistant varieties of Canada Western Red Spring wheat grown on the Prairies. The successful development of these resistant varieties involved many areas of expertise, including entomology, wheat breeding, molecular genetics and agronomy, as well as seed growers and regulatory agencies. Critical to this success were development of efficient methods for screening field plots for midge larvae, the establishment of laboratory colonies of wheat midge for use in bioassays of wheat lines, studying the phenology and life-history of wheat midge, especially regarding sex ratios, and developing a strategy to incorporate refuges into the resistant wheat varieties. These aspects of our work were significant in the development of midge-resistant varieties, but also in protecting the efficacy of the midge resistance gene in the future.

RISK ASSESSMENT OF PESTICIDES TO BEES: TIERED APPROACH AND ASSOCIATED UNCERTAINTIES.

Wayne Hou, and Connie Hart. Health Canada, Pest Management Regulatory Agency, Ottawa, Ontario, Canada K1A 0K9.

Pesticides along with several other factors have been considered to have a potential contribution to the world-wide pollinator declines. The traditional approach to pesticide risk assessment for pollinators was focused almost exclusively on adult effects resulting from direct exposure. A new pollinator risk assessment framework has been recently completed in North America in collaboration among Health Canada Pest Management Regulatory Agency (PMRA), US Environmental Protection Agency (USEPA) and California Department of Pesticide Regulation (CDPR). The new risk assessment (RA) framework uses a tiered approach, taking into consideration differences in physical-chemical properties of pesticides, exposure routes, stages of bees, and effects on individuals and colonies.

This presentation provides an overview of the new framework for determining the potential risks of pesticides to bees and uncertainties associated with the framework. The framework is composed of three tiers starting from the most conservative scenario at Tier I to progressively more realistic scenarios at Tier II and III. The Tier I RA is an initial screening to identify pesticides that may require more refined assessments. For Tier I, the conservative environmental exposure concentrations (EECs) are estimated depending on the application methods, and then compared with toxicity data generated under controlled laboratory conditions using individual organisms. For Tier II and III, risk is examined under progressively more realistic conditions under semi-field and field conditions, respectively, using whole bee colonies. The uncertainties associated with the RA will be discussed.

SUBMITTED PAPERS

SOYBEAN APHID CONTROL AND MOVEMENT OF NATURAL ENEMIES FROM ADJACENT HABITATS.

K.G.L.I. Samaranayake, and Alejandro C. Costamagna. Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

The strength of pest suppression varies across agricultural landscapes and immigration of natural enemies to crop fields is proposed as an important mechanism explaining this variability. We conducted field studies to compare suppression of the soybean aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae), in twelve landscapes in Manitoba, from 22 July to 9 August 2013. We used potted soybean plants infested with soybean aphids (14 aphids/pot), that were either exposed (completely open) or protected from predation (covered with a mesh cage). This design was replicated five times in each soybean field on six separate locations (1-3 landscapes/location) that included experimental (Carman and Glenlea) and commercial fields (Emerson, Morris, La Broquerie and Gimli). Aphids were counted once a week in each treatment. In addition, we monitored natural enemy movement between soybean and a neighbouring field (mainly natural vegetation, alfalfa, wheat, canola and grass) in one border of each field studied using bidirectional Malaise traps.

We observed significant suppression of soybean aphids in all landscapes studied, ranging from 3- to 22-fold reduction in aphid abundance in comparison with

predator exclusion controls. Fields also differed in aphid abundance, but there was not a significant field x predator manipulation interaction, indicating consistent aphid suppression across landscapes. Preliminary results from the Malaise trap samples indicate low number of natural enemies moving from neighbouring fields to soybean, which could be related to the absence of natural aphid infestations in the fields studied.

LEPIDOPTERAN DIVERSITY IN COMMERCIALLY MANAGED JACK PINE (*PINUS BANKSIANA*) AND RED PINE (*PINUS RESINOSA*) FOREST STANDS IN MANITOBA.

C. Grigoras, and A.R. Westwood. Centre for Forest Interdisciplinary Research, University of Winnipeg, Winnipeg, Manitoba, Canada R3B 2E9.

In Canada, red pine and jack pine are often grown and managed for sawlog and pulpwood production, either in extensively or intensively managed forest stands. Historically, red pine while native to eastern Manitoba, was considered an uncommon tree species in comparison to extensive stands of jack pine in the southeast portion of the province. The area planted to red pine in eastern Manitoba has increased substantially over the last 50 years, primarily in areas that once contained jack pine forests. The purpose of this research is to investigate the differences in diversity of herbaceous and shrub vegetation and night-flying Lepidoptera among various age cohorts of commercial red and jack pine stands in southeastern Manitoba to determine if diversity in red pine stands is less than that found in jack pine forests. Preliminary data analysis indicates that plant and night-flying Lepidoptera diversity is lower in red pine forests and that replacement of jack pine stands with red pine may cause changes in diversity within some forested areas of southeastern Manitoba.

HABITAT CHARACTERIZATION AND BIOLOGY OF THE THREATENED DAKOTA SKIPPER (*HESPERIA DAKOTAE*) IN MANITOBA.

C.L. Rigney, and A.R. Westwood. Department of Biology, University of Winnipeg, Winnipeg, Manitoba, Canada R3B 2E9.

The Dakota skipper (*Hesperia dacotae*) is a threatened butterfly restricted in Canada to fragmented prairies in the Interlake, southwestern Manitoba and southeastern Saskatchewan. There are limited data on the life history and habitat requirements in Canada to implement effective conservation measures. We seek to understand better the key biological and physical habitat requirements to develop a preferred site profile. Vegetation and nectar flower surveys were conducted in 2010 and soil-related surveys were conducted in 2011. Analysis of the vegetation abundance and soil-related parameters was used to develop critical habitat profiles to determine optimal Dakota skipper habitat in Canada. Observations of adult behaviour including nectaring, oviposition and predation will also be discussed.

THE RESIDUAL TOXICITY OF THE INSECTICIDES, LUFOX® AND MATCH®, ON A PARASITOID WASP (*HABROBRACON HEBETOR*) (HYMENOPTERA: BRACONIDAE) UNDER LABORATORY CONDITIONS.

M. Hooshmandi[1], M. Alichi, M. Aleosfur, K. Minaei. Department of Plant Protection, College of Agriculture, University of Shiraz, Iran; [1]Current address: Department of Biology, University of Winnipeg, Winnipeg, Manitoba, Canada R3B 2E9.

The residual toxicity of two newly introduced insect growth regulator insecticides (Match® and Lufox®) was tested against the parasitoid wasp, *Habrobracon hebetor* (Braconidae), under laboratory conditions. The purpose was to assess the effects of using these insecticides in an integrated pest management programme where parasitoid wasps were also being used as biological control agents. Bioassay tests were carried out in an incubator at 26±1°C, R.H. 65±10% and photoperiod of 16:8 (L:D). Young female wasps were exposed to 1, 24, 48 and 72 hour old residues of sublethal concentrations of the insecticides. Both insecticide treatments caused significantly higher mortality in comparison to the control treatment. Results also suggested that both Match and Lufox produced similar levels of toxicity to wasps and there should be a lag time between application of insecticides and release of parasitic wasps.

IDENTIFYING PCR PRIMERS TO FACILITATE MOLECULAR PHYLOGENETICS IN CADDISFLIES (ORDER TRICHOPTERA).

Bonnie S. McCullagh, and Jeffrey M. Marcus. Department of Biological Sciences, University of Manitoba, Winnipeg, Manitoba, Canada R3M OP8.

Molecular phylogenetics of the caddisflies (Order: Trichoptera) has been hindered by the limited availability of degenerate PCR primers for nuclear genes. Many PCR primers have been developed for nuclear genes in butterflies and moths (Order: Lepidoptera), which are in the sister order to the caddisflies. We tested a large number of degenerate PCR primer pairs originally designed for use in the Lepidoptera for use in trichopteran systematics. Six species of caddisflies (*Agrypnia deflata* (Family Phryganeidae) and *Asynarchus nigriculus*, *Hesperophyllax occidentalis*, *Grammotaulius lorettae*, *Limnophilus externus*, and *Limnophilus picturatus* (Family: Limnephilidae)), comprising two families and five genera, were collected in Gunnison County, Colorado, USA and stored in 100% ethanol at -20 C. Ninety primer pairs were tested on DNA extracted from the preserved samples of these six species. Twenty-six primer pairs produced PCR products of the expected size and these products were sequenced. The sequence data were used to confirm gene identity of the amplified bands. Phylogenetic trees were reconstructed utilizing these sequence data. Relative rates of sequence evolution for these genes were estimated using these data to facilitate future phylogenetic work.

ABUNDANCE AND GEOGRAPHIC DISTRIBUTION OF *DERMACENTOR VARIABILIS* IN SOUTHERN MANITOBA.

Diana Dunlop, and Kateryn Rochon. Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Abundance and geographic distribution of *Dermacentor variabilis,* the American dog tick, were monitored in Manitoba using a standard sampling protocol. Twenty-one sites in Manitoba were actively sampled from 22 May to 25 June, for a total distance sampled of 46.2 km^2. The density of *D. variabilis* ranged from 0.32 - 69.70 ticks/100 m^2 at Birds Hill Provincial Park and Eriksdale, respectively. A total of 28 blacklegged ticks, *Ixodes scapularis*, was also found at five of the sites: Roseau River (18), Margaret (5), Richer (2), Zhoda (1) and St. Malo Provincial Park (2). The density of *I. scapularis* ranged from 0 – 0.83 ticks/100 m^2. We compared the geographic distribution of the sampled ticks from both species with the distribution of tick submissions to the Blacklegged Tick Passive Surveillance Programme. There were more submissions from large population centres regardless of actual tick distribution and abundance.

SUITABILITY OF COVER CROPS AS ALTERNATIVE HOSTS PLANTS OF *COPIDOSOMA BAKERI* (HYMENOPTERA: ENCYRTIDAE), POTENTIAL NATURAL ENEMIES OF CUTWORMS.

Wanigasekara, R.W.M.U.M., and Barbara J. Sharanowski. Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Cutworms (Noctuidae) cause economic damage to several Canadian agricultural crops. The egg-larval parasitoid, *Copidosoma bakeri* (Hymenoptera: Encyrtidae), is likely to be the most effective parasitoid for controlling cutworms. However, the prevalence of parasitism is often too low to reduce cutworms below economic levels. Providing additional resources for parasitoids through habitat management has been shown as an effective method to increase prevalence of parasitism in biocontrol agents. We examined the potential utility of several prospective cover crops as additional nutritional resources for *C. bakeri* to develop effective habitat management strategies. Based on flowering period and flower colour, several plants were chosen for testing, including: flax, oriental mustard, phacelia, chickling vetch, camelina, buckwheat, tillage radish, field pennycress and canola. All experiments were performed with both food-inexperienced (water fed) and food-experienced (honey fed) individuals. Food-inexperienced wasps were preferentially attracted to canola, camelina, mustard and buck wheat. These four plants were then used in dual choice tests which were carried out to study visual and olfactory preferences of *C. bakeri.* Food-inexperienced wasps were significantly attracted to yellow and demonstrated a significant preference for Brassicaceae flowers over camelina and buckwheat. However, food-experienced parasitoids showed no preference for colour or floral odour. We also demonstrated that female *C. bakeri* lived significantly longer on honey than on water alone and without food. Additionally, survival times of parasitoids on canola, camelina, mustard and buckwheat were similar to each other, but reduced relative to honey. Therefore, canola, camelina and mustard are not only attractive to *C. bakeri*, but also provide nutritional resources that improve lifespan. Future research will examine the effectiveness of these plant species for improving prevalence of parasitism of *C. bakeri* on cutworms in the field.

SMALL WASPS, BIG PROBLEMS: RESOLVING THE *PERISTENUS PALLIPES* SPECIES COMPLEX USING MOLECULAR TECHNIQUES.

Y. Miles Zhang, and Barbara J. Sharanowski. Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Species of *Peristenus* (Hymenoptera: Braconidae) are important biological control agents of plant bugs (Hemiptera: Miridae), in particular the large genus *Lygus*. The central problem associated with *Peristenus* taxonomy is the *Peristenus pallipes* species complex. Members of the *P. pallipes* complex are Holarctic in distribution, ranging from temperate to boreal regions. At least nine Nearctic species are currently recognized; however, they are often unidentifiable without detailed biological data. The species concepts of members of *P. pallipes* complex are tested using multilocus phylogenetic analysis, and the results will be discussed in comparison with previous results.

DISTRIBUTION AND MORTALITY OF *CRYPTOLESTES FERRUGINEUS* AND *RHYZOPERTHA DOMINICA* IN SMALL BIN TRIALS IN RESPONSE TO LOW TEMPERATURES.

A.Y. Abdelghany, and P.G. Fields. Cereal Research Centre, Agriculture and Agri-Food Canada, Winnipeg, Manitoba, Canada R3T 2M9.

We examined the effect of low temperatures on insect density and mortality of adult and immature stages of *Cryptolestes ferrugineus* and *Rhyzopertha dominica* in barrels (n=3) with 300 kg of wheat. Barrels were infested with two insects/species/kg and left to develop at 30°C for five months. The grain temperatures were recorded at 16 locations (10, 20, 29 and 47 cm from front edge, at four depths; 0, 40, 80 and 120 cm from the surface). Segregated (11 segments) grain tier samples were collected from three locations (10, 29 and 47 cm from front edge), from 11 February until 4 March 2013 (six dates), and the number of live and dead adults and emerged offspring (grain held for five weeks 30°C) were counted. Temperature of the grain mass before cooling was 38°C in the centre to a low of 28°C on the edges. On 11 February, the garage door was opened to cool the grain. During the three weeks of cooling, temperatures in the centre reached as low as -5°C.

Adult *R. dominica* were found mainly in the top 40 cm of the barrel. There was little movement to the centre as the grain mass cooled. The initial distribution of adult *C. ferrugineus* was more complex; in two barrels adults were mostly in the centre of the grain mass, while in the other barrel, more adults were found on the edges. When the grain mass cooled, adults in all barrels were mostly in the centre.

On day 0, the average numbers of live adults of *C. ferrugineus* and *R. dominica* were 232±56 and 414±48 insects/100 g, respectively. Adult *R. dominica* (all dead at 7 d) were more susceptible to low temperatures than *C. ferrugineus* (all dead at 21 d). On day 0, the average numbers of immatures of *C. ferrugineus* and *R. dominica* were 652±275 and 677±120 insects/100 g, respectively. After 21 days, average numbers of immatures of *C. ferrugineus* and *R. dominica* were 41±27 and 147±36 insects/100 g, respectively.

INSECTS ON CROPS IN MANITOBA IN 2013- AN EXTENSION UPDATE.

John Gavloski. Manitoba Agriculture, Food and Rural Initiatives, Box 1149, Carman, Manitoba, Canada R0G 0J0.

Grasshoppers were a concern in many crops this year, resulting in insecticides being applied to many fields and the edges of fields being treated to prevent them from moving into crops. Cutworms were also a concern in many crops in 2013. The known range of cereal leaf beetles (*Oulema melanopus*) in Manitoba has expanded to the southwest and central regions of Manitoba. Two releases of *Tetrastichus julis,* a parasitoid of the cereal leaf beetle, were done in the Treherne area. Flea beetles (*Phyllotreta* spp.) were a concern on canola in the spring and early-summer, in spite of most canola seed containing a neonicotinoid seed treatment for early season protection from flea beetles. There were high levels of bertha armyworm (*Mamestra configurata*) larvae in some areas, with most of the control for bertha armyworm being in the southwest. Feeding from larvae of alfalfa weevil (*Hypera postica*) caused a lot of damage in some alfalfa fields from mid-June through the first two weeks of July. A sample of *Drosophila* collected in Manitoba in August, 2013 was sent to the National Identification Service in Ottawa and confirmed to be spotted wing *Drosophila* (*Drosophila suzukii*). Annual summaries of insect pests in crops in Manitoba are posted at: http://www.gov.mb.ca/agriculture/crops/insects/index.html

IMPROVED INJECTION NEEDLES FACILITATE GERMLINE TRANSFORMATION OF THE BUCKEYE BUTTERFLY, *JUNONIA COENIA*.

Jeffrey M. Marcus. Department of Biological Sciences, University of Manitoba, Winnipeg, Manitoba, Canada R3M 0P8.

Germline transformation with transposon vectors is an important tool for insect molecular biology. Progress in developing transformation techniques for butterflies has been hindered by the diversity of butterfly species used as model organisms and the difficulty of adapting methods between species. Here we present an improved glass injection needle design for delivering transposon constructs to butterfly ova. The improved needle design exceeds or meets the survival to hatching rate of injected ova in three butterfly species compared to the needle design used in previous studies. Using the improved needles, we transformed the buckeye butterfly *Junonia coenia* with a *piggyBac* transposon vector carrying *EYFP* coding sequences controlled by the *3XP3* synthetic enhancer to drive expression in the eyes. A candidate line, identified by *EYFP* expression in adult eyes, was confirmed by PCR, and flanking DNA was amplified by inverse PCR and sequenced. The hatch rate for injected *Junonia* ova was 21.7%, the transformation rate was 3%, and the overall transformation efficiency was 0.327%. Improved needle design allowed for substantially increased hatch rates and transformation efficiency. This greater efficiency makes germline transformation a more practical experimental technique for use in butterfly species for which limited numbers of fertilized ova are available.

NOVEL INSIGHTS INTO SPLICESOMAL INTRON EVOLUTION FROM MULTIPLEINSECT LINEAGES.

Barbara J. Sharanowski[1], Michael Domaratzki[2], Leanne Peixoto[1], and Phillip Snarr[1]. [1]Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2; [2]Department of Computer Science, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

After more than thirty years of research on introns, we still have a sparse understanding of the evolutionary mechanisms that affect the number, length, and mutation rate in splicesomal introns. Theories on intron evolution have been tested by comparing the genomes of a few distantly related model organisms or by examining closely related species of *Drosophila*. In this study, we examine intron evolution across various lineages of insects by comparing patterns of intron gain and loss, intron phase, and how intron length and position affects genetic divergence. Patterns of intron evolution found in *Drosophila* spp. are not ubiquitous across insects. This study highlights the need to study multiple lineages of organisms with a mixture of distantly and closely related species to reveal generalized patterns that will facilitate the development of robust theories on intron evolution.

MÜLLERIAN MIMICRY IN RACES OF *HELICONIUS ERATO* AND *HELICONIUS MELPOMENE* (LEPIDOPTERA: NYMPHALIDAE).

A.F. Rios-Martinez[1], and M.G. BarajasGuzman[2]. [1]Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2; [2]Department of Ecology and Natural Resources, National Autonomous University of Mexico (UNAM), Mexico City, Mexico.

Müllerian mimicry systems consist of aposematic prey species with sympatric distributions that undergo a process of phenotypic convergence to augment the effectiveness of their warning colourations toward potential predators. With more than 45 distinct races involved in several and often geographically overlapping mimicry rings, the Neotropical lepidopterans, *Heliconius erato* and *H. melpomene*, are engaged in a mutualistic Müllerian mimicry system. It is difficult to get a clear understanding of the mimetic strategies that they follow, as well as the particular sets of races involved in them. To achieve this, we have proposed a method that yields a quantitative evaluation of the phenotypic similarities among the different warning colorations of these races by analyzing digital images of their wings patterns. In addition, we measured geographical distribution parameters to estimate the relations between these races in all their possible combinations. There was a clear statistical relationship between the amount of distributional area in sympatry and the level of phenotypic similarity between pairs of races. This suggests that, in the case of these two species, true mimetic functionality entails very strong phenotypic convergence, and inside a certain habitat, it may only be considered to happen between pairs of races with very high phenotypic similarity. On the other hand, the presence of similarly-looking but more clearly distinguishable wing-patterned races in the same habitat as races that share strong resemblance may be explained as the result of geographical overlapping of other independent mimicry rings.

PREDICTING ADULT EMERGENCE OF DAKOTA SKIPPER AND POWESHIEK SKIPPERLING IN CANADA.

A.R. Westwood[1], and K. Dearborn[2]. [1]Department of Biology, The University of Winnipeg, Winnipeg, Manitoba, R3B 2E9; [2]Department of Geography, Queen's University, Kingston, Ontario, Canada K7L 3N6.

The Dakota skipper (*Hesperia dacotae* Skinner) (Lepidoptera: Hesperiidae), is now considered to be at-risk of extinction due to habitat destruction; an incomplete understanding of key life history characteristics has affected the success of management activities in remnant habitats. The Poweshiek skipperling, *Oarisma poweshiek,* Parker (Lepidoptera: Hesperiidae), is an endemic tall grass prairie species listed as threatened under the Species At Risk Act in Canada. In Manitoba, Dakota skipper and Poweshiek skipperling occur in three distinct regions of the province. Adult populations of each species are intensely surveyed on an annual basis and the scattered nature of the population centres in Manitoba provide logistical and time sensitive challenges to ensure the flight period for each population is accurately surveyed and the adult population can be estimated correctly at peak emergence. An accurate method to predict annual adult emergence dates would facilitate the most economical use of survey resources and ensure each population census began before populations reached or were past peak abundance. After testing several day degree accumulation models we make recommendations when to implement adult surveys in Manitoba to ensure the most accurate census data is obtained.

BOTANICAL FACTORS AFFECTING SEED DAMAGE BY THE WHEAT MIDGE *SITODIPLOSIS MOSELLANA* (GEHIN) TO SPRING WHEAT WITH THE *SM1* R-GENE.

Ian Wise[1],Marjorie Smith[1], and Stephen Fox[2]. [1]Cereal Research Centre, Agriculture and Agri-Food Canada, Winnipeg, Manitoba, R3T 2M9; [2]DL Seeds, Inc., Winnipeg, Manitoba, Canada R3T 6C5.

The *Sm1* R-gene protects spring wheat against midge damage by deterring larvae from feeding on newly developing seed. However, damage to the seed may occur before feeding stops, and can vary by wheat ploidy, cultivar, and by the growth stage of the spike at the time of oviposition by the midge. Seed damage can differ in severity to individual seeds and in its frequency. Damaged resistant seeds usually are distorted dorsally and either have no or only slight discolouration. *Sm1* was derived from hexaploid winter wheat, and its insertion into spring hexaploid wheat has produced cultivars with less seed damage than advanced lines of tetraploid durum wheats. Resistance is also variable within spring wheat cultivars, with Shaw having the least amount of damage. The variability is not related to the pedigree of the *Sm1* winter wheat source. The response of the seed to larval feeding increases with the age of the seed when feeding is initiated.

WE ALWAYS KNEW CHEWING LICE (PHTHIRAPTERA: MENOPONIDAE, PHILOPTERIDAE) ON PIGEONS (*COLUMBA LIVIA*) WERE SPECIAL – ABUNDANCE AND STABILITY ARE SPECIES TRAITS FOR FOUR OF THEM.

Terry D. Galloway, and Robert J. Lamb. Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

Population parameters of chewing lice (Phthiraptera) on feral pigeons, *Columba livia*, were determined from 1995-2012 in southern Manitoba: Philopteridae - *Campanulotes compar*, *Columbicola columbae*, and *Coloceras tovornikae*; Menoponidae - *Hohorstiella lata.* We used the data to test the hypothesis that both abundance and population stability are species specific traits. The four species of lice had distinct population dynamics during a ten-year sample period. *Campanulotes compar* and *C. columbae* were more abundant than *C. tovornikae*; *H. lata,* had higher male to female sex ratios and higher ratios of nymphs to females, different levels of aggregation, and more stable populations. *Campanulotes compar* was more prevalent than *C. columbae* and its prevalence was more stable; levels and stabilities of male and nymph to female ratios were also different for these two species. *Coloceras tovornikae* had a higher prevalence and sex ratio than *H. lata*, but the two species levels of stability for these parameters were similar. The level of stability of these populations was relatively high compared with many other organisms, and particularly higher than for plant ectoparasites. Although the four species may occur on the same bird, and three of the four feed in a similar way, they each show characteristic population biology.

POSTERS

STUDY OF SOYBEAN BEE POLLINATORS IN MANITOBA.

Cherilyn Babel, Zoe Rempel, and Alejandro C. Costamagna. Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Bee pollinators of soybean were surveyed in two fields over a two year period. In both years, the bees were captured by using blue, yellow and white coloured bowls (n=10/colour/field/date) that were put out for a 24 h period once a week during the soybean flowering period. The soybean fields were located in Glenlea and Carman, Manitoba. A total of 284 bees was captured and identified to genus. Bees belonged to three families containing seven genera: Apidae - *Apis*, *Bombus*, *Melissodes*; Halictidae - *Halictus, Lasioglossum, Agapostemon*; Colletidae - *Hylaeus.* The most abundant native genera were *Melissodes*, *Halictus* and *Lasioglossum*. Separate non-parametric Kruskal-Wallis tests were used to compare the effects of year and colour for the three most abundant genera: *Melissodes*, *Halictus*, and *Lasioglossum*. More *Melissodes* were captured in blue bowls in 2012, but for 2013 and both years for the other genera, there was no significant colour preference. ANOVA on log transformed data showed that significantly more bees were captured in 2012 compared to 2013. Several native

bee pollinators used soybean flowers as a resource and their populations can be threatened by insecticide applications targeting other insects in soybean fields.

INVASION DYNAMICS OF *WOLBACHIA* BACTERIA IN POPULATIONS OF THE WASP, *TRICHOMALOPSIS SARCOPHAGAE* (PTEROMALIDAE).

K.D. Floate, and P.C. Coghlin. Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada TlJ 4B1.

Wolbachia are obligate intracellular bacteria that are common in insects. Infections are passed via egg cytoplasm from mothers to offspring and can alter host reproduction to facilitate the spread of the bacteria in the host population. Infections in the wasp *Trichomalopsis sarcophagae* (Hymenoptera: Pteromalidae) cause 100% cytoplasmic incompatibility (CI); *i.e*., crosses between infected males and uninfected females (♂^{w} x ♀) only produce male offspring. All other crosses (♂x ♀^{w}, ♂ x ♀, ♂^{w} x ♀^{w}) produce an F1 sex ratio of about 1.8♀: 1♂. To test predictions that CI would facilitate the spread of *Wolbachia* in host populations, we used tetracycline to establish a *Wolbachia*-free colony of the wasp. We then added infected individuals to otherwise uninfected colonies of *T. sarcophagae* with starting infection levels of 5, 10, 25 or 50% (three colonies per treatment (T)). Each generation, 15 wasps per colony were tested to assess infection prevalence. For T5, infections could not be detected in two colonies after 2 and 4 generations, but low level infections persisted in the third colony for at least 23 generations. For T50, T25 and T10, infections approached fixation after 5, 10 and 15 generations, respectively. These results identify an invasion threshold of 5–10 per cent in this system. Unexpectedly, however, 100% fixation was not attained in any colony even though this is the normal condition in field populations of the host. We speculate that tetracycline treatment to remove *Wolbachia* may have altered some other aspect of host biology that prevents fixation.

EFFECT OF ANTIBIOTICS ON *WOLBACHIA* INFECTIONS IN *TRIBOLIUM CONFUSUM* AND ON HOST REPRODUCTION.

Y.Y. Li[1,2], K.D. Floate[1], P.G. Fields[3], and B.P. Pang[2]. [1]Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada TlJ 4B1; [2]College of Agriculture, Inner Mongolia Agricultural University, Hohhot, Inner Mongolia, China; [3]Cereal Research Centre, Agriculture and Agri Food Canada, Winnipeg, Manitoba, Canada R3T 2M9.

Tribolium confusum (Coleoptera: Tenebrionidae) is a pest of stored grain products worldwide. Beetles carry infections of *Wolbachia* bacteria, which can affect their host's reproduction. Here we examine infections of *Wolbachia* bacteria in *T confusum* as a possible method to control this pest. Colonies of beetles treated with tetracycline (0.1 mg/g flour) and rifampicin (0.05 mg/g flour) were cured in 4 and 1 generation, respectively. These results correspond with findings of previous studies on this insect. To assess the effect of infection on the host, four types of crosses were performed: ♂^{w} x ♀^{w} , ♂ x ♀^{w}, ♂ x ♀, ♂^{w} x ♀. The incompatible

crosses occur when uninfected females (♀) mate with infected males (♂^{w}), cause egg mortality. Uninfected males (♂) were compatible with all females (♀^{w}, ♀) whether infected or not.

ALYSIINAE (HYMENOPTERA: BRACONIDAE) IN CANOLA IN MANITOBA: INCREASING OUR KNOWLEDGE ON PARASITOID BIODIVERSITY IN AGROECOSYSTEMS.

Whitney Lodge-Zaparnick[1], and Barbara J. Sharanowski[2]. [1]Department of Biological Sciences, [2]Department of Entomology, Winnipeg, Manitoba, Canada R3T 2N2.

Parasitoid wasps provide a natural means of biological control for pests in agricultural crops and therefore offer a sustainable method of control and an alternative to pesticides. However, we have limited knowledge on the species of parasitoids in agroecosystems and which species effectively attack and control crop pests in Manitoba. We focused on braconid (Hymenoptera) parasitoid wasps in canola, particularly in the subfamily Alysiinae. We discovered a high diversity of species of *Chorebus*, a genus known to attack grass flies (Chloropidae), rust flies (Psilidae), and leaf-mining flies (Agromyzidae). We discovered four morphospecies of *Chorebus,* which at minimum quadruples the number of species known in Manitoba and the Prairies Ecoregion. From examinations of original descriptions, North American species of *Chorebus* are in desperate need of revision. We present diagnoses and an identification key to the morphospecies of *Chorebus* found in canola to facilitate future biological control and taxonomic research. We highlight the need for taxonomic research on parasitoids found in agroecosystems, which would benefit both the fields of entomological taxonomy and integrated pest control management.

SYMPHYTA (HYMENOPTERA) OF NOPIMING PROVINCIAL PARK, MANITOBA.

Chalsie V.M. Warren[1, 2], and Barbara J. Sharanowski[1]. [1]Department of Biological Sciences, [2]Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

Sawflies and wood wasps (Symphyta: Hymenoptera) are herbivorous insects many of which are destructive forests pests. Despite this, little taxonomic work has been done on Symphyta in Manitoba and the distributions of most species are largely unknown. To examine the diversity of Symphyta in the Boreal Shield Ecozone, Malaise traps were set up in Nopiming Provincial Park from May to August in 2013. Specimens were identified to the lowest taxonomic level possible; however, there were few comprehensive taxonomic resources available for identification to species. A total of 15 different genera in five families were identified from the 57 specimens collected. The greatest diversity was in Tenthredinidae (89%), in particular Nematinae. This work expands the distributional knowledge of several species including: *Abia americana* (Cresson), *Xiphydria millipes* Harris, and *Cephalcia provancheri* (Huard). These three species have never been found in the Boreal Shield Ecozone in Manitoba. It is clear that further taxonomic and natural

history research needs to be completed on the sawflies and wood wasps of Manitoba.

OVERWINTERING SURVIVAL OF ADULT AMERICAN DOG TICK, *DERMACENTOR VARIABILIS*, IN A SECOND WINTER AT THE NORTHERN LIMIT OF ITS RANGE IN MANITOBA, CANADA.

Matthew E.M. Yunik[1], Terry D. Galloway[1], and L. Robbin Lindsay[1, 2]. [1]Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2; [2] National Microbiology Laboratory, Public Health Agency of Canada, Winnipeg, Manitoba, Canada R3E 3R2.

The American dog tick, *Dermacentor variabilis,* is a known vector of numerous pathogens of veterinary and medical importance. Manitoba, Canada, is at the northern limits of the tick's range. Here, unfed adult ticks can be found questing on vegetation shortly after snowmelt in April. Ticks that are unable to find a new host cease questing by mid-August. These unsuccessful ticks were assumed to be lost due to starvation or freezing during the following winter. In June 2013, 1700 unfed adult *D. variabilis* were collected from Sandy Hook, Manitoba. These ticks were separated into 34 groups of 50, 25 females and males, and deposited into outdoor terraria south of Winnipeg. These ticks were confined to the terraria and were exposed to the weather. Survival of the ticks was assessed in May 2013. We demonstrated that up to 20% of any adult tick cohort can survive a second winter under Manitoba's snow. This has implications for the northward range expansion demonstrated by the tick and the pathogens it carries. These ticks may also be serving as reservoirs of pathogenic agents, further complicating the epidemiology of tick-vectored diseases

The Entomological Society of Manitoba gratefully acknowledges the following organizations which provided financial support for the 69th Annual Meeting

Abell Pest Control

Bayer Cropscience Canada Co.

Canadian Centre for Mosquito Management

Canadian Grain Commission

Canola Council of Canada

City of Winnipeg Insect Control Branch

Dow Agro Sciences Canada, Inc.

Gilles Lambert Pest Control

Metro Pest Control

Monarch Pest Control

North South Consultants

Orkin PCO Services

Poulins Pest Control

Viceroy Distributors

The Entomological Society of Manitoba 69th Annual Business Meeting

2 November, 2013
Agriculture Canada Cereal Research Centre, Dafoe Road, University of Manitoba

Attendanc

President	Robert Lamb
Secretary	David Wade
President-elect	Robbin Lindsay
Regional Director to ESC	Kateryn Rochon
Proceedings Editor	Terry Galloway
Member-at-Large	Lara Toews
Treasurer	Ian Wise
Paul Fields	
Rob Currie	
John Gavloski	
Kim Stadnyk	
Alejandro Costamagna	
Erica Smith	
Jordan Bannerman	
Pat Mackay	
Marjorie Smith	
Noel White	
Richard Westwood	
Joel Gosselin	
Barry Konzelman	
Richard Westwood	
Robert Wrigley	
Kathy Cano	
Barb Sharanowski	
Lisa Capar	

Regrets
Desiree Vanderwel
Colin Demianyk

1 **Acceptance of Agenda**
Motion: Mackay/White – to accept the Agenda (Appendix A) .....Carried

2 **Acceptance of the Minutes of the Last Annual Business Meeting (13 October 2012)**

Motion: Smith/Currie – to accept previous Minutes of the 68th Business Meeting.....Carried

3 **Business Arising from the Minutes**
There was no business arising for the Minutes.

4 **Reports – Executive**
Motion: Currie/Mackay – to receive the reports.....Carried

Appendix B – President
Lamb listed off the major projects he was involved in on behalf of the Society for the past year. This included coordinating the digitization of the back issues of the Proceedings and Manitoba Entomologist.

Appendix C – Treasurer
Wise reviewed the financial statement for the year. The Society currently has $55,219 in assets. There was some general discussion about the financial statement from the Society members including renewing the next GIC for 4 years so a GIC comes due every year.

Appendix D – Regional Director to the ESC
Rochon reported on this year's ESC governing board meeting which was held in October in Guelph. Highlights of her report included the impact of the new Canada Non-Profit Corporations Act on the ESC and ESM, the unexpected shortfall in revenue from Cambridge University Press, the increase in ESC membership dues, and upcoming joint meetings. Rochon also brought up our need to find a chair for our 2017 joint meeting with ESC. Lindsay asked if the increase in fees offset the shortfall in revenue and Rochon said not entirely and that there would be other cuts. Fields asked if ESM falls under the new act and Rochon said no because we are registered provincially.

Appendix E – Editor of the *Proceedings*
Galloway reported that volume 68 (2012) was printed and distributed at this year's meeting but publication costs were not available yet. There were no scientific papers submitted and he again stressed he is looking for scientific papers and notes to publish in upcoming volumes of the *Proceedings* and noted there are no page charges.

Appendix F – Endowment Fund Board
Cano reported the principal stood at $44,000 at the time of the meeting.

5 **Reports – Committees**

Appendix G – Finance
Cano reported that we are still in good financial shape. There was general discussion about GICs, savings from internal audit, and charitable limits to savings.

Appendix H – Publicity/Newsletter
Smith reported that two issues were produced in the past year. She thanked those who submitted articles, especially Bob Wrigley and Todd Lawton. She also thanked Mahmood Iranpour for his five years as co-editor and that she

was looking for a new co-editor.

Appendix I – Social
Capar reported that the New Members Social was held on April 11th at the Pony Corral on Pembina with students getting discount rates. Lamb and Mackay gave a very interesting and informative presentation about their trip to the Amazon. Mackay thanked Capar for organizing the food and beverages for this year's meetings.

Appendix J – Youth Encouragement/Public Education
Nagalingam reported on this year's activities. She highlighted the loss of the stick insect colony and that they presented to over 1500 people. She also mentioned everyone who volunteered to assist with tours and presentations. There was some general discussion regarding how to increase the number of volunteers and choosing a new chair.

Appendix K – Archives
Sharanowski reported that there was no activity to report. Currie suggested adding CRC photos to archives.

Appendix L – Common Names
Sharanowski reported that there was no activity to report but there was a new wasp family discovered.

Appendix M – Scholarship and Awards
Westwood presented his report. The winners were as follows: Student Achievement – Zoe Rempel; Orkin award – Whitney Lodge-Zaparnick; ESM Graduate Scholarship – Alexandra Grossi; Student Paper Competition – Miles Zhang. Smith requested pictures be taken of the award presentations to include in the next issue of the newsletter.

Appendix N – Fundraising
Gosselin reported that $1500 was raised from 13 donors from September 2012 to August 2013.

Appendix O – Scientific Programme
Fields reported that there were 16 submitted papers, of which 9 were part of the student paper competition. There were also 4 submitted posters. Thanks were given to all the sponsors.

Appendix P – Membership
Presented by Currie. Membership is at 104, up from 103 last year.

Appendix Q – Web Page
Currie provided a summary of the status of the web site. The scanning of older Proceedings and Manitoba Entomologist has been completed with the help of Robert Lamb and his "helpers" and has been posted on the web site.

6 **Election Results**

President Elect ..... Richard Westwood
Member-at-Large ..... Lara Toews
Honorary Member ..... Joel Gosselin

Appendix R

Motion: Currie/Mackay – to destroy the ballots .....Carried

7 **New Business**

a) Savings from not having an external audit
There was discussion on what to do with the approximately $1000 savings from not having an external audit. Some suggestions included having separate speaker awards for graduate and undergraduate students, having an award for posters, or raising the values of the awards.

Motion: White/Sharanowski – Allow Awards Committee to decide and report back to the Executive Committee .....Carried

b) Cancelling the external audits
External audit costs over $1000 or 18% of expenditures. Consensus was to stop the external audit and conduct internal audits only. There was some discussion regarding concerns in years we have a joint meeting but everything should be fine as accounts are kept separate. We could do an audit in those years if necessary.

Motion: Lamb/Gosselin – The President, or designate of the Executive, will conduct an annual review of the finances of ESM, based on the financial records, receipts, and bank statements provided by the Treasurer .....Carried

c) Changing of the mailing address
With closing down of Cereal Research Centre, the Society needs a new mailing address. Discussion focused on using the University of Manitoba's Department of Entomology address. Currie was supportive but wondered how it would be distributed from there. Lamb decided to let the Executive Committee decide.

d) Need for chair for 2017 JAM
Need to prepare in advance for JAM in 2017. Some names were discussed as possibilities. Decision to be made by the Executive Committee in 2014.

8 **Moment of Silence for Deceased Members This Year**
There was a moment of silence for Bill Preston and Ranen Sinha who both passed away in 2013.

9 **Transfer of Office** – Robert Lamb to Robbin Lindsay

10 **Other Business** – None

11 **Adjournment** – 2:44 p.m.
Motion: Lindsay – to adjourn the meeting .....Carried

APPENDIX A

The Entomological Society of Manitoba, Inc.
Agenda of the Entomological Society of Manitoba
69th Annual Business Meeting
2 November, 2013

1. Acceptance of Agenda
2. Acceptance of the Minutes of the Last Annual Meeting (13 October 2012)
3. Business Arising from the Minutes
4. Reports – Executive
   President – Bob Lamb
   Treasurer – Ian Wise
   Regional Director to the ESC – Kateryn Rochon
   Editor of the *Proceedings* – Terry Galloway
   Endowment Fund Board – Kathy Cano
5. Reports – Committees
   Finance – Kathy Cano
   Publicity/Newsletter – Marjorie Smith
   Social – Lisa Capar
   Youth Encouragement/Public Education – Tharshi Nagalingam
   Archives – Barb Sharanowski
   Common Names – Barb Sharanowski
   Scholarship and Awards – Richard Westwood
   Fund-Raising – Joel Gosselin
   Scientific Programme – Paul Fields
   Membership – Désirée Vanderwel
   Web Page – Rob Currie
6. Election Results – Scrutineer, Colin Demianyk
7. New Business
8. Moment of Silence for Deceased Members This Year
9. Transfer of Office
10. Reappointment of Auditor
11. Other Business
12. Adjournment

APPENDIX B

Entomological Society of Manitoba
President's Report – Annual Business Meeting

I am pleased to report that the Society continues to thrive, as a result of the activities of our members. One member in particular should be acknowledged. Joel Gosselin was nominated by the Executive and ratified by the membership as the newest Honorary Member of the Society, for his many contributions over the years.

Besides the usual presidential duties, which I have to say are not very onerous, I undertook two projects on behalf of the Society. The main one was to coordinate the digitizing of back issues of the Proceedings and the Manitoba Entomologist for the ESM website. The process of producing a digitized version of our past publications is easy in theory: scan the document, and then use optical character reading software to make text searchable. In practice, the process was a little more challenging. We were dealing with a single copy of 1000's of pages of published in a variety of formats, from faded mimeograph pages stapled together, to tightly bound, book-like formats. Thanks tro Michelle Wetton and Gwen Band who spent many hours copying the documents, and to Rob Currie, Web Page coordinator, for uploading files to the ESM website. The work is now complete, and I invite you to have a look at the remarkable history of Manitoba entomology summarized in these digital "pages".

The second project was to find a way to reduce the cost of the outside financial review of our financial transactions. In 2012, the financial review cost $1008 or 18% of all our expenditures. I checked with a different accounting firm and they confirmed that the charge was reasonable, but they pointed out that some non-profit organizations do an internal review instead. So, I performed a review of the Treasurer's accounts, bank statement and receipts, and this review will be submitted for your consideration along with the Treasurer's report. My reading of the Bylaws suggests that we have leeway to use this approach, but this matter should come up for further discussion as part of the Treasurer's report.

Another matter that we should consider is the need for a Society mailing address. Currently the Executive and Committee chairs use their work addressed to receive Society correspondence, and this approach has worked fine. With the impending closure of the Cereal Research Station, our Newsletter Editor, Treasurer, and soon the Past-President will no longer have a work address. Should members in this position use their home address or should we establish a more permanent Society address for correspondence?

Thank you for the opportunity to serve as President, and thanks to all of you who participated in the activities of your Society in 2012–2013.

Bob Lamb, President
Entomological Society of Manitoba

APPENDIX C

THE ENTOMOLOGICAL SOCIETY OF MANITOBA INC.

Financial Statements
Year Ended August 31, 2013

Note: These Financial Statements have not been audited. The Accounts, Bank Statements and Receipts were provided by the Treasurer and reviewed by the President to prepare these summary financial statements.

President: Robert J. Lamb Date: 30 October 2013

Robert J Lamb

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
Statement of Financial Position
August 31, 2013

	2013	2012
ASSETS		
CURRENT		
Cash	$ 7,501	$ 8,513
Money market fund	3,718	3,698
	11,219	12,211
TERM DEPOSITS	$ 44,000	$ 42,280
	$ 55,219	$ 54,491
LIABILITIES		
CURRENT	$ NIL	$ NIL
NET ASSETS		
Unrestricted net assets	11,219	12,211
Internally restricted	44,000	42,280
	$ 55,219	$ 54,491

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
Statement of Financial Position
August 31, 2013

	2013	2012
REVENUES		
Annual meeting	$ 758	$ 775
Donations	1,500	1,700
Interest income	1,824	1,080
Membership fees	1,570	1,499
Miscellaneous	82	136
Proceedings	80	159
Youth encouragement & public education	250	575
	6,064	5,924
EXPENDITURES		
Awards and scholarships	1,300	1,500
Donations	-	900
General	1,629	1,079
Meetings	1,522	896
Newsletter	85	282
Proceedings	600	759
Social committee	200	163
Youth encouragement & public education	-	154
	5,336	5,733
EXCESS (DEFICIENCY) OF REVENUES OVER EXPENDITURES	$ 728	$ 191

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
Statement of Financial Position
August 31, 2013

	Unrestricted net assets	Internally restricted	2013	2012
NET ASSETS – BEGINNING OF YEAR	$ 12,211	$ 42,280	**$ 54,491**	$ 54,300
Excess of revenues over expenditures	728		**728**	191
Fund transfer	(1,720)	1,720	-	-
NET ASSETS – END OF YEAR	$ 11,219	$ 44,000	**$ 55,219**	$ 54,491

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
Statement of Financial Position
August 31, 2013

TERM DEPOSITS

Certificate Number	Interest Rate (%)	Purchase Date	Maturity Date	Par Value ($)	Interest, 2012 ($)
900055611-0011	3.85		9 Nov 2012		308.00*
960006276-0012	3.50		12 Dec 2012		900.18*
900055611-0012	3.00	5 Nov 2009	5 Nov 2014	8,000	240.00
900055611-0013	2.10	12 Dec 2010	16 Nov 2015	9,000	189.00
900055611-0014	1.85	16 Nov 2011	16 Nov 2016	9,000	166.50
900055611-0015	2.05	9 Nov 2012	9 Nov 2017	9,000	-
900055611-0016	2.10	12 Dec 2012	12 Dec 2019	9,000	-
			Total	**44,000**	**1,803.68**

*This GIC yielded $1180.18 in compounded interest over 5 years, of which $280 was declared internally restricted in 2011/12 and $720 was reinvested in 900055611-0016. 900055611-0011 plus $1000 was reinvested as 900055611-0015.

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
Statement of Financial Position
August 31, 2013

Memberships and Meeting Registrations

Membership: Regular - $25, Student - $10
Registration: Regular - $20, Student - $5, 1-day - $10

	Membership			Registration	
	Regular	Student	Life	Regular	Student
Number	57	21	6	34	22
Income ($)	1,425	210	-	650	110
Total	$1,569.82*			$758.47*	

*Note: Exchange rate on US$ checks reduced actual totals slightly, and members who made a donation are excluded.

APPENDIX D

Entomological Society of Manitoba
Report of the ESC Regional Director

The 150th Annual meeting of the Entomological Society of Canada was held in Guelph, Ontario October 20–23. Although I was not able to attend, all agree it was a great success. Brent Elliott kindly accepted to deliver my report at the ESC Governing Board meeting.

The new ESC President is Rebecca Hallett.

New Business:
- New Canada Non-Profit Corporations Act
There are many new rules the Society must adhere to, and this means some changes to the by-laws to insure compliance. Garry Gibson and Bill Riel have been working very hard and going a tremendous job of going through the bylaws to satisfy the conditions.

There is a change that affects the Regional Societies, but it is mainly a procedural change. All Directors of the ESC must be elected by the membership. This means the Regional Director for Manitoba must be elected by the entire ESC membership, not the ESM membership. The way this will be handled is that Regional Societies will vote in their Directors as usual, and that single name will be put on the ballot for an ESC membership vote.

- Unexpected shortfall in revenue from Cambridge University Press
Earlier this year Cambridge University Press (CUP) re-forecasted royalties for 2013 and 2014 and the drastic decrease in expected revenue from CUP has put the Society in the position of having to continue operations with approximately $30K– $40K per year less than anticipated. For 2013, CUP has agreed to pay the guaranteed revenue portion of the royalties as per the forecast presented in the original contract.

- Membership dues to increase
Membership dues will increase for the first time since 1989. They will go up from $80 to $100.
The proposal to create an "Early Career" membership category remains under review.

- Upcoming joint meetings
Discussions about the 2016 meeting to be held in conjunction with the International Congress of Entomology in Orlando, Florida. Recommending joint scientific sessions with separate business meetings held prior to the ICE meeting.

There are also discussions about a joint meeting with the ESA in 2018, when the ESC will be held in Vancouver. The proposal is now with the ESBC for a membership vote.

Next meeting in Saskatoon (Sept. 28–Oct.1) – see you there!

Kateryn Rochon
Regional Director

APPENDIX E

Entomological Society of Manitoba
Report of the *Proceedings* Editor

Volume 68 (2012) of the *Proceedings* of the Entomological Society of Manitoba was sent to Warren Schuetz and his staff in The University of Winnipeg print shop in September, and was available for distribution to the ESM membership in time for the Annual General Meeting. Volume 68 consists of 54 pages, with one submitted manuscript, the abstracts from the Annual Meeting of the Entomological Society of Manitoba held at the Freshwater Institute and the Department of Entomology on 12–13 October, 2012, and the Minutes of the 68th Annual Business Meeting of the Entomological Society of Manitoba held on 13 October in Room 219, Animal Science/ Entomology Building. Bound copies of the *Proceedings* were printed and available just this week, so I don't know the total cost yet. I shall present the bottom line to the ESM Executive at its next meeting. Warren and his staff, as always, made production of the Proceedings as simple and easy as possible. I also thank Carol Galloway for her keen eye and assistance in proof-reading the various drafts of the Proceedings.

There were no scientific papers submitted for publication in the Proceedings in 2012-13. Thanks to Bob Lamb *et al*. for submitting their history of the Cereal Research Centre. This manuscript was accepted with permission from the Editor of the ESC Bulletin, where it was published in the fall of 2013. It seemed eloquently fitting to have this manuscript also published in the *Proceedings*, given the closure of the research station scheduled for 2014, and the programme features for the Annual Meeting of the ESM in 2013. If you have a manuscript of relevance to entomology in Manitoba, I encourage you to consider submitting it to the *Proceedings*. Scientific Notes as well as full Scientific Papers are welcome. I think the *Proceedings* is an excellent place to publish new distribution records and faunal lists for insects and related arthropods in Manitoba. All submitted manuscripts are peer-reviewed; all published papers are available as PDF reprints on the web. Rob Currie has posted Volume 68 on the ESM website; thanks very much to Rob who posts the *Proceedings* so efficiently. The Proceedings are fully accessible using on-line search engines. There are no page charges to authors for published manuscripts of reasonable length. The Proceedings are freely available to entomologists around the world, so your papers can be accessed easily with the touch of a button.

Proceedings Editor
Terry Galloway

APPENDIX F

ENTOMOLOGICAL SOCIETY OF MANITOBA
Report of the Endowment Fund Board for 2012-2013

A summary of investments and projected interest income for the fiscal year is attached (Table 1). Interest generated by the Endowment Fund provides a basis for funding the publication of the Proceedings and other Society activities. The Endowment Fund principal was $44,000 as of August 31, 2013.

GIC#' 900055611-0011 matured on Nov 9, 2012 (interest 308.00) and GIC# 960006276-0012 matured on Dec 12 2012 (interest 900.18). GIC # 960006276-0012 yielded 1180.18 in compounded interest over 5 years, of which 280.00 was declared internally restricted in 2011/2012 and 720.00 was reinvested in GIC# 900055611-0016.
GIC# 900055611-0011 + $1,000 was reinvested as GIC# 900055611-0015.

Kathy Cano, Chair
Ian Wise
Bob Lamb

Endowment Fund Guaranteed Investment Certificates

Table 1: Account information as of August 31, 2013. Interest generated during the 2012-2013 fiscal year.

Certificate No.	Principal	Interest Rate (%)	Maturity Date (Purchase Date)	Annual Interest
900055611-0012	8,000.00	3.00	Nov. 5, 2014 (Nov 5, 2009)	240.00
900055611-0013	9,000.00	2.10	Nov 16, 2015 (Dec 12 2010)	189.00
900055611-0014	9,000.00	2.10	Nov 16, 2016 (Nov 16 , 2011)	166.50
900055611-0015	9,000.00	2.05	Nov 9, 2017 (Nov 9 2012)	-
900055611-0016	9,000.00	2.10	Dec 12, 2019 (Dec 12 2012)	-
Total	**$44,000.00**			**$1,803.68**

APPENDIX G

ENTOMOLOGICAL SOCIETY OF MANITOBA
Report of the Finance Committee for 2012-2013

The financial statement and the budgets for the current and next fiscal years are attached. The Society continues to be in good financial shape.

Kathy Cano, Chair
Ian Wise
Bob Lamb

ENTOMOLOGICAL SOCIETY OF MANITOBA

Income and expenses for fiscal year endin 31 August.

BUDGET ITEMS	**2011-2012**	**2012-2013**	**2013-2014**	**2014-2015**
REVISED 31 August 2013	**Actual**	**Actual**	**Actual and Projected**	**Projected**
ASSETS				
Cash	8,513	7,501	7,500	7,500
Money Market fund	3,698	3,718	3,500	3,500
TOTAL (Cash + Money Market Fund)	12,211	11,219	11,000	11,000
Term Deposits (Endowment fund)	42,280	44,000	44,000	45,000
NET ASSETS (Cash+ Money Market fund + Term Deposits)	**54,491**	**55,219**	**55,000**	**56,000**
REVENUE				
Membership Fees	1,499	1,570	1,500	1,500
Proceedings	159	80	100	100
Social Committee	0	0	0	0
Youth Encouragement & Public Education Committee	575	250	500	500
Donations	1,700	1,500	1,600	1,600
Meetings: ESM/AGM	775	758	800	800
Interest income:	1,080	1,824	1,100	1,100
Miscellaneous	136	82	500	500
TOTALS	**5,924**	**6,064**	**6,100**	**6,100**
EXPENSES				
General Society Expenses	1,079	1,629	1,000	1,000
Proceedings	759	600	500	500
Newsletter	282	85	100	100
Social Committee	163	200	200	200
Youth Encouragement & Public Education Committee	154	200	200	200
Fundraising Committee	0	0	0	0
Student Awards and Scholarships	1,500	1,300	1,500	1,500
Meetings: ESM/AGM	896	1,522	1,700	1,700
Donations	900	0	0	0
Representation at ESC	0	0	600	600
TOTALS	**5,733**	**5,336**	**5,800**	**5,800**
Net gain (loss), year ending Aug. 31	**191**	**728**	**300**	**300**

APPENDIX H

Entomological Society of Manitoba
Report of the Newsletter Committee

The Newsletter Committee produced two issues of the ESM Newsletter in the past fiscal year, published as a combined Volume 39, Issues 2 and 3, and distributed in May 2013. The cost was $85.24 for 11 pages, and was distributed along with the Proceedings. Mailing costs were covered by the Editor of the Proceedings.

Thank you to those members who have contributed articles to the Newsletter, in particular to Bob Wrigley and Todd Lawton who have been regular contributors to the Newsletter over the past few years.

Mahmood Iranpour resigned as co-editor with the completion of Volume 39. Thank you to Mahmood for five years of service to the Committee. The co-editor position is currently vacant. If anyone is interested in volunteering for the position, please let Marjorie Smith know.

Marjorie Smith
Mahmood Iranpour
Co-Editors, ESM Newsletter Committee

APPENDIX I

Entomological Society of Manitoba
Report of the Social Committee

On April 11th, we had our New Members Social at the Pony Coral on Pembina. Pat and Bob spoke about their trip to the Amazon in their talk, “In Amazonia: Bugs, Beasts, and River Boats". During Their presentation Pat and Bob showed us several amazing slides of trip down the Amazon River. Thank you Pat and Bob for the interesting and informative presentation. If anyone is interested in speaking at one of our social events, we would be pleased to have you present your research; you can contact me or another committee member for more information.

Discounts were given to students attending this year’s New Members Social.

Lisa Capar
Chair, Social Committee

APPENDIX J

Entomological Society of Manitoba
Youth Encouragement and Public Education Committee

This programme has been disseminating entomological knowledge to kids, teenagers and young adults in Manitoba. Our usual activities of the programmes are to have presentations on insects followed by a display of live and pinned insects. Our live insect display attracts most of the audience. Unfortunately for this year we lost our stick insect colony and we mostly used Madagascar hissing cockroaches and Brazilian cockroaches in the presentations. In 2013, the programmes were either conducted in the public schools, or schools visits to the Department of Entomology. Also we worked together with University of Manitoba, Faculty of Agricultural and Food Sciences information office and Farm and Field Research Station, Glenlea and thereby we were able to reach more number of audiences during a short time period. Some schools borrowed our insect collections to use in their class during this year.

Over 1500 persons were able to enjoy our presentations in year 2013. Compared to the other years the number of presentations we did was less due to the unavailability of most of our student volunteers consequently we stopped accepting requests from daycares. We were helped by a number of staff members and student volunteers for the presentations or to take care of live insects. Following volunteers helped us to run the program during this year. Tharshi Nagalingam, Lars Andreasson, Alexandra Grossi, Cherilyn Babel, Melanie Scallion, Witney Lodge-Zaparnick, Kateryn Rochon, Diana Dunlop, Miles Zhang and Chalsie Warren, John Gavloski, Lishani Sri and Nelson. We had a positive evaluation for all of our presentations and we received $200 grant from ESC.

Tharshi Nagalingam
Chair, Youth Encouragement & Public Education Committee

APPENDIX K

Entomological Society of Manitoba
Report of the Archivist

No activity to report.

Barb Sharanowski
Archivist

APPENDIX L

Entomological Society of Manitoba
Report of the Common Names Committee

No activity to report.

Barb Sharanowski

APPENDIX M

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 of the Entomological Society of Manitoba Student Achievement award is Ms. Zoe Rempel. Zoe has developed a diverse experience in entomology having worked on parasites of birds, stored product pests, pests in agricultural systems and parasites in bees for a variety of faculty at the University of Manitoba. Zoe is currently working towards a minor in Entomology and has taken a significant proportion of the courses offered in the Entomology Department. She has excellent grades and received an NSERC Undergraduate Research Award to work in the Entomology Department in 2011 and 2012. Zoe has proved to be an independent worker and has excellent potential as a scientist.

Orkin 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 of the 2011 Orkin award is Ms. Whitney Lodge-Zaparnick. Whitney has been a teaching assistant for entomology courses at the University of Manitoba and has worked in the Dept. of Entomology on parasitoid taxonomy and biological control of insect pests. Whitney is an excellent student with a high GPA and received an NSERC Undergraduate Research Award in 2012. Whitney has worked on the Bugline insect identification service and has volunteered to provide entomology demonstrations to school aged children.

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 year's winner is Ms. Alexandra Grossi. Alexandra is enrolled as a M.Sc. candidate in the Department of Entomology at the University of Manitoba and is being supervised by Dr. T. Galloway. Alexandra received her B.Sc. in Forensic Entomology from Trent University in 2009. Alexandra's M.Sc. research quantifies the infestation parameters of chewing lice on Canada geese and mallards, including prevalence, mean intensity, sex ratio and seasonal population fluctuations. Alexandra already has one publication accepted from her research project and expects to continue her education by enrolling in a Ph.D. program at the University of Alberta.

Désirée Vanderwel
Joel Gosselin
Richard Westwood, Chair

APPENDIX N

Entomological Society of Manitoba
Fundraising Committee

The Fundraising Committee raised a total of $1,500 from 13 donors to cover some of the costs of the AGM, such as bringing in the speakers from out of town. The Fundraising Committee acknowledges the continued support of our sponsors in making the AGM successful in providing quality speakers for this very educational event. The Fundraising Committee would appreciate leads from its members for parties who are using the valuable services that entomologists provide, so the Committee could solicit them for financial support.

Joel Gosselin,
Chair, Fundraising Committee

APPENDIX O

Entomological Society of Manitoba
Report of the Scientific Programme Committee

The 69th Annual Meeting Entomological Society of Manitoba was held in Winnipeg MB at the Freshwater Institute, Fisheries and Oceans Canada on 1 November 2013 and at the Cereal Research Centre, Agriculture and Agri-Food Canada on 2 November 2013. The theme of the meeting was "Entomology at the Cereal Research Centre: Past, Present and Future" in honour of the closing the Winnipeg location of the Cereal Research Centre.

The invited speakers were:

Introductory Speaker
Bob Lamb, Emeritus Research Scientist, AAFC Winnipeg
History of entomology at the Cereal Research Centre

Keynote Speaker
Curt McCartney, Research Scientist, AAFC Winnipeg
Genomics of wheat midge resistance

Saturday Symposium:
Noel White, Research Scientist, AAFC Winnipeg, Manitoba
Pests of stored grain and food products: Detection and control

Wayne (Xingwei) Hou, PMRA, Ottawa, Ontario
Pollinators and pesticides

Kevin Floate, Research Scientist, AAFC Lethbridge, Alberta
DNA barcoding of insects

Marjorie Smith, Retired Biologist, AAFC Winnipeg, Manitoba
Wheat midge in Western Canada: A multidisciplinary approach to pest management

There was a full programme with: 1 keynote talk, 4 symposium papers, 7 submitted oral papers, 4 submitted posters, 9 student oral papers. The meeting organizers thank our generous sponsors for their support; Abell Pest Control Inc, Bayer Cropscience Canada Co., Canadian Centre for Mosquito Management, Canadian Grain Commission, Canola Council of Canada, City of Winnipeg Insect Control Branch, Dow Agro Sciences Canada Inc., Gilles Lambert Pest Control, Metro Pest Control, Monarch Pest Control, Orkin PCO Services, Poulins Pest Control and Viceroy Distributors.

As in other years, the ESM Annual General Meeting was held after the symposium on the Saturday and the mixer was held at Pat McKay and Bob Lamb's house on the Saturday evening.

Chair: Paul Fields
Member: Bob Lamb
Social: Lisa Caspar
Registration: Ian Wise
Past Chair: Terry Galloway
Fund Raising: Joel Gosselin
Venue: Cheryl Podemski

APPENDIX P

Entomological Society of Manitoba
Report of the ESM Membership Committee

There are currently 104 members in the ESM, compared to 103 last year. I would like to thank Ian Wise (Treasurer) for his careful record keeping of the membership.

Désirée Vanderwel
Chair, Membership Committee

APPENDIX Q

Entomological Society of Manitoba
Web Site Report

The Entomological Society of Manitoba operates a website that is currently hosted through the public access portion of Paul Field's personal University of Manitoba web page. The website contains information about the Society and its committees, dates of meetings, programmes for meetings, and provides links to other sources of entomological resources on the web. Other suggestions for content are welcome.

The website contains archival copies of the newsletter and *Proceedings*. These are typically posted shortly after (or before) they are released to the membership. PDF-reprints of papers that have been published in the *Proceedings* are available on the site and papers from back issues are posted for years dating back as far as 1989. Bob Lamb arranged for scanning all remaining versions of the proceedings and Manitoba Entomologist and these have been posted on proceedings page on the website. These papers are picked up by many search engines and thus provide a wide exposure for the published research. Thanks to Bob and his "helpers" for taking the initiative to complete this important task

Any suggestions for additions or changes to the website should be forwarded to Rob Currie, Dept. of Entomology, University of Manitoba (rob_currie@UManitoba.ca).

Rob Currie

APPENDIX R

Entomological Society of Manitoba
Election Report 2011-2012

Elections closed September 30, 2013 for the Entomological Society of Manitoba offices of President-elect, Member-at-Large and Regional Director. The successful candidate for President-Elect is Richard Westwood, for Member-at-Large is Lara Toews, and for Honourary Member is Joel Gosselin. We thank all candidates for their willingness to participate in the election. Formal announcement and commencement of terms will be at and after the ESM Annual Business Meeting, respectively.

Colin Demianyk, Chair, Scrutineer Committee
Noel White, Witness