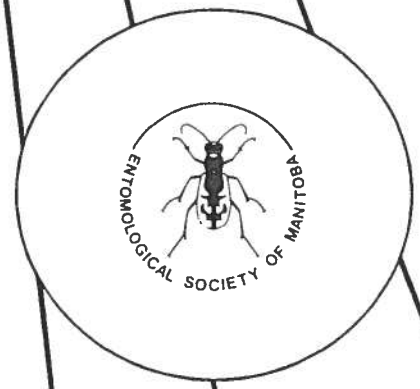
Proceedings *of the* Entomological Society of Manitoba



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CONTENTS

SUBMITTED PAPER ABSTRACTS:

CONSTANT-TEMPERATURE DEVELOPMENT RATES OF PRE-IMAGINAL COLORADO POTATO BEETLES (*Leptinotarsa decemlineata* (SAY), COLEOPTERA: CHRYSOMELIDAE) FROM MANITOBA AND BRITISH COLUMBIA

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ABSTRACT

Colorado potato beetle eggs and larvae from Winnipeg, Manitoba (49° 54' N, 97° 9' W) (two collections), and Winfield, British Columbia (50° 02' N, 119° 24'W) were reared at a range of constant temperatures. In all stages, development was fastest between 29 and 31° C. Developmental responses to temperature did not differ significantly among the three collections. Developmental rates of larvae in the present study are similar to those in the literature, but egg development was faster at low temperatures and increased more slowly with temperature than did published values. However, if the experiment-wise error rate is protected at 0.05, none of the comparisons is significant.

INTRODUCTION

To construct a predictive model of Colorado potato beetle population trends under field conditions, the relationship of developmental rate to temperature must be quantified. Although several groups of researchers have measured Colorado potato beetle developmental rates under constant conditions, the study was repeated here because developmental rates may vary among populations of different geographic origins (Tauber *et al.* 1988) and because specimens used in the present trials were collected ca. 7° latitude (ca. 800km) north of those tested in the other trials (Walgenbach and Wyman 1984, Wisconsin; Ferro *et al.* 1985, Massachusetts; Logan *et al.* 1985 and Groden and Casagrande 1986, Rhode Island; and Tauber *et al.* 1988, coastal and inland New York state).

METHODS

All trials were conducted in environmental chambers during fall and winter 1990 and 1991 at the University of Manitoba (Winnipeg), under a 14L:10D diel cycle. The following rearing procedures were the same in all trials. Adult Colorado potato beetles were reared in transparent plastic boxes (10 x 10 x 30cm), with moistened paper towels and excised 'Russet Burbank' potato foliage *ad libitum*. Eggs and the first, second and third instars were reared in 10cm x 1.5cm plastic petri dishes with fresh excised potato leaflets and moist paper towel. Fourth instars were reared in 20 cm diameter x 3 cm petri dishes with fresh excised potato leaflets and a 2-cm layer of moistened perlite as a pupation medium. Leaflets in petri dishes were replaced at least daily and the paper towels or perlite were kept moist with distilled water.

To obtain egg masses, boxes with adults were established at the desired rearing temperature and inspected twice daily. Egg masses produced in known intervals were collected and placed in petri dishes. Eggs were considered individuals; this is distinct from Logan *et al.* (1985), who assigned this status to egg masses.

Petri dishes with eggs or larvae were inspected at least once each day. Dates and times of inspection ($\pm$ 15 min) were recorded for each dish. The number of eggs or larvae hatched, moulted, dead, or unchanged, was noted at each inspection. The fourth instar was considered to end when larvae entered the soil; the subterranean non-feeding 'prepupal' stage (*sensu* Groden and Casagrande 1986) was disregarded. At each temperature and instar, rearing groups were assembled from larvae which hatched or moulted in the same interval.

Adult beetles were collected near Winnipeg, Manitoba, Canada, (49° 54' N, 97° 9' W) in the spring of 1990 and 1991, and Winfield, British Columbia, Canada (50° 02' N, 119° 24' W) in the spring of 1992. The three lineages descending from the collections taken from these two founder populations will be called isolates.

In all isolates, adults of the first filial generation (F1) produced the larvae used in the trials. F1 adults from both Winnipeg isolates were maintained in diapause at 5° C until required. Diapausing F1 adults were transported from Winfield to Winnipeg in soil in a cooler with ice, in October 1991. In each isolate, 20 to 30 adults provided the eggs used; sex ratios of these samples, and the relative contributions by the individuals, are not known.

Developmental rates were measured for eggs and all larval instars of each isolate. Some methods varied among years. In 1990 only the Manitoba isolate was tested. Rearing temperatures were 17°, 21°, 25°, and 29° C.

Time limitation precluded following individuals from egg to pupation. Consequently, a stock colony was reared at 29° C in plastic boxes of the type used to rear adults, and used to supply larvae of the desired instar as follows.

First instar larvae all originated in the 29° C chamber. Egg masses at 29° C were inspected twice daily; larvae which hatched in a given interval were assigned randomly into groups of 10 - 15, and each group was assigned randomly to a nominal rearing temperature.

Data obtained for the first instar appeared anomalous, even after adjusting for time spent in 29° C, and were disregarded.

The supply of other instars at each rearing temperature was obtained by transferring larvae of the previous instar from the stock colony into the rearing temperature, and rearing these to the desired instar before initiating rate measurement. The interval from transfer to moult into the desired instar always exceeded 24 h.

In 1991 both the Manitoba and British Columbia isolates were tested. Rearing temperatures were 17°, 21°, 24°, 27°, 29°, 31° and 33° C. Colorado potato beetles reared at temperatures ≥ 24° were inspected twice daily.

In 1991, larvae remained at the same temperature throughout their lives wherever possible. Exceptions occurred at 31° and 33° C, due to high mortality rates; replacement larvae of a particular instar were obtained by moving larvae of the preceding instar from 29° C into the nominal rearing temperature and awaiting moult to the desired instar.

ANALYSIS

Only surviving larvae were included in the analysis. Egg or instar developmental time (the stadium, in days) was estimated to be from the midpoint of the two inspections bracketing oviposition or moult into the instar, to the midpoint of the two inspections bracketing moult into the next instar (Logan *et al.* 1985). Developmental rate was calculated for each larva as the reciprocal of the stadium.

Temperature-dependence of developmental rates was modelled using equation (1) (Logan *et al.* 1976).

$$r_j(T) = \Psi\left[e^{\rho T} - e^{\left(\rho T_{max} - \frac{(T_{max}-T)}{\Delta}\right)}\right] \quad (1)$$

Where T is ° C above some arbitrary base temperature, usually the lowest used in the trial (in this trial, 17°); $r_j(T)$, constrained to be non-negative, is the developmental rate for life stage **j** at temperature T; T_{max} is the upper temperature at which development ceases; Ψ may be a basal developmental rate, usually calculated at the lowest rearing temperature; ρ "can be interpreted as a composite Q_{10} for critical enzyme-catalysed, biochemical reactions" (Logan *et al.* 1976, p. 1134); and Δ measures the upper temperature range in which developmental rate diminishes. Parameters were estimated using iterative nonlinear regression (PROC NLIN, DUD algorithm; SAS Institute 1988).

Development functions for each instar obtained in the present study were compared to a literature data set consisting of pooled results from five studies of Colorado potato beetle developmental rate (Walgenbach and Wyman 1984; Logan *et al.* 1985; Ferro *et al.* 1985; Groden and Casagrande 1986 [only beetles reared on *Solanum tuberosum*]; Tauber

et al. 1988). Alone among these groups of authors, Tauber *et al.* (1988) included the subterranean prepupal stage in the fourth instar; because of this difference in method, their fourth-instar data are not included in the following comparisons.

Direct comparison of parameter estimates by t-tests, is invalid for two reasons. First, PROC NLIN merely finds a best fitting curve; where parameter estimates are strongly correlated (as in the present case), a change in the estimate of one parameter can be compensated by a change in that of one or more others, with no apparent change to the curve. The parameters estimates combine to provide a good fit to the data, but they are not necessarily the best estimates of the parameters. The second reason is that the standard errors produced by PROC NLIN are only approximate. For these reasons, conclusions based on direct comparison of parameter estimates are of limited merit. Direct comparison of trends is more appropriate.

Therefore, analysis of covariance (ACOVA) was used in statistical comparison of data sets. ACOVA requires that the functions compared be linear, but the developmental rate function (above) is nonlinear and apparently cannot be converted to a linear form, so the analyses considered data only from the approximately linear portion of the curve ($\leq$ 29° C).

RESULTS AND DISCUSSION

Developmental rates and standard errors from the present study are plotted in Fig. 1. The model used to describe these relationships between temperature and developmental rate (Logan *et al.* 1976) is composed of two components, which sum to give the overall response. All data contribute to the estimation of both components, and therefore the descending portion of the response can be estimated even in the absence of data in this region. The extrapolated sections of the curves are drawn to facilitate comparison with the literature data, but should be interpreted cautiously.

ACOVA on the linear portions of the developmental rate curves revealed no difference in slope ($F_{2,9} < 0.7$, $p > 0.05$) or intercept ($F_{2,9} < 1$, $p > 0.05$) among isolates in any instar, so data are pooled for analysis. Parameter estimates of the fitted models for the pooled data from the present study, and from the literature, are listed in Table 1. The estimate of the parameter Ψ depends on the basal temperature chosen; to simplify comparison among data sets, this temperature has been standardized at 17° C in the table.

At 31° C, eggs and first instar larvae survived better than did later instars; this trend accounts for the diminution of sample sizes with age at this temperature (Table 2). At 33° C, all larvae ($n \approx 15$ per temperature) died within 1 - 2 days and none moulted. This is a noticeable departure from the results of Logan *et al.* (1985), Ferro *et al.* (1985) and Groden and Casagrande (1986) who were able to measure larval development at 33° C, although survival was poor in all cases.

Comparison among data sets.

The developmental rate models as fitted to the present data are compared to data from the literature in Fig. 2. Response functions from the present trial, and the pooled literature data were compared by analysis of covariance on the linear portions of the data. Among larvae there was no significant difference in slope ($F_{1,21} < 0.9$, $p > 0.05$) or intercept ($F_{1,21} < 1.19$, $p > 0.05$) between the responses in any instar.

Among the eggs, the intercept and slope calculated from the present data were significantly lower ($F_{1,21} = 7.44$, $p < 0.05$), and higher ($F_{1,21} = 7.30$, $p < 0.05$) respectively, than those describing the data from the literature review. Hence, development of eggs used in the present trial was slower at low temperatures, and increased more rapidly with temperature, than did the pooled literature values.

However, using a comparison-wise $\alpha_c = 0.05$, the occurrence of one significant difference among five independent comparisons is similar to the expected experiment-wise error rate (α_e) of 0.22 (Sidak 1967). If α_e is protected at 0.05 by adjusting α_c to 0.01, none of the comparisons among data sets is significant. An ACOVA which simultaneously compared all temperature responses, with origin (CANADA vs. US) as a primary covariate, and origin nested within instar, as a secondary covariates, also failed to detect significant difference in trends between the isolates tested here, and the pooled literature data ($p >> 0.05$).

Results at $T \leq 29°C$ corroborate those of Tauber *et al.* (1988), who detected no significant difference in developmental rate curves between two populations of Colorado potato beetles from New York state. Observed (non-significant) variation among populations may simply derive from differences in experimental apparatus or procedure; difficulty in specifying the moment of ecdysis is a particularly important source of error.

At temperatures $> 29°C$, the extrapolated sections of the developmental rate curves for eggs, and instars 1 and 3, appear to fall below the published data. This may suggest a difference in response at these temperatures, but interpretation of this observation is not possible because of uncertainty about the accuracy of the extrapolated curve.

One possible explanation of the similarity in thermal response among these geographically separated Colorado potato beetle populations is that the thermal physiology in this species is relatively 'static' (Hertz *et al.* 1983) owing to lack of requisite genetic variance, or to resistance to directional selection. "Development" is a process involving the coordinated action of numerous enzymes; conceivably, a change in organismal thermal response might require substantial rearrangement to this coordinated system, with interim reduction in fitness (Ushakov 1964). If this is the case, such changes would meet selective resistance. Alternative methods of ameliorating suboptimal conditions would be more likely to spread through the gene pool; behavioral adjustments, such as changes in timing of activity, or in intensity of basking, are some of the possibilities (van Damme *et al.* 1990).

Alternatively, even if selection does act directly on thermal physiology, the advantageous traits may be initially so uncommon in the populations that their spread is

impeded by the rarity of chance meetings between bearers of the trait (Wright 1932), or by dilution by immigrant genetic material. Adaptation is expected to occur most rapidly in small, isolated populations under strong selective forces (Wright 1968). Because Colorado potato beetles often occur in great numbers, and disperse relatively well as adults (Johnson 1969), extensive gene flow among populations occurs (Hsiao 1985). Hence, lack of local adaptation in thermal physiology is not unexpected.

ACKNOWLEDGEMENTS

We thank D. Holder for technical assistance and D. Murphy for statistical advice.

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Table 1. Parameter estimates from nonlinear regression of developmental rates of Colorado potato beetle eggs and larvae on constant temperature. Model used (equation 3 in text) is equation 6 in Logan et al. (1976). For comparison purposes, base was temperature standardized at 17°C for estimation of Ψ in both data sets.

a) Present study.

INSTAR	Ψ		ρ		T_{max}		Δ		r^2
	EST	S.E.	EST	S.E.	EST	S.E.	EST	S.E.	
EGGS	0.146	0.00	0.169	0.000	35.18	1.88	4.68	11.52	0.99
1	0.189	0.00	0.153	0.008	34.47	0.89	3.84	0.55	0.99
2	0.501	0.00	0.191	0.042	37.14	3.70	4.87	0.91	0.98
3	0.150	0.07	0.162	0.026	33.68	1.60	3.29	0.72	0.99
4	0.150	1.08	0.134	0.221	36.54	4.42	4.78	11.50	0.99

b) Pooled literature review data.

INSTAR	Ψ		ρ		T_{max}		Δ		r^2
	EST	S.E.	EST	S.E.	EST	S.E.	EST	S.E.	
EGGS	0.328	0.00	0.127	0.000	38.65	0.378	6.89	0.487	0.99
1	0.349	0.00	0.146	0.469	37.46	2.37	5.53	20.4	0.96
2	3.645	0.00	0.145	0.000	37.15	1.21	6.77	1.20	0.98
3	0.213	0.04	0.104	0.056	35.75	1.486	3.63	3.39	0.97
4	0.132	0.25	0.151	0.166	34.49	0.832	4.06	5.56	0.98

Table 2. Sample sizes (N) and survivorship (S) in developmental rate trials. (isolates: MB, Manitoba; BC, British Columbia).

		1990		1991			
		MB		BC		MB	
INSTAR	°C	N	S	N	S	N	S
EGGS	17	111	13	107	64	119	64
	21	68	14	141	34	106	67
	24	.	.	156	53	112	51
	25	54	10	.	.	.	.
	27	.	.	195	45	68	21
	29	83	20	9	0	194	47
	31	.	.	143	27	114	13
FIRST	17	.	.	118	29	51	12
	21	.	.	49	35	67	49
	24	.	.	87	45	63	40
	25	.	.	.	.	.	.
	27	.	.	81	51	34	15
	29	.	.			51	27
	31	.	.	110	68	33	7
SECOND	17	42	10	39	16	11	1
	21	18	12	37	27	48	31
	24	.	.	39	25	38	26
	25	19	11	.	.	.	.
	27	.	.	58	39	22	11
	29	26	9	.	.	28	15
	31	.	.	64	27	18	9
THIRD	17	23	12	15	9	.	.
	21	19	15	26	20	31	30
	24	.	.	26	22	26	24
	25	17	12	.	.	.	.
	27	.	.	39	30	13	9
	29	23	14	.	.	15	12
	31	.	.	39	21	6	3
FOURTH	17	23	13	12	8	.	
	21	26	22	22	18	30	28
	24	.	.	21	17	23	21
	25	28	23	.	.	.	.
	27	.	.	32	23	9	9
	29	39	27	.	.	14	2
	31	.	.	9	5	1	0

Figure 1. Mean developmental rates of pre-imaginal Colorado potato beetles from Manitoba (MB) and British Columbia (BC). A) eggs; B) first instar; C) second instar; D) third instar; E) fourth instar.
SYMBOLS: Diamond: MB isolate 1990.
Open square: BC isolate 1991.
Filled square: MB isolate 1991.
Standard error bars for the BC isolate 1991 and the MB isolate 1991 are offset left and right, respectively.

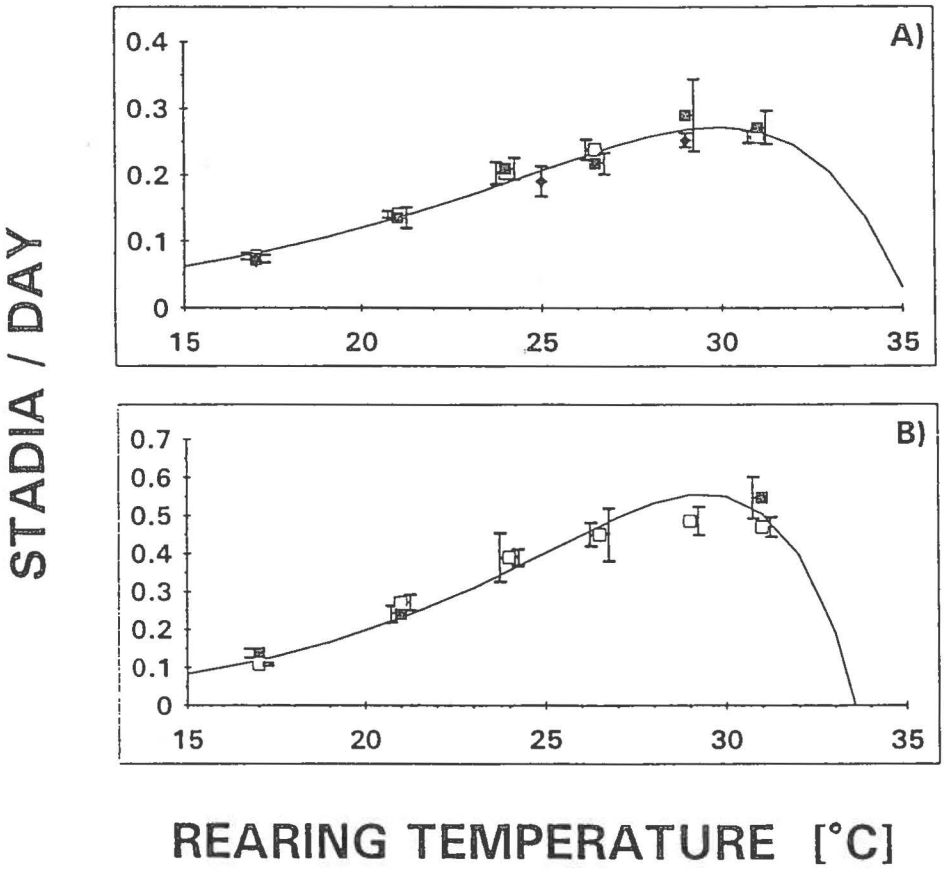


Figure 1. Continued

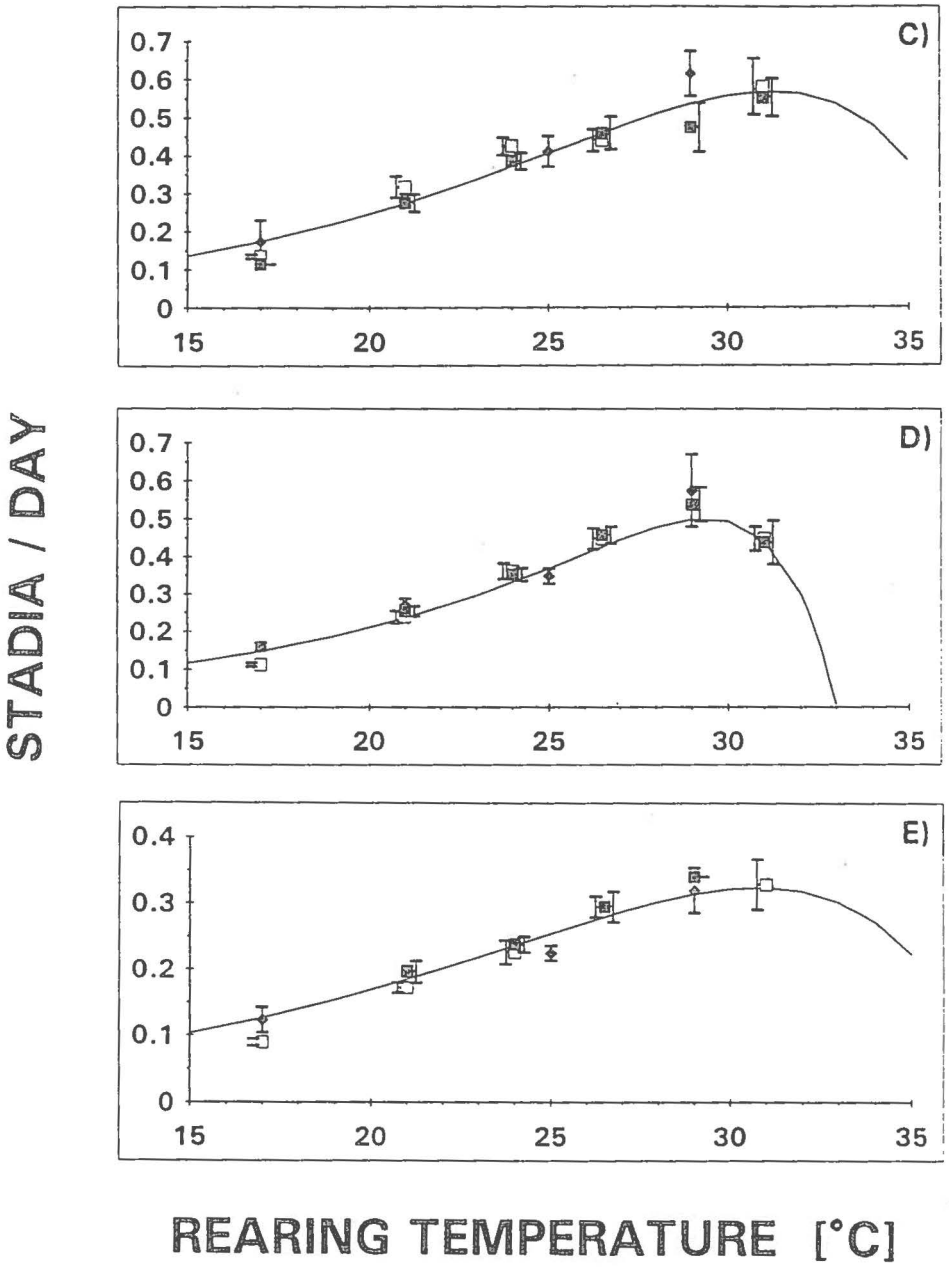
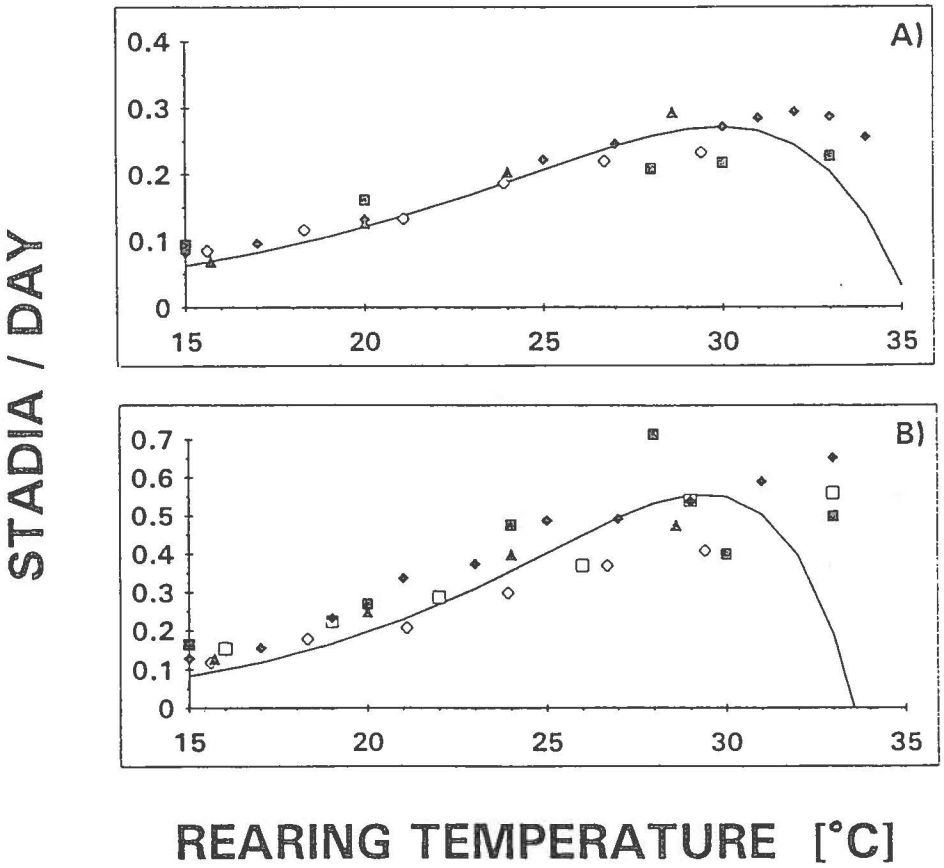


Figure 2. Developmental rates of pre-imaginal Colorado potato beetles. Comparison of regression description of data from present study, to 5 sets of published data.
A) eggs; B) first instar; C) second instar; D) third instar; E) fourth instar.

SYMBOLS:

Filled square:	Ferro et al. 1985
Open square:	Groden and Casagrande 1986
Filled diamond:	Logan et al. 1985.
Open diamond:	Tauber et al. 1988
Filled triangle:	Walgenbach and Wyman 1984



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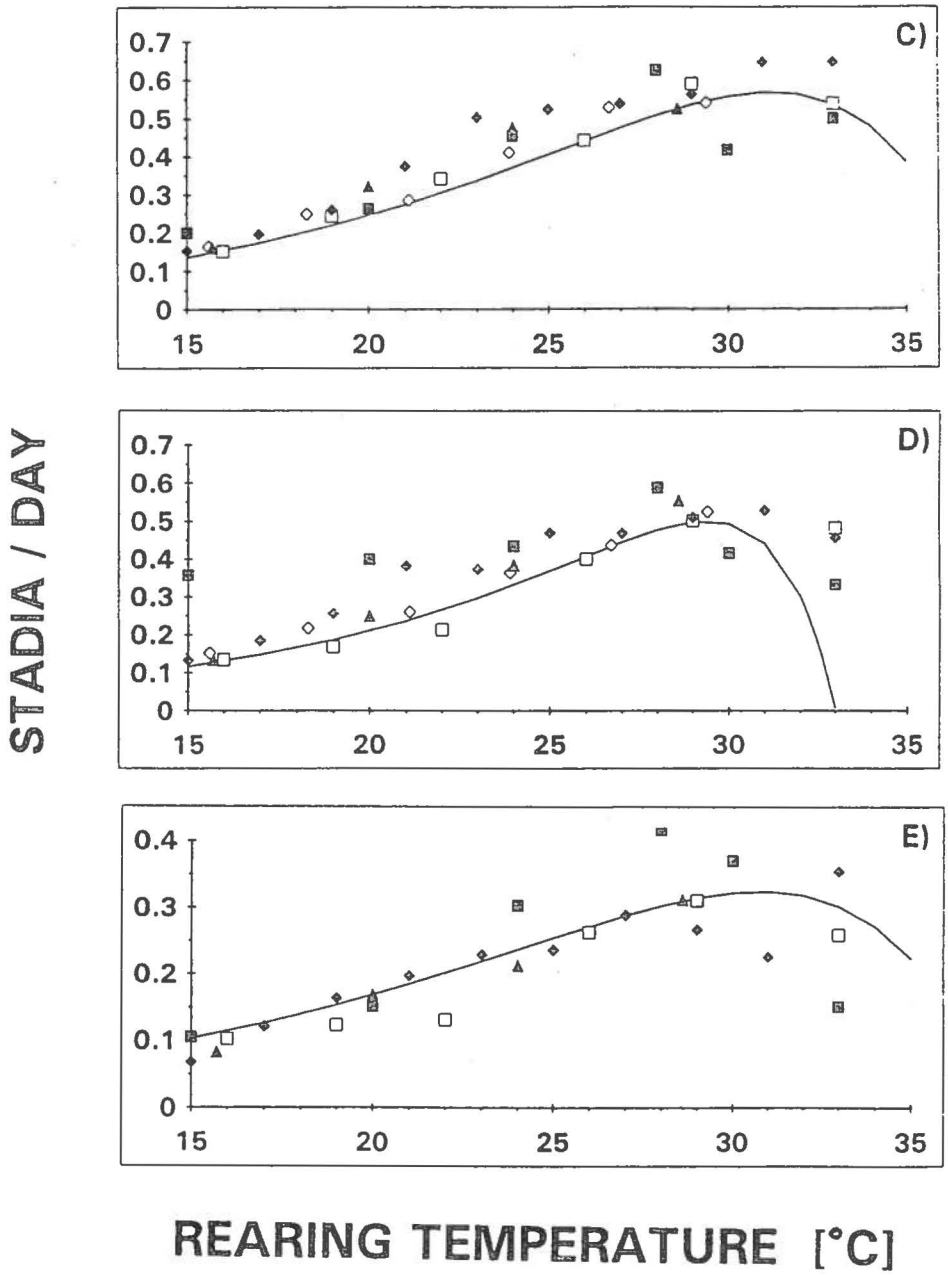

NEW RECORDS OF SASKATCHEWAN STONEFLIES (PLECOPTERA)

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ABSTRACT

Suwallia pallidula (Banks) (Chloroperlidae) is reported from Saskatchewan for the first time. New distribution records are presented for 14 species known previously from the province: *Pteronarcys dorsata* (Say), *Capnia gracilaria* Claassen, *Amphinemura linda* (Ricker), *Malenka californica* (Claassen), *Zapada cinctipes* (Banks), *Haploperla brevis* (Banks), *Perlesta placida* (Hagen), *Acroneuria lycorias* (Newman), *Paragnetina media* (Walker), *Claassenia sabulosa* (Banks), *Isoperla decolorata* (Walker), *Isoperla transmarina* (Newman), *Isoperla petersoni* Needham and Christensen, and *Isoperla quinquepunctata* (Banks). To date, 43 species of Plecoptera representing 29 genera and eight families are known from Saskatchewan. A new locality record is given for the chironomid, *Nanocladius (Plecopteracoluthus) branchicolus* Sæther, which was found in phoretic association with a nymph of the stonefly, *A. lycorias*. The significance of the new stonefly collection records and the biogeographical affinities of Saskatchewan Plecoptera are discussed.

INTRODUCTION

In their classic treatise on the taxonomy of North American stoneflies, Needham and Claassen (1925) listed only two species from Saskatchewan [*Pteronarcys dorsata* (Say) and *Isoperla bilineata* (Say)]. Ricker (1944, 1946, 1965) later published records and descriptions of prairie and northern stoneflies that included nine species from Saskatchewan, and Cushing (1961) reported two species not known previously from the province. The most exhaustive survey of Saskatchewan Plecoptera, undertaken by Dosdall and Lehmkuhl (1979), identified a total of 41 species representing 29 genera and eight families. Since then, Dosdall and Lehmkuhl (1987) discovered one additional species from Lake Athabasca in the northwestern corner of the province (*Capnia nearctica* Banks) and provided new distribution records from the same area for 12 species reported previously. Atton (1987) added a new distribution record for *Diura bicaudata* (L.) in northeastern Saskatchewan.

The objectives of this paper are: 1) to list new distribution records of stonefly species previously reported from the province, 2) to present one new species record from Saskatchewan, 3) to discuss the significance of the new collection records, and 4) to describe the biogeographical affinities of Saskatchewan Plecoptera.

METHODS

Stoneflies were collected by kick sampling benthos into a standard D-frame aquatic net with a 1-mm-mesh bag, by picking specimens from stones removed from stream substrates, and by sweeping stream-bank vegetation with an aerial net. Specimens were preserved in 95% ethanol. Species identifications, made using taxonomic keys and descriptions of Ricker (1952, 1965), Stark and Gaufin (1976), Dosdall and Lehmkuhl (1979), and Surdick (1985), were confirmed by comparisons with verified specimens in the author's personal collection and the Canadian National Collection.

RESULTS

New distribution records were made for 14 species previously reported from Saskatchewan, and one species, *Suwallia pallidula* (Banks) (Chloroperlidae), is recorded from the province for the first time.

Family Pteronarcyidae

Pteronarcys dorsata (Say)

Pteronarcys dorsata occurs in both prairie and boreal lotic habitats and is probably the most common and widely distributed stonefly species in Saskatchewan. New distribution records include: Cluff Creek near Cluff Lake (58° 22' N, 109° 34' W), 18 August 1978 (7 nymphs); Etoumai Creek, Jct. Hwy 23 (52° 35' N, 102° 35' W), 7 August 1976 (1 nymph); Douglas River, Jct. Hwy. 955 (58° 20' N, 109° 34' W), 12 June 1981 (4 nymphs); Geikie River 15 km upstream from Jct. of Hwy. 905 (57° 43' N, 104° 02' W), 12 June 1982 (1 nymph); Peter River near Cluff Lake townsite (58° 23' N, 109° 34' W), 11 June 1981 (1 nymph); Clearwater River, Jct. Hwy. 955 (56° 53' N, 109° 01' W), 13 May 1981 (1♀); stream at km 195 of Hwy. 905 near Wollaston Lake townsite (58° 03' N, 103° 33' W), 14 June 1982 (1 nymph); Upperville River, Jct. Hwy. 905 (58° 06' N, 103° 47' W), 15 June 1982 (2 nymphs, 1♂) (Fig. 1).

Family Taeniopterygidae

Oemopteryx sp.

Oemopteryx fosketti (Ricker) is the only species of this genus reported previously from Saskatchewan, from various sites on the North and South

Saskatchewan Rivers (Dosdall and Lehmkuhl 1979). Collection of a single female belonging to this genus was made from MacKay Creek, Jct. Hwy. 102 (55° 25' N, 104° 52' W), 8 June 1981 (Fig. 1). Because females of *O. fosketti* cannot be distinguished from those of *O. glacialis* (Newport) (Ricker 1965), the species designation is not made at this time.

Family Capniidae

Capnia gracilaria Claassen

In Saskatchewan, this species was known previously only from Battle Creek, Cypress Hills in southwestern Saskatchewan. It has since been collected from two additional sites, both springs, in central Saskatchewan: 8 km east of Cecil Ferry on the North Saskatchewan River (53° 09' N, 105° 21' W), 17 April 1984 (8♂, 12♀); 57 km north of Saskatoon, Jct. Hwy. 12 on the north bank of the North Saskatchewan River (52° 38' N, 106° 54' W), 20 April 1985 (7♂, 4♀) (Fig. 2).

Family Nemouridae

Amphinemura linda (Ricker)

New provincial distribution records of this widespread boreal species include: Crean River, Jct. Hwy. 2 (54° 08' N, 105° 57' W), 12 August 1981 (2♂, ♀); McDougal Creek, Jct. Hwy. 106 (54° 07' N, 104° 33' W), 7 October 1979 (2♂, 3♀); Nemei River, Jct. Hwy. 135 (55° 28' N, 102° 19' W), 21 June 1981 (4 nymphs); stream near Piprell Lake, Jct. Hwy. 106 (54° 09' N, 104° 54' W), 13 July and 3 August 1977 (5 nymphs, 3♂, 2♀) (Fig. 2).

Malenka californica (Claassen)

This species, previously reported from boreal streams in central Saskatchewan, also was collected from McDougal Creek, Jct. Hwy. 106 (54° 07' N, 104° 33' W), 21 September 1981 (2 nymphs, 2♂, ♀) (Fig. 3).

Zapada cinctipes (Banks)

New distribution records of this widespread boreal species include: McDougal Creek, Jct. Hwy. 106 (54° 07' N, 104° 33' W), 30 April 1982 (24♂, 16♀); Boulder Creek near Cluff Lake (58° 22' N, 109° 34' W), 14 October 1978 (1 nymph); spring 8 km east of Cecil Ferry on the North Saskatchewan River (53° 09' N, 105° 21' W), 17 April 1984 (12 nymphs, 5♂, 8♀); spring 57 km north of Saskatoon, Jct. Hwy. 12 on the north bank of the North Saskatchewan River (52° 38' N, 106° 54' W), 20 April 1985 (6 nymphs, 4♂, 1♀) (Fig. 3).

Family Chloroperlidae

Suwallia pallidula (Banks)

Adults (6♂, 3♀) were collected at Broad Creek, Jct. Hwy. 904 (54° 48' N, 108° 29' W) on 28 June 1976 (Fig. 4). Nymphs were not present in benthic samples taken on this date. *Suwallia pallidula* has not been recorded previously from Saskatchewan.

Haploperla brevis (Banks)

New records of this widespread prairie and boreal species include: Swan River, Jct. McBride Lake Road (52° 24' N, 102° 09' W), 29 June 1981 (2 nymphs, 1♀); Douglas River, Jct. Hwy. 955 (58° 20' N, 109° 34' W), 12 June 1981 (1♂, 3 nymphs); stream at km 232, Jct. Hwy. 955 (58° 14' N, 109° 29' W), 13 June 1981 (2 nymphs, 1♂, 2♀) (Fig. 4).

Family Perlidae

Perlesta placida (Hagen)

Previous Saskatchewan records of this species are from only two localities: Bisset Creek and Assiniboine River in central Saskatchewan (Dosdall and Lehmkuhl 1979). New distribution records also in this region of the province include: Smoking Tent Creek, Jct. Hwy. 3 (52° 52' N, 102° 03' W), 2 July 1981 (3 nymphs); Poplar River, Jct. Hwy. 9 (52° 56' N, 102° 22' W), 3 July 1981 (1 nymph); Carrot River, Jct. Hwy. 23 (53° 11' N, 103° 36' W), 4 July 1981 (1 nymph); Carrot River, Jct. Hwy. 335 (53° 06' N, 104° 07' W), 4 July 1981 (1 nymph) (Fig. 5).

Acroneuria lycorias (Newman)

New distribution records of this widespread, boreal species include: stream at km 135, Jct. Hwy. 102 (55° 54' N, 104° 24' W), 18 June 1982 (3 nymphs); stream at km 135, Jct. Hwy. 905 (57° 20' N, 104° 0' W), 16 June 1982 (4 nymphs); stream at km 155, Jct. Hwy. 905 (57° 29' N, 103° 57' W), 16 June 1982 (2 nymphs); stream at km 188, Jct. Hwy. 905 (57° 47' N, 103° 55' W), 14 June 1982 (3 nymphs); stream at km 195, Jct. Hwy. 905 (57° 52' N, 103° 54' W), 14 June 1982 (2 nymphs); Johnson River, Jct. Hwy. 905 (57° 05' N, 103° 44' W), 16 June 1982 (2 nymphs); Poplar River, Jct. Hwy. 9 (52° 56' N, 102° 22' W), 3 July 1981 (1 nymph); Fir River, Jct. Hwy. 9 (52° 50' N, 102° 25' W), 2 July 1981 (1 nymph); Woody River at Woody Lake (52° 25' N, 101° 42' W), 2 July 1981 (1 nymph); Assiniboine River at Hwy. 9 (51° 48' N, 102° 24' W), 29 June 1981 (1 nymph); Carrot River at Hwy. 9 (53° 37' N, 102° 0' W), 24 June 1981 (1 nymph); Carrot River, Jct. Hwy. 23 (53° 11' N, 103° 36' W), 4 July 1981 (1 nymph); Meridian Creek at Hwy. 167 (54° 32' N, 102° 08' W), 23 June 1981 (1 nymph); Peter River at Cluff Lake townsite (58° 23' N, 109° 34' W), 11 June 1981 (1 nymph) (Fig. 5).

It is noteworthy that one nymph of *A. lycorias* from the stream at km 155, Jct.

Hwy. 905, 16 June 1982 had two larvae of the chironomid *Nanocladius (Plecopteracoluthus) branchicolus* Sæther living phoretically beneath its metathoracic wing pads. This site can be added to the Saskatchewan distribution list for *N. branchicolus* given by Dosdall and Mason (1981).

Paragnetina media (Walker)

In Saskatchewan, *P. media* occurs in boreal streams; new distribution records include: Nemei River, Jct. Hwy. 135 (55° 28' N, 102° 19' W), 22 June 1981 (1 nymph); stream at km 51, Jct. Hwy. 905 (56° 40' N, 103° 38' W), 9 June 1977 (2 nymphs) (Fig. 6).

Claassenia sabulosa (Banks)

New distribution records of this boreal species include: stream at km 241, Jct. Hwy. 905 (58° 06' N, 103° 47' W), 17 August 1976 (2 nymphs); Douglas River, Jct. Hwy. 955 (58° 20' N, 109° 34' W), 12 June 1981 (2 nymphs); stream 3 km east of Beauval (55° 10' N, 107° 37' W), 14 June 1981 (4 nymphs) (Fig. 6).

Family Perlodidae

Isoperla decolorata (Walker)

A single nymph of this species was collected from the North Saskatchewan River at Gronlid Ferry, 48 km north of Melfort (53° 15' N, 104° 30' W), 25 May 1985 (Fig. 7). The specimen was reared in a laboratory aquarium, and a female emerged on 30 May 1985. Previously, Dosdall and Lehmkuhl (1979) collected only a single nymph (reared to an adult male) from the North Saskatchewan River at Hwy. 16 (Borden Bridge) (52° 22' N, 107° 09' W). *Isoperla decolorata* is Nearctic, and mainly northern in its distribution; previous records include Alaska, Great Bear Lake, Keewatin, and Fort Churchill (Ricker 1944, 1955, 1964).

Isoperla transmarina (Newman)

New collection records of this widespread boreal species include: stream at km 51, Jct. Hwy. 905 (56° 41' N, 103° 38' W), 9 June 1977 (1♂); stream at km 135, Jct. Hwy. 905 (57° 20' N, 104° 0' W), 16 June 1982 (4 nymphs); stream at km 195, Jct. Hwy. 905 (57° 52' N, 103° 54' W), 14 June 1982 (4 nymphs); stream at km 208, Jct. Hwy. 905 (57° 56' N, 103° 51' W), 9 June 1977 (2♂); stream at km 215, Jct. Hwy. 905 (57° 57' N, 103° 49' W), 14 June 1982 (3 nymphs); Johnson River, Jct. Hwy. 905 (57° 05' N, 103° 44' W), 16 June 1982 (2 nymphs); Upperville River, Jct. Hwy. 905 (58° 06' N, 103° 47' W), 15 June 1982 (2 nymphs); Douglas River, Jct. Hwy. 955 (58° 20' N, 109° 34' W), 12 June 1981 (1 nymph); Swan River, Jct. Hwy. 8 (52° 01' N, 102° 04' W), 3 August 1975 (2 nymphs); Geikie River, 15 km upstream from Hwy. 905 (57° 43' N, 104° 02' W), 12 June 1982 (3 nymphs); stream at km 178, Jct. Hwy. 955 (57° 41' N,

109° 28' W), 9 July 1981 (1 nymph); Clearwater River, Jct. Hwy. 955 (56° 53' N, 109° 01' W), 13 June 1981 (1 nymph) (Fig. 7).

Isoperla petersoni Needham and Christensen

In Saskatchewan, *I. petersoni* was known previously from only two boreal streams (Dosdall and Lehmkuhl 1979); new distribution records include: Boulder Creek near Cluff Lake (58° 22' N, 109° 34' W); stream 10 km east of Cole Bay, Jct. Hwy. 965 (55° 06' N, 108° 20' W), 8 June 1981 (1 nymph); Earl Creek at Carswell Lake Road, near Cluff Lake (58° 27' N, 109° 11' W), 11 June 1981 (4 nymphs); stream at km 195, Jct. Hwy. 905 (57° 52' N, 103° 54' W), 14 June 1982 (1 nymph); stream at km 215, Jct. Hwy. 905 (57° 57' N, 103° 49' W), 14 June 1982 (2 nymphs, 1♂) (Fig. 8).

Isoperla quinquepunctata (Banks) (= *I. patricia* Frison)

Isoperla quinquepunctata is common throughout the Rocky Mountains of Canada and the United States (Baumann *et al.* 1977), and in Saskatchewan is known from the South Saskatchewan River and from streams in the southwest (Dosdall and Lehmkuhl 1979). A new distribution record for this species is the stream 15 km northwest of Eastend, Jct. Hwy. 614 (49° 35' N, 108° 55' W), 24 May 1981 (5 nymphs) (Fig. 8).

DISCUSSION

For several species (*P. dorsata*, *A. linda*, *M. californica*, *H. brevis*, *A. lycorias*, *P. media*, *C. sabulosa*, *I. decolorata*, *I. transmarina*, and *I. quinquepunctata*), the new distribution records presented here represent collection localities within the known range of the species, and as such these records could have been predicted with the addition of roads to sites that were previously inaccessible. For other species, however, the new records are perhaps more noteworthy. Previously, *C. gracilaria* was reported only from Cypress Hills in southwestern Saskatchewan, but its range is now known to extend to boreal spring habitats. Similarly, *Z. cinctipes* should now be considered a member of the stonefly fauna of Saskatchewan boreal springs. *Perlesta placida* was collected previously in only two eastcentral Saskatchewan localities, but it is now known to be more widespread in this region. *Isoperla petersoni* was known previously from only two boreal sites, but has now been found to occur more extensively throughout this region of Saskatchewan.

The new record for the province of *S. pallidula* in the Southern Boreal Ecoregion of western Saskatchewan is noteworthy because previous collections of this species have been made principally in the Rocky Mountain or Intermountain Regions. Baumann *et al.* (1977) considered *S. pallidula* the most common and widespread chloroperlid of the Rocky Mountains. The western Nearctic distribution of *S. pallidula* extends from Alaska to California and east to New Mexico, Colorado, Montana, and Manitoba (Gaufin *et al.* 1972;

Friesen *et al.* 1984; Surdick 1985; Stark *et al.* 1986). Previous Canadian distribution records of *S. pallidula* include numerous sites throughout the Rocky Mountains of British Columbia and Alberta (Ricker and Scudder 1975; Baumann *et al.* 1977; Surdick 1985), with its most eastern collection record from the Duck Mountain region of Manitoba (Friesen *et al.* 1984).

The most probable dispersal route of *S. pallidula* to Saskatchewan following the destructive effects of the Wisconsinan glaciation (which ended about 11,000 years before present) was to the north and east from a southwestern North American refugium. This is the dispersal route proposed by Dosdall and Lehmkuhl (1979) for other stonefly species with widespread distributions in the mountains of western North America and in Saskatchewan boreal regions.

A comparison was made of the stonefly fauna of Saskatchewan with that of Manitoba (46 species, Burton 1984), British Columbia (120 species, Ricker and Scudder 1975), Montana (119 species, Gaufin *et al.* 1972), and Minnesota (51 species, Harden and Mickel 1952). Of these, Saskatchewan has the greatest similarity with the fauna of Manitoba, with 72% (31 species) of species in common, compared with 56% (24 species), 51% (22 species), and 37% (16 species) of species in common with British Columbia, Montana, and Minnesota, respectively. Of the 12 species reported from Saskatchewan but not from Manitoba, most are montane species that occur in the Cypress Hills region of southwestern Saskatchewan [*Isocapnia crinita* (Needham and Claassen), *Isocapnia missourii* Ricker, *Paraleuctra vershina* Gaufin and Ricker, *Podmosta delicatula* (Claassen), *Hesperoperla pacifica* (Banks), *Suwallia lineosa* (Banks), and *Isoperla quinquepunctata* (Banks)]. These species may have passed the Wisconsinan glacial maximum in the Cypress Hills refugium, or may have dispersed to Cypress Hills through a connecting bridge of montane climatic and edaphic conditions that formed as the ice retreated (Dosdall and Lehmkuhl 1979). They apparently have been unsuccessful in dispersing to, or populating, streams in Manitoba probably because of their ecological preference for cool water, the vast expanses of prairie separating them from suitable habitats, and their poor dispersal capabilities. The remaining species found in Saskatchewan but not in Manitoba include species [*Pteronarcella badia* (Hagen) and *Triznaka signata* (Banks)] which probably survived glaciation in the western portion of the southern North American refugium and dispersed north and east with the eastern limit of their range occurring in central Saskatchewan (Dosdall and Lehmkuhl 1979), and species [*Leuctra ferruginea* (Walker), *Arcynopteryx compacta* (MacLachlan), and *Isoperla petersoni* Needham and Christensen] which probably occur in Manitoba but have not yet been collected there (Burton 1984). Most of the 15 stonefly species found in Manitoba but not in Saskatchewan have eastern North American distributions. These species probably originated in an eastern North American refugium and dispersed to the north and west following the Wisconinan glaciation, but apparently have not colonized Saskatchewan streams. They include *Strophopteryx fasciata* (Burmeister), *Allocapnia granulata* (Claassen), *Capnia manitoba* Claassen, *Pteronarcys pictetii* Hagen, *Isoperla dicala* Frison, *Isoperla frisoni* Illies, *Isoperla signata* (Banks), *Isogenoides krumholzi* (Ricker), *Acroneuria carolinensis* (Banks), *Attaneuria ruralis* (Hagen), and *Agnetina capitata* (Pictet). Of the remaining

stonefly species found in Manitoba but not in Saskatchewan, two are questionable records from Manitoba [*Megaleuctra stigmata* (Banks) and *Pteronarcys proteus* Newman] (Ricker 1946; Burton 1984). *Taeniopteryx parvula* Banks occurs in both Manitoba and Alberta (Flannagan 1978; Stark *et al.* 1986), and may also occur in Saskatchewan. In Manitoba, *Nemoura arctica* Esben-Petersen was collected in Churchill and near Southern Indian Lake in the northern boreal forest (Burton 1984); it also probably occurs in the same region of northern Saskatchewan but to date few collections have been made from this area.

The new distribution records presented in this study indicated that collections from new sites in Saskatchewan and more intensive collecting in areas sampled previously resulted in the discovery of only one (*S. pallidula*) or perhaps two (*S. pallidula* and *Oemopteryx* sp.) species not reported previously from the province. The most likely species that remain to be collected are *N. arctica* and *T. parvula*. To date, the most poorly collected region of the province is the most northern portion because of the lack of access roads; it is certain that future collections from this area will extend the ranges of several species already recorded from Saskatchewan and may even produce records of species not collected previously.

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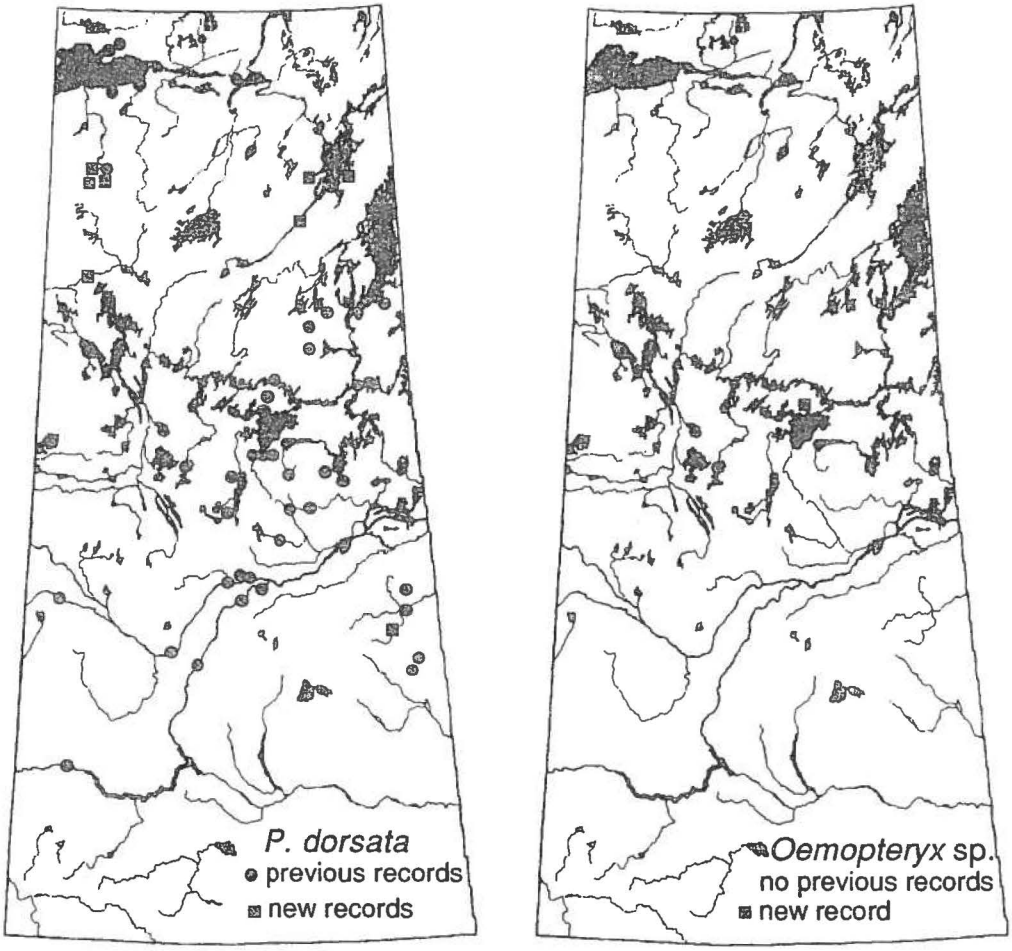

Fig. 1. New and previous Saskatchewan distribution records for *Pteronarcys dorsata* and *Oemopteryx* sp.

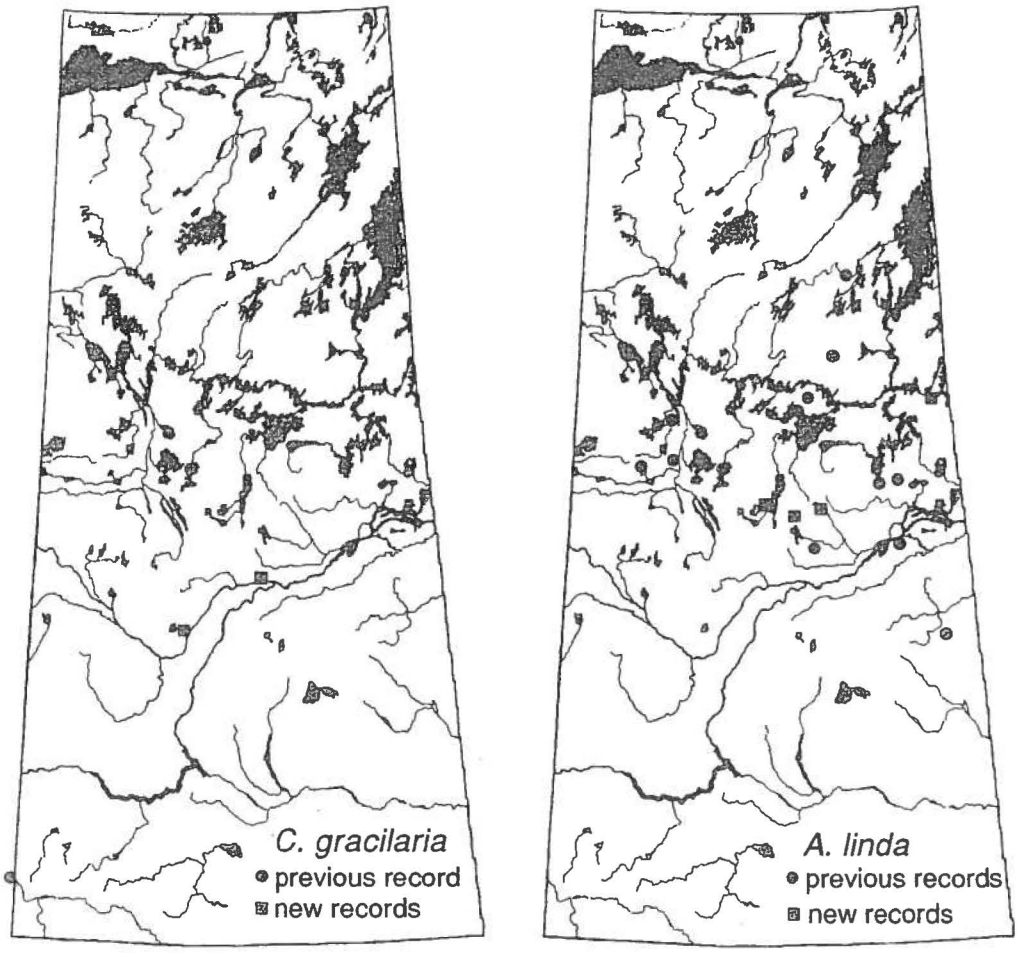

Fig. 2. New and previous Saskatchewan distribution records for *Capnia gracilaria* and *Amphinemura linda*.

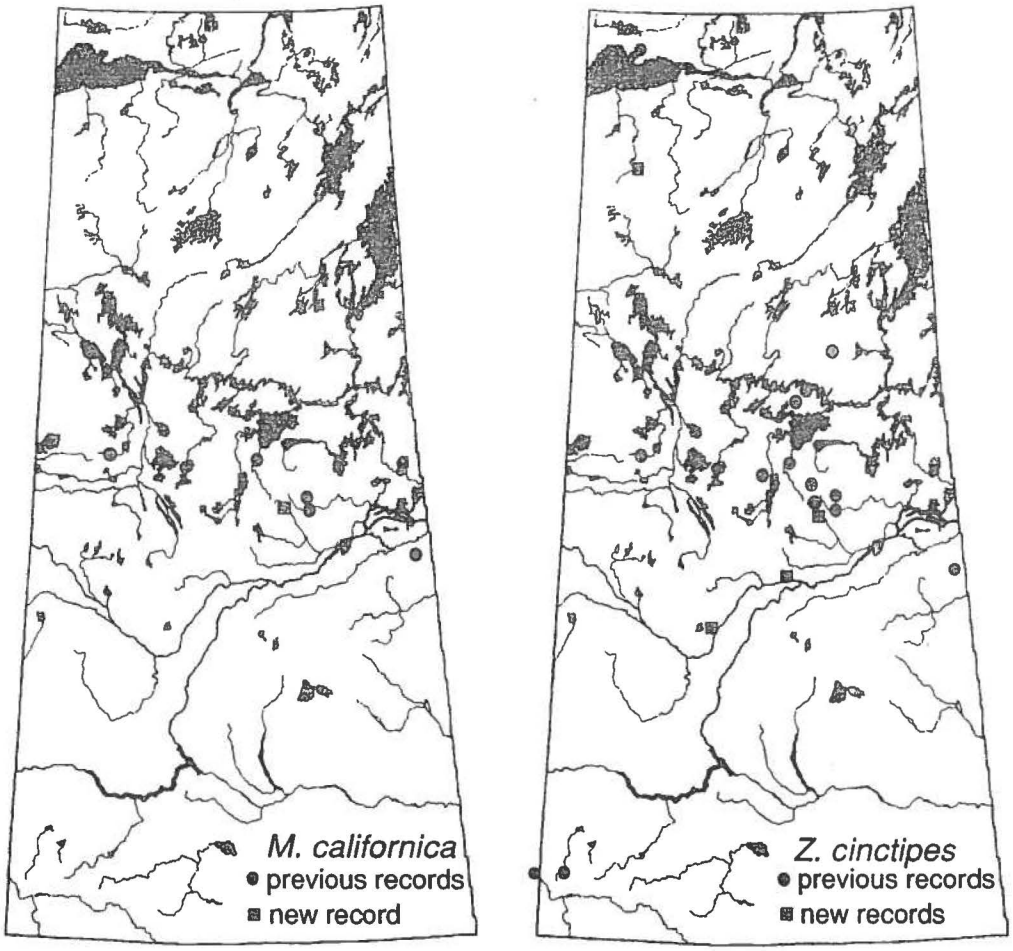

Fig. 3. New and previous Saskatchewan distribution records for *Malenka californica* and *Zapada cinctipes*.

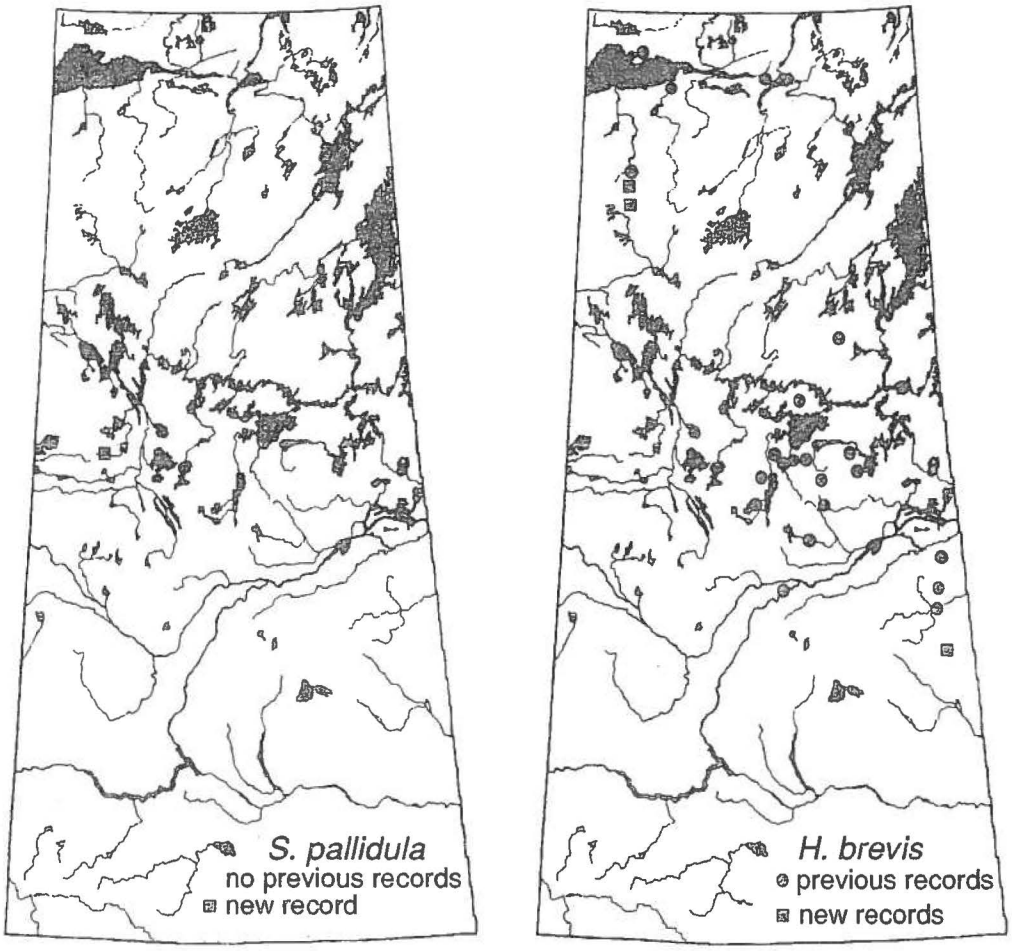

Fig. 4. New and previous Saskatchewan distribution records for *Suwallia pallidula* and *Haploperla brevis*.

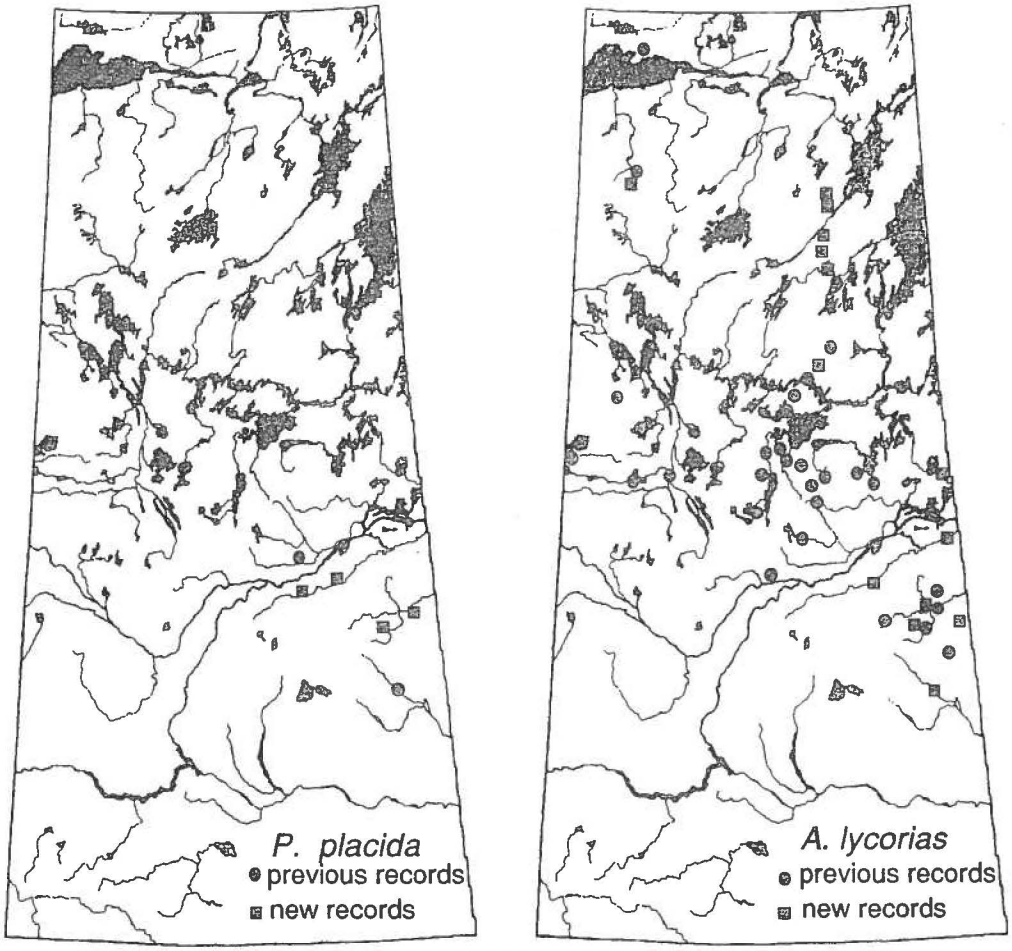

Fig. 5. New and previous Saskatchewan distribution records for *Perlesta placida* and *Acroneuria lycorias*.

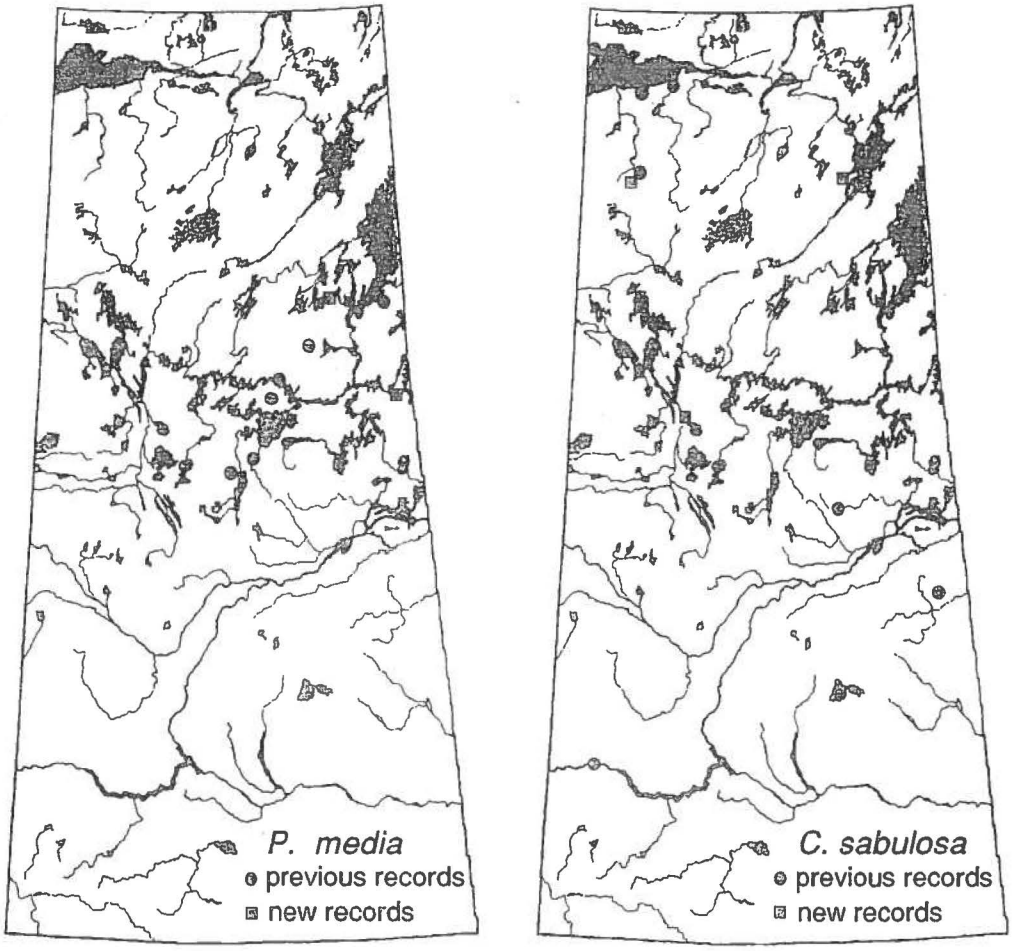

Fig. 6. New and previous Saskatchewan distribution records for *Paragnetina media* and *Claassenia sabulosa*.

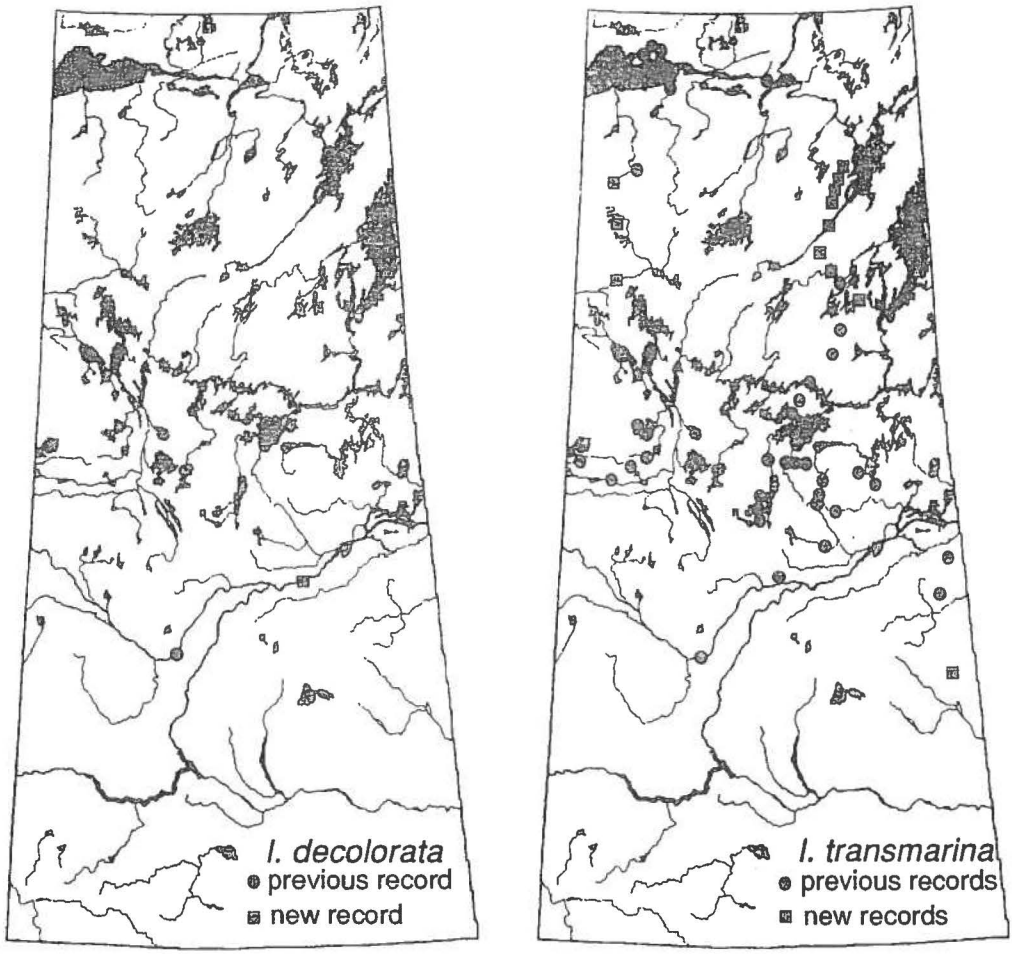

Fig. 7. New and previous Saskatchewan distribution records for *Isoperla decolorata* and *Isoperla transmarina*.

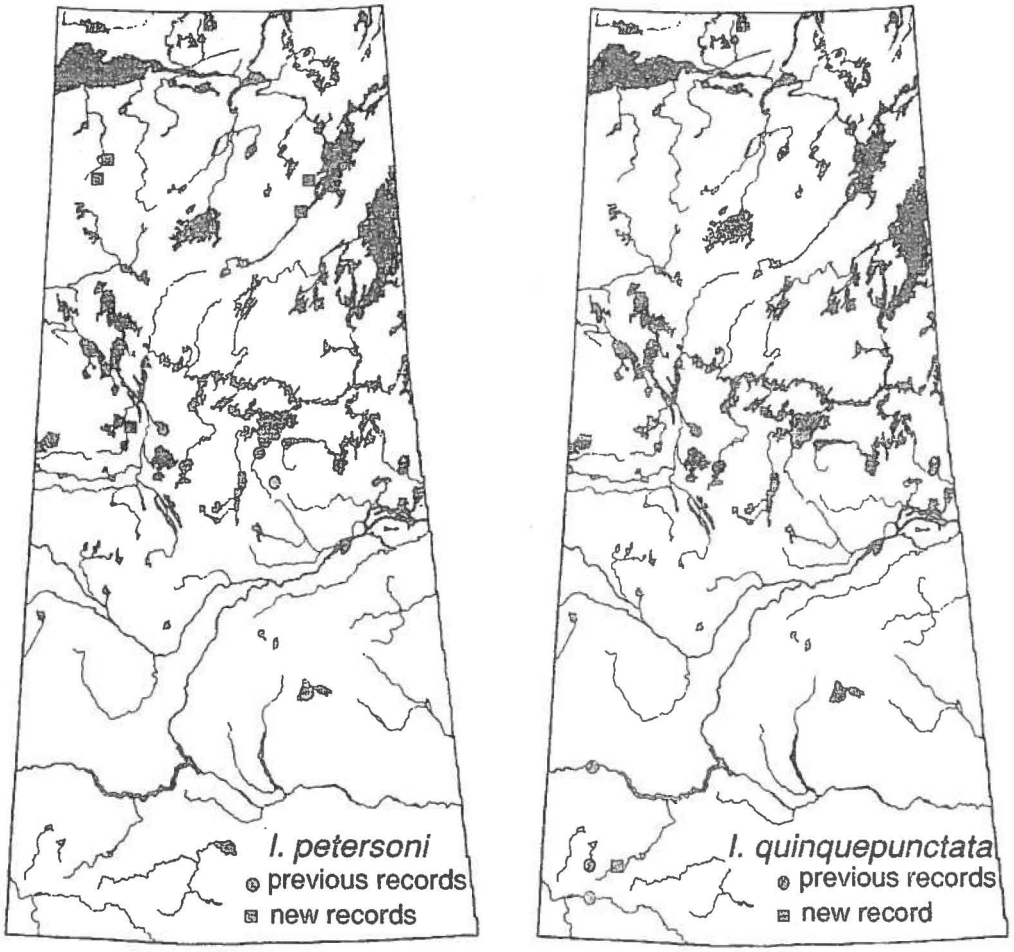

Fig. 8. New and previous Saskatchewan distribution records for *Isoperla petersoni* and *Isoperla quinquepunctata*.

THE IMPACT OF A SPRUCE BUDWORM INFESTATION ON FOREST PRODUCTION IN EASTERN MANITOBA

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ABSTRACT

A spruce budworm, *Choristoneura fumiferana* (Clem.), infestation has persisted in eastern Manitoba since 1979. Aerial and ground surveys were carried out in 1991 in an area encompassed by the Abitibi-Price Inc. Forest Management License to determine the volume of dead timber and the economic impact that could be attributed to the spruce budworm infestation. The survey concentrated on type aggregates containing balsam fir, *Abies balsamea* (L.) Mill., and white spruce, *Picea glauca* (Moench) Voss, as the major components. Approximately 27,447 ha of spruce budworm vulnerable forest were evaluated. The current (1991) volume of dead timber within the spruce budworm vulnerable type aggregates was 242,385 m^3 or approximately 15% of the spruce/fir component. Additional mortality of up to 3% was predicted for the period 1992 to 1993, increasing the total potential volume loss to 295,623 m^3 or 18% of the spruce/fir component. This volume of dead timber could have potentially contributed approximately $30 million to Manitoba's gross domestic product. The economic impact of this infestation is briefly discussed.

INTRODUCTION

The impact of spruce budworm, *Choristoneura fumiferana* (Clem.), outbreaks in eastern North America have been well documented (Morris 1963, Blais *et al.* 1981, Sanders *et al.* 1985, Milne 1986, Ennis and Caldwell 1991). Milne (1991) stated that the economic costs for timber salvage operations and lost stumpage revenues approached $72 million for a spruce budworm outbreak in Newfoundland during the 1970's and early 1980's. To date there exists no accurate volume loss assessment or evaluation of the economic impact of spruce budworm infestations on Manitoba's forest industry. The purpose of this study was to quantify the effects of the most recent spruce budworm outbreak in Manitoba.

The Abitibi-Price Inc. Forest Management License (FML) occupies an area of approximately 855,700 ha in eastern Manitoba, between the Ontario/Manitoba border and Lake Winnipeg. The outbreak of the spruce budworm in the FML was first detected in 1979 (Hiratsuka *et al.* 1982). The outbreak increased in size and intensity, and peaked in 1984. Spruce budworm populations remained at high levels throughout the remainder of the decade. Beginning in 1990, surveys indicated a significant decline in egg mass and larval numbers throughout the FML (Knowles 1991). The overall severity of defoliation on balsam fir, *Abies balsamea* (L.) Mill., and white spruce, *Picea glauca* (Moench) Voss, has decreased significantly since 1990. Balsam fir mortality has been extensive throughout the infestation area. White spruce, which is more tolerant than balsam fir of repeated defoliation (Tothill 1923), has suffered less mortality to date than balsam fir. Black spruce, *Picea mariana* (Mill). B.S.P., which is an occasional host species for spruce budworm has also shown decline and mortality where it occurs in conjunction with balsam fir and white spruce.

METHODS

The geographic information systems (GIS) of the Manitoba Forestry Branch and Abitibi-Price Inc. were used to identify forest type aggregates of spruce budworm habitat in the FML for inclusion in this assessment. All subtypes in the white spruce working group (subtype codes 10, 11, 50, and 51) and balsam fir working group (subtype codes 20, 21, 60, and 61) in the FML area were included for evaluation (Table 1). Subtypes 15, 55, and 58 of the black spruce working group were also included (Table 1). In these subtypes black spruce growing in association with balsam fir and/or white spruce was commonly a host species for spruce budworm (Graham 1940). Other black spruce subtypes were excluded as they rarely harbour spruce budworm populations in Manitoba. Subtype 82 of the trembling aspen working group was included in the assessment because of its significant spruce/fir component.

The areas surveyed fell into two broad ecological categories. The first category included beach, outwash and moraine ridges. Common indicator plants included *Arctostaphylos uva-ursi* (L.) Spreng., *Cladonia mitis* (Sandst.), *Cladonia rangiferina* (L.) Wigg., *Oryzopsis pungens* (Torr.) Hitchc., and *Juniperus horizontalis* Moench. Within Manitoba's forest inventory system (Anonymous 1989) these are classified as "dry" or Site 3 ecosystems. In Sims *et al.* (1989) these forest ecosystems correspond to V20 and V33 vegetation types. It should be noted that Sims *et al.* (1989) referred to *Cladonia* spp. as *Cladina* spp. The second site type, which included most of the area surveyed, consisted of lacustrine flats, higher flood plains, outwash on till plains and depressional areas of outwash and lacustrine deposits. These are denoted as "moist or very moist" or Site 1 ecosystems. Common indicator plants include *Cornus stolonifera* Michx., *Cornus canadensis* L., *Ribes* spp., *Mitella nuda* L., *Gaultheria hispidula* (L.) Muhl. and *Alnus* spp. In Sims *et al.* (1989) these ecosystems correspond to V7, V9, V11, V14, V15, V16, V19, V24 and V25 vegetation types.

The stands within the area surveyed consisted of three harvesting classes. These included immature stands with merchantable volume growing at or near their maximum rates, mature stands which had reached rotation age and overmature stands. Juvenile stands were not included in the survey because they have no merchantable volume. Stands with crown closures of 21-50%, 51-71% and 71-100% were included in the aerial survey. Stands with crown closures of 21-50% were not included in the ground survey as they did not have a merchantable volume large enough to support a commercial harvest.

To implement the aerial survey in April 1991, 11 blocks having the majority of spruce budworm vulnerable type aggregates were delineated on the flight maps. Parallel flight lines, 1200 metres apart were flown in each of the 11 blocks. Damage categories (Moody 1979) were assigned continuously along the flight lines as follows:

Category 1: extensive mortality
Category 2: declining, not likely to recover
Category 3: severe defoliation, likely to recover
Category 4: nil or light defoliation

Following the aerial survey, a single damage category was assigned to each stand with a budworm vulnerable type aggregate. Given that the rating of damage was continuous along the flight lines, larger stands could receive a number of values. Therefore, the category given to a stand was often an average of the values from the continuous rating. In cases where a stand was missed in the aerial survey, the average damage category in the immediate vicinity was assigned to it. A damage category of 4 was assigned to stands outside of the survey block having vulnerable type aggregates. There may have been some inaccuracy in assigning values to stands which were not actually viewed from the air. However, it was necessary to include all stands with vulnerable type aggregates as this study focused on the entire FML. The number and size of stands assigned values in this manner was small. Colour-coded GIS maps were produced displaying the damage category for budworm vulnerable stands in the FML.

A detailed ground survey was carried out from May to August 1991 to determine stand volumes in the budworm vulnerable type aggregates. Manitoba Forest Inventory temporary sample plot procedures were used in data collection (Anonymous 1989). A total of 915 temporary sample plots were established in 140 stands. All sample plot trees within the ground survey were assigned damage categories in a similar manner to the aerial survey.

Gross merchantable volume calculations were done for the temporary sample plot data using the Manitoba Forest Inventory prismsor.wk 1 computer program (calculations originally based on Spurr 1952) to determine the current 1991 volume. Current volumes for spruce budworm host tree species (balsam fir, white spruce, and black spruce) in each of the surveyed type aggregates were subtracted from the 1977 forest inventory gross merchantable volumes,

calculated prior to the latest spruce budworm outbreak, to estimate the volume of dead timber. There was no significant budworm damage in the FML at the time of the 1977 inventory. The volume of dead timber was calculated for individual type aggregates, by tree species working group and harvesting or cutting class. Volume calculations pertain to only the spruce/fir component of the surveyed type aggregates.

A prediction of further loss of timber volume for the period 1992 to 1993 was made by excluding all declining trees (category 2) from the volume calculation. Trees in this category were expected to die within this period. This volume was then subtracted from the 1977 forest inventory gross merchantable volume to project future loss of timber.

RESULTS

The aerial survey covered an area of 27,447 ha of spruce budworm vulnerable type aggregates. Damage category 1 (extensive mortality) was assigned to 105 ha. There were 2,007 ha in damage category 2 (declining, not likely to recover). These areas of severe damage were predominantly in the Bird Lake area, along the Wanipigow River and in the Long, Happy, Manigotogan and Quesnel Lakes areas. Damage category 3 (severe defoliation, likely to recover) was assigned to 9,270 ha. Major concentrations of this category were found near Bird River, Bird Lake, and to the northwest of the Winnipeg River. The eastern portions of the Maskwa River and much of the Manigotogan River and Wanipigow River watersheds also had extensive areas in damage category 3. The remainder of the survey area, 16,063 ha fell into the damage category 4 (nil or light defoliation) classification.

By 1991 the current loss of timber in the spruce budworm vulnerable type aggregates within the FML was 242,385 m^3 or approximately 15% of the total spruce/fir component of those type aggregates (Tables 2 and 3). The loss of timber was predicted to rise to 295,623 m^3 or 18% of the spruce/fir component by 1993. The loss of timber for individual type aggregates ranged from 0% to 60% of the spruce/fir component. Ten type aggregates had no current loss of timber and nine types aggregates had no predicted timber loss.

The largest loss of timber occurred in the trembling aspen working group. The current timber loss was 86,784 m^3 or 11% and the predicted loss of timber was 122,406 m^3 or 16% of the spruce/fir component (Table 3). The largest loss of timber for an individual type aggregate was in the aspen working group. The current loss of timber in this type aggregate (82-1-5-4 - Table 2) was 51,811 m^3 or 20% of the total spruce/fir volume. The predicted loss of timber was 57,160 m^3 or 22% of the spruce/fir component.

The white spruce working group had the greatest percent timber loss, with a current loss of 45,486 m^3 or 23% and a predicted mortality of 51,879 m^3 or 26% of the spruce/fir

component (Table 3). The greatest percent loss of timber for an individual type aggregate was within the white spruce working group. Approximately 4,531 m^3 or 60% of the current volume in type aggregate 50-1-4-4 (Table 2) was killed by spruce budworm. The predicted loss of timber in this type aggregate was 4,796 m^3 or 64% of the total spruce/fir volume.

Timber losses were also summarized by cutting class (Table 4). Overmature stands (cutting class 5) had the greatest percent loss of timber, with a current volume loss of 75,963 m^3 or 20% and a predicted loss of 89,782 m^3 or 24% of the spruce/fir component. Immature stands (cutting class 3) had the greatest timber loss with a current volume loss of 108,836 m^3 or 16% and a predicted loss of 132,945 m^3 or 20%. The timber loss in cutting class 3 stands will not effect the annual allowable harvest within the FML as the annual incremental growth of the forest should have a compensating effect. However, the effect of this budworm outbreak has reduced the mean annual volume increment of the spruce/fir component in the FML to 148,608 m^3 from 153,898 m^3 (G. Becker, H. Lamont, pers. comm., Manitoba Forestry Branch, Winnipeg, Manitoba).

Steele and Williamson (1985) provided the most recent calculations of the contribution of forestry products to Manitoba's economy. In 1985, one cubic metre of timber had the potential to contribute $132 to the provincial gross domestic product. This figure was a provincial average for all forest products, with newsprint and other processed paper products providing more value added potential than lumber. Estimates of the value of a cubic metre of wood as they relate to harvesting and processing to produce wood fibre and end products at the Abitibi-Price Inc., Pine Falls, Manitoba mill agree closely with the provincial average figure of $132 (H. Peacock, pers. comm., Abitibi-Price Inc., Pine Falls, Manitoba). Using this value ($132 per m^3), the current loss of merchantable timber in the FML attributable to spruce budworm had a potential value of approximately $30 million to Manitoba's gross domestic product.

In addition to the loss of potentially merchantable material, the Province of Manitoba has spent approximately $250,000 on suppression programs with biological insecticides to protect certain stands of high value timber threatened by spruce budworm (Westwood 1989; 1990). Suppression costs were above and beyond annual costs incurred by the Province of Manitoba for spruce budworm survey programs.

The value of the additional 3% predicted timber volume loss was estimated using the same method to be approximately $7.0 million. However, this loss may not occur as this material may yet be harvested (H. Peacock, pers. comm., Abitibi-Price Inc., Pine Falls, Manitoba). A small amount of the wood volume damaged by spruce budworm during the period 1987 to 1990 has been salvaged, but accurate data are unavailable to calculate this percentage (Peacock and Keenan 1992). The potential loss of $30 million to the provincial gross domestic product includes the loss of approximately $1.6 million of Crown stumpage fees and forest

renewal charges.

DISCUSSION

The most recent spruce budworm outbreak in Manitoba has resulted in a significant loss of white spruce, balsam fir and to a lesser degree black spruce within the Abitibi-Price Inc. FML area. All accessible merchantable stands of white spruce and balsam fir within the FML have been included in short and long range forest harvest and management plans by Abitibi-Price Inc. to secure a continued supply of wood for the mill at Pine Falls, Manitoba.

The majority of the current timber loss and predicted loss occurred in the Bird Lake, Happy Lake, Long Lake, Quesnel Lake, and Wanipigow and Manigotogan River watersheds with significant areas in damage categories 1 and 2. Over 9,000 ha were identified in damage category 3. The high percent of timber loss which occurred in cutting class 5 type aggregates was expected as these areas contained mostly overmature trees which are less able to withstand continued budworm defoliation. There was a greater percent of timber loss in cutting class 3 than cutting class 4 type aggregates (16% and 10% respectively). This was primarily due to the significant amount of balsam fir, the most vulnerable species to spruce budworm (Greenbank 1963). The amount of balsam fir in cutting class 3 was more than double that of cutting class 4. In addition to its vulnerability to budworm, balsam fir is very susceptible to decay and other insects and disease (USDA 1965). Consequently, balsam fir frequently dies prior to reaching maturity (cutting class 4).

The largest loss of timber occurred in the trembling aspen working group and in a trembling aspen type aggregate (82-1-5-4). This working group and type aggregate occupy a greater area and have a larger volume of white spruce and balsam fir than any other working group or type aggregate in the FML.

The impact of spruce budworm outbreaks in the FML area could be reduced by lowering the incidence of balsam fir. During the reforestation process sufficient stocking with white and black spruce would prevent balsam fir from becoming a major component in the traditionally budworm prone areas. This may lower the vulnerability of the forest and therefore reduce the impact of budworm outbreaks. The loss of forest renewal charges in budworm killed stands (fees are not collected from unharvested areas) makes conversion of these stands to predominantly spruce and away from balsam fir more difficult.

The impact of spruce budworm may be slightly underestimated by excluding type aggregates in which balsam fir and white spruce are minor components. However, the authors believe that this effect is minor.

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Table 1. Forest subtypes surveyed for Spruce budworm damage.

SUBTYPE	TREE SPECIES COMPOSITION
10	76% and greater softwood, white spruce[a] 71-100%
11	76% and greater softwood, white spruce 40-70% with balsam fir[b], jack pine[c] or black spruce[d]
50	51-75% softwood, 51% and greater white spruce
51	51-75% softwood, 50% or less white spruce with some balsam fir, jack pine or black spruce
20	76% or greater softwood, balsam fir 71-100%
21	76% or greater softwood, balsam fir 40-70% with some spruce
60	51-75% softwood, balsam fir 51% or greater
61	51-75% softwood, balsam fir 50% or less with some spruce
15	76% or greater softwood, 40-70% black spruce with some balsam fir or white spruce
55	51-75% softwood, black spruce 50% or less with some balsam fir
58	51-75% softwood, black spruce 50% or less with some white spruce
82	26-50% softwood, trembling aspen with spruce, balsam fir or tamarack[e]

a. white spruce, *Picea glauca*, (Moench) Voss
b. balsam fir, *Abies balsamea*, (L.) Mill.
c. jack pine, *Pinus banksiana* Lamb.
d. black spruce, *Picea mariana*, (Mill.) B.S.P.
e. tamarack, *Larix laricina* (Du Roi) K. Koch

Table 2: Current and predicted volume loss of timber to Spruce budworm by type aggregate[a].

1. WHITE SPRUCE WORKING GROUP

TYPE AGGREGATE	AREA(ha)	1977 VOLUME(m^3)	1991 VOLUME(m^3)	VOLUME LOSS 1991 (m^3)	% LOSS 1991	PREDICTED VOL(m^3)[b]	PREDICTED LOSS(m^3)	PREDICTED % LOSS[c]
10-1-3-4[d]	3.0	413	308	105	25%	308	105	25%
11-1-3-3	182.1	15699	9561	6138	39%	9250	6448	41%
11-1-4-3	84.6	6354	7173	0	0%	6401	0	0%
11-1-4-4	255.6	29062	30033	0	0%	29394	0	0%
50-1-3-3	63.6	4059	3829	230	6%	3758	300	7%
50-1-4-4	75.9	7544	3013	4531	60%	2747	4796	64%
51-1-3-3	318.3	17277	14641	2636	15%	13273	4004	23%
51-1-3-4	451.9	32776	15229	17547	54%	12427	20348	62%
51-1-4-3	399.3	26872	29425	0	0%	29425	0	0%
51-1-4-4	672.8	59040	40504	18536	31%	40504	18536	31%
51-1-5-3	25.9	1619	1513	106	7%	1349	270	17%

a. Losses refer to white and black spruce and balsam fir only.
b. Predicted timber volume in 1993.
c. Predicted percent of dead timber (loss) in 1993.
d. Type Aggregate: 10 = forest subtype (see Table 1).
1 = site type; 1 = moist, 3 = dry.
3 = harvesting or cutting class: 3 = immature; 4 = mature; 5 = overmature.
4 = crown closure class: 2 = 21-50%; 3 = 51-70%; 4 = >70%.

Table 2 [continued]: Current and predicted volume loss of timber to Spruce budworm by type aggregate.

2. BALSAM FIR WORKING GROUP

TYPE AGGREG.	AREA(ha)	1977 VOLUME(m^3)	1991 VOLUME(m^3)	VOLUME LOSS 1991(m^3)	% LOSS 1991	PREDICTED VOL(m^3)	PREDICTED LOSS (m^3)	PREDICTED LOSS
20-1-3-3	28.7	1975	1332	632	33%	1332	643	33%
21-1-3-3	568.2	37384	39774	0	0%	39774	0	0%
21-1-3-4	430.7	47015	26229	20786	44%	24847	22167	47%
21-1-4-3	133.6	9445	11235	0	0%	11235	0	0%
21-1-4-4	68.1	7640	4201	3439	45%	4038	3601	47%
60-1-3-3	190.8	10341	5457	4884	47%	5037	5303	51%
60-1-3-4	57.8	4514	2699	1815	40%	2560	1953	43%
60-1-4-4	34.6	2667	4612	0	0%	4612	0	0%
61-1-3-3	184.2	9810	15601	0	0%	10867	0	0%
61-1-3-4	541.3	44491	33723	10786	24%	33019	11474	26%
61-1-4-3	288.6	19574	16969	2605	13%	15988	3558	18%
61-1-4-4	433.6	31192	30134	1058	3%	28878	2314	7%

Table 2 [continued]: Current and predicted volume loss of timber to Spruce budworm by type aggregate.

3. BLACK SPRUCE WORKING GROUP

TYPE AGGREGATE	AREA(ha)	1977 VOLUME(m^3)	1991 VOLUME(m^3)	VOLUME LOSS 1991(m^3)	% LOSS 1991	PREDICTED VOL(m^3)	PREDICTED LOSS(m^3)	PREDICTED % LOSS
15-1-3-3	1842.2	135355	92797	42558	31%	92747	42588	31%
15-1-3-4	1300.6	122947	113802	9145	7%	113152	9795	8%
15-1-4-3	545.4	39502	29888	9614	24%	29397	10105	26%
15-1-4-4	151.1	23998	15789	8209	34%	15488	8510	35%
15-3-3-3	1258.1	72717	61520	11197	15%	61520	11197	15%
55-1-4-3	280.5	20612	25918	0	0%	25918	0	0%
58-1-3-4	30.2	2277	1661	616	27%	1661	616	27%

4. TREMBLING ASPEN WORKING GROUP

82-1-3-3	1166.7	30077	31033	0	0%	31033	0	0%
82-1-3-4	1987.8	78951	90046	0	0%	78518	432	1%
82-1-4-3	2424.5	81274	71280	9994	12%	66916	14358	18%
82-1-4-4	4339.4	191767	178783	12984	7%	172708	19059	10%
82-1-5-3	3625.6	116465	92419	24046	21%	84114	32351	28%
82-1-5-4	5943.1	261603	209792	51811	20%	204442	57160	22%

Table 3: Current and predicted volume loss of timber to Spruce budworm by working group[a].

WORKING GROUP	AREA(ha)	1977 VOLUME(m^3)	1991 VOLUME(m^3)	VOLUME LOSS 1991(m^3)	% LOSS 1991	PREDICTED VOL(m^3)	PREDICT LOSS(m^3)	PREDICTED % LOSS(m^3)
White Spruce[b]	2533	200715	155229	45486	23%	148836	51879	26%
Balsam Fir[c]	2960	226048	191066	34082	15%	182187	43861	19%
Black Spruce[d]	5407	417408	341375	76033	18%	339931	77477	19%
Trembling Aspen[e]	19487	760137	673353	86784	11%	637731	122406	16%
Totals	30387	1604308	1361923	242385	15%	1308685	295623	18%

a. Volumes and % loss refer only to the white spruce, balsam fir and black spruce components of the surveyed type aggregates.
b. Subtypes 10, 11, 50, and 51, site 1, cutting classes 3, 4, and 5 and crown closures 3 and 4.
c. Subtypes 20, 21, 60 and 61, site 1 cutting classes 3, 4, and 5 and crown closures 3 and 4.
d. Subtypes 15, 55 and 58, sites 1 and 3, cutting classes 3, 4 and 5 and crown closures 3 and 4.
e. Subtype 82, site 1, cutting classes 3, 4 and 5, and crown closures 3 and 4.

Table 4: Current and predicted volume loss of timber to Spruce budworm by cuuting class[a].

CUTTING CLASS	AREA(ha)	1977 VOLUME(m^3)	1991 VOLUME(m^3)	VOLUME LOSS 1991 (m^3)	% LOSS 1991	PREDICTED VOL (m^3)	PREDICTED LOSS(m^3)	PREDICTED % LOSS
3	10605	668078	559242	108836	16%	535133	132945	20%
4	10187	556543	498957	57586	10%	483649	72894	13%
5	9595	379687	303724	75963	20%	289905	89782	24%
TOTALS	30387	1604308	1361923	242385	15%	1308687	295621	18%

a. Includes all spruce budworm, vulnerable subtyes [10, 11, 15, 20, 21, 50, 51, 55, 58, 60, 61, and 82], sites 1 and 3 and crown closures 3 and 4 within the Abitibi-Price Inc. FML area. Volumes and % loss refer only to the white spruce, balsam fir and black spruce components of the surveyed type aggregates.

ARTHUR GRANT ROBINSON (1916-1992): TRIBUTE, BIBLIOGRAPHY, DESCRIBED APHID TAXA, AND DEPOSITIONS OF HIS APHID COLLECTION.

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A TRIBUTE

Grant Robinson, Professor Emeritus of Entomology at the University of Manitoba, died on 21 October 1992 at the age of 76 years. Grant was born in Wadena, Saskatchewan. His father was a school master, whose job required him to move frequently, and so Grant spent his youth in a succession of small towns in Saskatchewan. Grant obtained his Senior Matriculation at Langham High School in 1933, the height of the Great Depression. Of those times, two of Grant's recollections come to mind. One, how as a school boy, armed with tin can and wooden spoon, he walked the fields for pennies an hour, spreading bait for grasshopper control. The second, of how he, like many others, rode the rails in search of work.

In 1938, he joined the Princess Patricia Canadian Light Infantry. During the Second World War, he served overseas for five and a half years, and saw action in campaigns from North Africa to Germany. He was awarded the Military Cross for his service in Italy. Although he retired to civilian life in 1946, Grant served with the University of Manitoba contingent of the Canadian Officer Training Corps from 1953-1967, and retired at the rank of Lieutenant-Colonel after 7 years as Commanding Officer of the unit. In 1961, he received the Canadian Forces Decoration for service to the Canadian Armed Forces and Canada.

While in England during the war, he met and married Rose, his wife of almost 50 years, and in 1946 they moved to Winnipeg, where Grant began his university education. In 1950, he graduated from the University of Manitoba with a B.S.A. degree and the H.W. Kennedy Prize in Horticulture and Forestry. He earned his M.Sc. from McGill University in 1952, and his Ph.D. from the University of Manitoba in 1961. He gained experience in entomology during summer work at the Agriculture Canada Research Stations at Morden (1948) and Brandon (1949-52), Manitoba. After his M.Sc., he was a Research Officer at the Agriculture Canada Research Station in Vineland Station, Ontario, until, in 1953, he joined the Department of Entomology, University of Manitoba as an Assistant Professor. He became an Associate Professor in 1957, was promoted to Professor in 1966, and was Head of the Department from 1977 until his retirement in 1981. Then, the title "Professor Emeritus" was conferred upon him. For a decade following his retirement he continued to participate in the Department's activities, and to hold

Arthur Grant Robinson

research grants and be active in research.

Grant taught undergraduate courses in the areas of introductory entomology, insect control and insect taxonomy; he also taught graduate courses in taxonomy and economic entomology. His lecture style was not flamboyant, but it was effective. He was a kindly teacher who extracted the best from his graduate and undergraduate students. He supervised six Ph.D. and 13 M.Sc. students, all of whom remember him as an outstanding supervisor and teacher. He strongly believed that research should be approached methodically and with discipline. Most of his students worked on applied or basic aspects of Homoptera. Topics included the biology of the leafhopper, *Macrosteles fascifrons*, and aster yellows disease; effects of plant growth regulators and chemosterilants on aphids; interactions of aphids and their host plants; natural enemies of aphids; ant - aphid associations; and a series of taxonomic studies of aphids.

Grant was a key figure in the Department's extension activities on insect control. His name appeared on over 100 extension publications relating to insects of fruit, vegetables, field crops, trees and livestock. He also wrote the entomology section in all five editions of "Principles and Practices of Commercial Farming" produced by the Faculty of Agriculture. His breadth of taxonomic knowledge, and his long experience, enabled him to deal effectively with the numerous requests from the public and extension workers for insect identification and control recommendations. After his retirement, when his colleagues assumed this load, he remained an invaluable, willing, and frequently-consulted source of information.

Grant believed strongly in service and duty and this was evident when, as its head, he guided the Department of Entomology through some difficult times. His leadership benefited the discipline of Entomology far beyond the University of Manitoba. He served effectively on numerous university, professional society, and church committees, and was President of the Entomological Society of Manitoba for two terms. He was a member of the Canadian Colombo Plan Team at Khon Kaen University, Thailand 1969-1970. He served the Manitoba Institute of Agrologists in several capacities, and in 1981 the Institute awarded him a 25 year pin. He was a long-standing member of the Entomological Society of America, and regularly attended E.S.A. annual meetings. For his outstanding contributions to entomology, he was elected an Honorary Member of both the Entomological Society of Manitoba and the Entomological Society of Canada. In 1980, in recognition of his excellence in teaching, research and service, he was elected a Fellow of the Entomological Society of Canada.

Grant's greatest research love was aphid taxonomy, and in this area he had an international reputation. He and his graduate students collected aphids across Canada, but particularly in the North. He amassed one of the largest aphid collections in Canada, containing almost 100,000 specimens. He described 64 new species and four new genera of aphids; of the species he described, only two have since been synonymized. He published 76 scientific papers and was a participant and invited speaker in a number of international symposia dealing with aphids. He looked upon retirement as an opportunity to concentrate on his taxonomic research; for a full 10 years, he was to be found at his microscope almost every morning, and he produced a steady stream of research papers.

Grant Robinson demanded of himself great self-discipline and high standards of behaviour, and expected the same of those around him. At first contact, he did not reveal much of his inner self, and he could appear gruff and forbidding. Beneath this rather austere surface, was a kind, unselfish man with a quiet sense of humour, a man who was a true friend. His wise counsel was sought after by students and colleagues alike. He was, to use a currently fashionable word, a mentor; he had a ready ear, offered sound advice, and displayed the utmost discretion and integrity. He was a loving husband, and a doting father and grandfather. He is survived by his wife, Rose, whom he married in England in 1942, their daughter Shirley and her husband Jim, and two granddaughters Jodi and Dana.

To those of us who knew Grant well, he will be remembered as an officer, a gentleman, a splendid teacher, administrator and researcher - but most of all, as a dear friend. In early 1992, the Department of Entomology presented Grant with a plaque, to recognize a decade of post-retirement contribution to the Department. The plaque's inscription perhaps best encapsulates the esteem with which Grant was held by his colleagues and friends, it reads, in part, "... an inspiration to us all."

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A LIST OF THE APHID TAXA DESCRIBED BY A.G. ROBINSON

A.G. Robinson described four new genera and 64 new species, all of which are listed below. References for original descriptions are provided, along with page numbers for associated figures where these figures do not occur in the page series of the description.

alaskense, Uroleucon (Uroleucon) Robinson (1985) - The Canadian Entomologist, 117: 1035-1037. Type data: alate, Anchorage, Alaska, 24.vii.61., on *Achillea* sp. Type deposit: USNM. Current status: valid.

arnesense, Uroleucon (Uroleucon) Robinson (1985) - The Canadian Entomologist, 117: 1037-1038 (Fig. p.1036). Type data: apterous viviparous female, Arnes, Manitoba, 10.viii.71., on *Solidago* sp. Type deposit: CNC No. 18439. Current status: valid.

assiniboinensis, Acyrthosiphon Robinson (1973) - The Canadian Entomologist, 105: 813-814. Type data: apterous viviparous female, Winnipeg, Manitoba, 19.viii.71., on *Potentilla fruticosa* L. Type deposit: CNC No. 13034. Current status: valid.

barbarae, Aphis Robinson (1980) - The Canadian Entomologist, 112: 123-125. Type data: Winnipeg, Manitoba, 2.viii.63., on *Arctium minus* (Hill) Bernh. Type deposit: CNC No. 15989. Current status: valid.

boreale, Uroleucon (Uroleucon) Robinson (1985) - The Canadian Entomologist, 117: 1038-1039 (Fig. p.1036). Type data: apterous viviparous female, Yellowknife, Northwest Territories, 11.viii.78., on *Solidago* sp. Type deposit: CNC No. 18440. Current status: valid.

brevitarsus, Dactynotus Robinson (1974) - The Canadian Entomologist, 106: 467-469. Type data: alate viviparous female, Duck Mountain Provincial Park, Manitoba, 30.vii.73., on *Solidago* sp. Type deposit: CNC No. 13358. Current status: *Uroleucon (Lambersius) brevitarsus*.

bromi, Cryptaphis Robinson (1967) - The Canadian Entomologist, 99: 566-569. Type data: apterous viviparous female, Winnipeg, Manitoba, 17.v.65., on *Bromus inermis* Leyss. Type deposit: CNC No. 9444. Current status: valid.

bulleri, Aphis Robinson and Rojanavongse (1976) - The Canadian Entomologist, 108: 160-161. Type data: alate viviparous female, Winnipeg, Manitoba, 11.vi.71., on *Ribes aurium* Pursh. Type deposit: CNC No. 13917. Current status: valid.

canadensis, Kakimia Robinson (1968) - The Canadian Entomologist, 100: 276-279. Type data: apterous viviparous female, Willow Flat, Cub River Canyon, Idaho, 10.vii.67., on fruits of "twinberry". Type deposit: CNC No. 9652. Current status: *Delphiniobium canadense*.

capilanoensis, Aulacorthum Robinson (1969) - The Canadian Entomologist, 101: 1119-1120 (Fig. p.1118). Type data: apterous viviparous female, Vancouver, British Columbia, 19.vii.68., on *Rubus spectabilis* Pursh. Type deposit: CNC No. 10741. Current status: *Aulacorthum capilanoense*.

carberriense, Uroleucon (Lambersius) Robinson (1986) - The Canadian Entomologist, 118: 562-565. Type data: apterous viviparous female, Carberry, Manitoba, 15.viii.72., on *Chrysopsis villosa* (Pursh) Nutt. Type deposit: CNC No. 19073. Current status: valid.

chani, Uroleucon (Uroleucon) Robinson (1985) - The Canadian Entomologist, 117: 1039-1041. Type data: apterous viviparous female, Vancouver, British Columbia, 1.x.82., on *Grindelia nana* Nuttall. Type deposit: CNC No. 18441. Current status: valid.

chiengmaiensis, Greenidea (Trichosiphum) Robinson (1972) - The Canadian Entomologist, 104: 1927-1928 (Fig. p.1926). Type data: apterous viviparous female, Mount Sutep, near Chieng Mai, northwest Thailand, on unidentified woody shrub. Type deposit: CNC No. 12759. Current status: valid.

churchillense, Acrythosiphon Robinson (1979) - The Canadian Entomologist, 111: 447-450. Type data: alate viviparous female, Churchill, Manitoba, 23.vii.75., from sweeping mixed meadow. Type deposit: CNC No. 15838. Current status: *Acyrthosiphon churchillensis*.

clydesmithi, Macrosiphum (Sitobion) Robinson (1980) - The Canadian Entomologist, 112: 959-960. Type data: apterous viviparous female, Rogue River Forest, Oregon, 3.vi.78., on *Pteridium aquilinum* (L.) Kuhn. Type deposit: CNC No. 16174. Current status: *Sitobion clydesmithi*.

clydesmithi, Uroleucon (Lambersius) Robinson (1986) - The Canadian Entomologist, 118: 565-566 (Fig. p.563). Type data: apterous viviparous female, Doughton Park, North Carolina, 6-3-61, no host data. Type deposit: USNM. Current status: valid.

coloradensis, Uroleucon (Lambersius) Robinson (1986) - The Canadian Entomologist, 118: 566-567 (Fig. p.563). Type data: alate viviparous female, Estes Park, Colorado, 11.viii.77., on *Eriogonum flavum* Nutt. Type deposit: CNC No. 19074. Current status: *Uroleucon (L.) coloradense*.

cystopteris, Macrosiphum Robinson (1966) - The Canadian Entomologist, 98: 1253-1255. Type data: apterous viviparous female, State College (The Rock), Pennsylvania, 13.vi.65., on *Cystopteris bulbifera* (L.). Type deposit: CNC No. 9217. Current status: *Sitobion cystopteris*.

deltense, Uroleucon (Uroleucon) Robinson (1985) - The Canadian Entomologist, 117: 1042. Type data: apterous viviparous female, Delta Field Station, Delta Marsh, Manitoba, 26.vii.67., on *Lactuca pulchella* (Pursh) DC. Type deposit: CNC No. 18442. Current status: valid.

duckmountainensis, Aphis Rojanavongse and Robinson (1977) - The Canadian Entomologist, 109: 652-653 (Figs. p.654). Type data: alate viviparous female, Duck Mountain Provincial Forest, Manitoba, 20.vii.73., on *Senecio pauperculus* Michx. Type deposit: CNC No. 15067. Current status: valid.

elephantopicola, Uroleucon (Uroleucon) Robinson (1985) - The Canadian Entomologist, 117: 1042-1043 (Fig. p.1040). Type data: apterous viviparous female, Ware, Illinois, 9.3.60., on *Elephantopus carolianus*. Type deposit: USNM. Current status: valid.

floricola, Uroleucon (Uroleucon) Robinson (1988) - The Canadian Entomologist, 120: 583-584 (Fig. p.582). Type data: apterous viviparous female, Sunset Park, 11.ix.74., on *Aster* sp. Type deposit: CNC No. 19780. Current status: valid.

gallowayi, Aphis Robinson (1991) - The Canadian Entomologist, 123: 462-464. Type data: apterous vivipara, Bow Valley Provincial Park, Alberta, 13.vii.90., on *Astragalus pectinatus* Dougl. Type deposit: CNC No. 20920. Current status: valid.

hamiltoni, Macrosiphum Robinson (1968) - The Canadian Entomologist, 100: 275-276 (Figs. p.277). Type data: apterous viviparous female, Winnipeg, Manitoba, 19.vii.67., on *Humulus lupulus* L. Type deposit: CNC No. 9651. Current status: valid.

holodisci, Aphis Robinson (1984) - The Canadian Entomologist, 116: 853-854 (Fig. p.852). Type data: alate viviparous female, University of British Columbia campus, Vancouver, British Columbia, 26.v.81., on *Holodiscus discolor* Maxim. Type deposit: CNC No. 18128. Current status: valid.

hudsonicus, Capitophorus Robinson (1979) - The Canadian Entomologist, 111: 451-452 (Fig. p.448). Type data: apterous viviparous female, Churchill, Manitoba, 18.viii.77., from sweeping mixed vegetation. Type deposit: CNC No. 15840. Current status: valid.

ivae, Uroleucon (Uroleucon) Robinson (1985) - The Canadian Entomologist, 117: 1044-1047. Type data: alate viviparous female, St. Norbert, Manitoba, 24.vii.82., on *Iva xanthifolia* Nutt. Type deposit: CNC No. 18443. Current status: valid.

jeanae, Macrosiphum Robinson (1972) - The Canadian Entomologist, 104: 955-957. Type data: alate viviparous female, Telford, Whiteshell Forest Reserve, Manitoba, 20.vii.71., on *Sarracenia purpurea* L. Type deposit: CNC No. 12684. Current status: valid.

khasyae, Cinara Robinson (1972) - The Canadian Entomologist, 104: 1925-1927. Type data: apterous viviparous female, Mount Sutep, near Chieng Mai, northwest Thailand, 26.iii.70., on *Pinus khasya* Royale. Type deposit: CNC No. 12757. Current status: synonym of *Cinara atrotibialis* David and Rajasingh, 1968.

khonkaenensis, Tinocallis Danielsson and Robinson (1978) - The Canadian Entomologist, 109: 101-105. Type data: alate vivipara, Campus of Khon Kaen University, Khon Kaen, Thailand, 17.i.70., on *Lagerstroemia macropcarpa* Wall. Type deposit: CNC No. 15387. Current status: valid.

knowltoni, Myzodium Smith and Robinson (1975) - Proceedings of the Entomological Society of Washington, 77: 482-485. Type data: apterous viviparous female, Logan Canyon, Utah, 12.viii.62., no type host determined, but type specimen collected from sample of "moss" using a Berlese funnel. Type deposit: USNM. Current status: valid.

lambi, Macrosiphum (Sitobion) Robinson (1980) - The Canadian Entomologist, 112: 956-958. Type data: apterous viviparous female, Little Joe Lake, Algonquin Provincial Park, Ontario, 25.vii.77., on *Athyrium filixfemina* (L.) Roth. Type deposit: CNC No. 16175. Current status: *Sitobion lambi*.

longiunguis, Chaitophorus Robinson (1974) - The Canadian Entomologist, 106: 112 (Fig. p.111). Type data: apterous viviparous female, St. George, Utah, on *Salix* sp. Type deposit: CNC No. 13289. Current status: synonym of *Chaitophorus eoessigi* Hille Ris Lambers, 1966.

madderae, Aphis Robinson (1979) - The Canadian Entomologist, 111: 450 (Fig. p. 448). Type data: apterous viviparous female, Churchill, Manitoba, 18.viii.73., on *Taraxacum lacerum* Greene. Type deposit: CNC No. 15841. Current status: valid.

manitobensis, Aphis Robinson and Rojanavongse (1976) - The Canadian Entomologist, 108: 162-163. Type data: alate viviparous female, Winnipeg, Manitoba, 28.vi.74., on *Ribes* sp. Type deposit: CNC No. 13918. Current status: valid.

manitobensis, Macrosiphum (Sitobion) (Robinson) (1965) - The Canadian Entomologist, 97: 1011-1012 (Figs. p.1013); holotype, apterous, viviparous female. Type data: Winnipeg, Manitoba, 6.vi.63., on *Cornus stolonifera* Michx. Type deposit: CNC No. 8923. Current status: *Sitobion manitobense*.

manitobensis, Uroleucon (Lambersius) Robinson (1986) - The Canadian Entomologist, 118: 570-571 (Fig. p.563). Type data: alate viviparous female, Agassiz Provincial Forest, 18.vii.78., swept from mixed herbaceous plants. Type deposit: CNC No. 19075. Current status: *Uroleucon (L.) manitobense*.

maximilianicola, Uroleucon (Uroleucon) Robinson (1985) - The Canadian Entomologist, 117: 1047-1048 (Figs. p.1045). Type data: alate viviparous female, Winnipeg, Manitoba, 22.viii.65., on *Helianthus maximiliani*. Type deposit: CNC No. 18444. Current status: valid.

menziesiae, Masonaphis Robinson (1969) - The Canadian Entomologist, 101: 1116-1117 (Fig. p.1118). Type data: apterous viviparous female, Lake Louise, Alberta, 16.vii.68., on *Menziesia ferruginea* Smith. Type deposit: CNC No. 10742. Current status: *Illinoia (Masonaphis) menziesiae*.

neomonardae, Aphis Rojanavongse and Robinson (1977) - The Canadian Entomologist, 109: 655-657. Type data: alate viviparous female, Patricia Beach, Manitoba, 3.vii.73., on *Agastache foeniculum* (Pursh) Ktze. Type deposit:CNC No. 15069. Current status: valid.

nevadensis, Uroleucon (Lambersius) Robinson (1986) - The Canadian Entomologist, 118: 571 (Fig. p.572). Type data: apterous viviparous female, Pyramid Lake, Nevada, 2.vii.79., on *Brickelia microphylla*. Type deposit: collection of the Illinois Natural History Survey. Current status: *Uroleucon (L.) nevadense*.

nigratibialis, Aphis Robinson and Chen (1969) - The Canadian Entomologist, 101: 524-526. Type data: alate viviparous female, Cub River Canyon, Idaho, 13.vii.65. on *Cornus stolonifera* Michx. Type deposit: CNC No. 10337. Current status: valid.

olmsteadi, Macrosiphum Robinson (1965) - The Canadian Entomologist, 97: 1009-1011 (Figs. p.1013); holotype, apterous viviparous female. Type data: Vermilion Bay, Ontario, 8.vii.63., on *Aster* sp. Type deposit: CNC No. 8924. Current staus: valid.

Papulaphis Robinson (1966) - The Canadian Entomologist, 98: 1256. **New genus**, with type species *Macrosiphum sleesmani* Pepper, 1950. Current status: valid.

patriciae, Masonaphis Robinson (1969) - The Canadian Entomologist, 101: 1115-1117 (Fig. p.1118). Type data: alate, viviparous female, Vancouver, British Columbia, 19.vii.68., on *Tsuga heterophylla* (Raf.). Type deposit: CNC No. 10743. Current status: *Illinoia (Masonaphis) patriciae*.

paucisetosa, Macrosiphoniella Robinson (1987) - The Canadian Entomologist, 119: 917-918. Type data: apterous viviparous female, Sandilands Forest Reserve, Manitoba, 12.viii.66., on *Artemisia ?abrotanum*. Type deposit: CNC No. 19652. Current status: valid.

penderum, Uroleucon (Lambersius) Robinson (1986) - The Canadian Entomologist, 118: 571-574. Type data: apterous viviparous female, Pender Island, British Columbia, 31.vii.84., on *Grindelia integrifolia* DC. Type deposit: CNC No. 19076. Current status: valid.

pinawae, Masonaphis Robinson (1973) - The Canadian Entomologist, 105: 814-815. Type data: apterous viviparous female, Pinawa, Manitoba, 11.viii.72., on *Ledum groenlandicum* Oeder. Type deposit: CNC No. 13035. Current status: *Illinoia (Masonaphis) pinawae*.

Pseudasiphonaphis Robinson (1965) - The Canadian Entomologist, 97: 1009. **New genus**, with type species *Asiphonaphis anogis* Hottes and Frison, 1931 = *Pergandeida corni* Tissot, 1929. Current status: valid.

richardsi, Dactynotus Robinson (1964) - The Canadian Entomologist, 96: 1330-1332. Type data: apterous viviparous female, Winnipeg, Manitoba, 15.viii.63., on *Grindelia squamosa* (Pursh) Dunal. Type deposit: CNC No. 8452. Current status: *Uroleucon (Lambersius) richardsi*.

rubiradicis, Aphis Robinson (1969) - The Canadian Entomologist, 101: 1117-1119. Type data: apterous viviparous female, La Ronge, Saskatchewan, 6.viii.68., on *Rubus chamaemorus*. Type deposit: CNC No. 10740. Current status: valid.

sandilandica, Nasonovia (Hyperomyzus) Robinson (1974) - The Canadian Entomologist, 106: 471-472 (Fig. p.468). Type data: alate, viviparous female, Sandilands Provincial Forest, Manitoba, 27.vi.73., on *Crepis tectorum* L. Type deposit: CNC No. 13361. Current status: *Hyperomyzus (Neonasonovia) sandilandicus*.

schuhi, Aphis Robinson (1984) - The Canadian Entomologist, 116: 851-852. Type data: apterous viviparous female, Gresham, Oregon, 7.vii.42., on *Holodiscus discolor* Maxim. Type deposit: CNC No. 18127. Current status: valid.

shiloensis, Misturaphis Robinson (1967) - The Canadian Entomologist, 99: 565-566 (Figs. p.567). **New genus** (p. 565). Type data: apterous viviparous female, Camp Shilo, Manitoba, 6.vi.65, on *Artemisia caudata* Michx. Type deposit: CNC No. 9443. Current status: valid.

stoetzelae, Uroleucon (Lambersius) Robinson (1988) - The Canadian Entomologist, 120: 581-583. Type data: apterous viviparous female, 10.ix.74., on *Achillea millefolium* L. Type deposit: CNC No. 19779. Current status: valid.

stolonis, Amphorophora Robinson (1974) - The Canadian Entomologist, 106: 470-471 (Fig. p.468). Type data: apterous viviparous female, Pine Grove Halt, Sandilands Provincial Forest, Manitoba, 27.vi.73., on *Rubus pubescens* Raf. Type deposit: CNC No. 13360. Current status: valid.

subarcticum, Macrosiphum Robinson (1979) - The Canadian Entomologist, 111: 454-456 (Fig. p.448). Type data: alate viviparous female, Churchill, Manitoba, 18.viii.77., on *Epilobium angustifolium* L. Type deposit: CNC No. 15839. Current status: valid.

suzannae, Uroleucon (Lambersius) Robinson (1986) - The Canadian Entomologist, 118: 574 (Figs. p.572). Type data: apterous viviparous female, Elk Flat, Umatilla National Forest, Oregon, 9.viii.79., on *Haplopappus hirtus* var. *sonchiolius*. Type deposit: collection of the Illinois Natural History Survey. Current status: valid.

thailandicum, Tritrichosiphum Robinson (1972) - The Canadian Entomologist, 104: 606-608. **New genus**. Type data: apterous viviparous female, Khon Kaen, Thailand, 3.x.69., on *Dipterocarpus tuberculatus* Roxb. Type deposit: CNC No. 12667. Current status: valid.

valuliae, Myzus Robinson (1974) - The Canadian Entomologist, 106: 469 (Fig. p.468). Type data: alate viviparous female, Birds Hill Provincial Park, Manitoba, on *Fragaria vesca* L. Type deposit: CNC No. 13359. Current status: *Ovatus valuliae*.

vancouverense, Uroleucon (Uroleucon) Robinson (1985) - The Canadian Entomologist, 117: 1050-1051 (Fig. p.1045). Type data: apterous viviparous female, University of British Columbia campus, Vancouver, British Columbia, 13.ix.78., on *Solidago canadensis* L. var. *salesbrosa*. Type deposit: CNC No. 18445. Current status: valid.

villosae, Pleotrichophorus Robinson (1974) - The Canadian Entomologist, 106: 111-112. Type data: apterous viviparous female, Carberry, Manitoba, 10.vii.72., on *Chrysopsis villosa* (Pursh) Nutt. Type deposit: CNC No. 13290. Current status: valid.

walkeri, Macrosiphum (Sitobion) Robinson (1980) - The Canadian Entomologist, 112: 960-961 (Fig. p.959). Type data: alate viviparous female, Arcadia, California, 29.iv.69., on *Nephrolepis exaltata* (L.) Schott. Type deposit: CNC No. 16176. Current status: *Sitobion walkeri.*

whiteshellensis, Aphis Rojanavongse and Robinson (1977) - The Canadian Entomologist, 109: 658-660. Type data: alate viviparous female, Pinawa, Manitoba, 12.vii.71., on *Amelanchier alnifolia* Nutt. Type deposit: CNC No. 15068. Current status: valid.

woodsiae, Macrosiphum (Sitobion) Robinson (1980) - The Canadian Entomologist, 112: 958-959 (Fig. p.957). Type data: apterous viviparous female, Yellowknife, Northwest Territories, 12.viii.78., on *Woodsia ilvensis* (L.) R. Br. Type deposit: CNC No. 16177. Current status: *Sitobion woodsiae.*

yongyooti, Macrosiphum (Sitobion) Robinson (1972) - The Canadian Entomologist, 104: 1928-1929 (Fig. p.1926). Type data: apterous viviparous female, Mount Sutep, near Chieng Mai, northwest Thailand, 26.iii.70., on unidentified shrub. Type deposit: CNC No. 12758. Current status: *Sitobion yongyooti.*

LIST OF SPECIES OF APHIDS IN THE COLLECTION OF A.G. ROBINSON

Compiled by A.G. Robinson

One of the last projects Grant Robinson completed was to catalogue the species of aphids held in his collection. This list was hand written, and the following list was derived from it, with slight modifications to indicate specimens donated to the Canadian National Collection and the United States National Museum. In addition to deposition of specimens from type series, Grant made major donations to these museums on two separate occasions. In some cases, Grant sent individual specimens or short series to these museums, and none were kept at the University of Manitoba. Grant maintained detailed accounts of specimens sent to each of these museums, and these records greatly facilitated preparation of the following list, which includes 1177 identified taxa. Grant was very generous with material he collected and that he thought might be useful to other researchers, especially those starting in aphid taxonomy. No attempt was made to document all these donations. Except where indicated, specimens of each of the listed taxa are held in the J.B. Wallis Museum of Entomology, Department of Entomology, University of Manitoba.

[1] Specimens deposited in the Canadian National Collection, Ottawa.
[2] Specimens deposited in the United States National Museum of Natural History.
[*] No specimens deposited in the J.B. Wallis Museum of Entomology.

Acaudinum centaureae (Koch)*,1
Acuticauda erigerontis Leclant and Remaudière
Acyrthosiphon assiniboinensis Robinson[1,2]
" *asterfoliae* (Strom)[1,2]
" *brachysiphon* Hille Ris Lambers
" *brevicornis* Hille Ris Lambers[1,2]
" *caraganae* (Cholodkovsky)[1,2]
" *churchillensis* Robinson[1,2]
" *cyparissiae* (Koch)
" *gossypii* Mordvilko
" *ignotus* Mordvilko*,1
" *kondoi* Shinji[1,2]
" *lactucae* (Passerini)[1,2]
" *lambersi* Leclant and Remaudière
" *macrosiphum* (Wilson)[1,2]
" *malvae* (Mosley)[1,2]
" *pisum* (Harris)[1,2]
" *pseudodirhodum* (Patch)[1,2]
Adelges spp. (Chermidae)[1,2]
Aiceona? longisetosa Ghosh and RayChaudhuri*,1
Akkaia polygoni Takahashi[1,2]
" *taiwana* Takahashi[1,2]
Aleurodaphis blumeae van der Groot*,1
Aloephagus myersi Essig
Alphitoaphis lonicericola (Williams)[1,2]
Amegosiphon platicaudum (Nazikulov)
Amphicercidus flocculosus (Gillette and Palmer)[1,2]
" *pulverulens?* (Gillette)*,1
Amphorophora agathonica Hottes[1,2]
" *ampullata* Buckton*,1
" *ampullata laingi* Mason[1,2]
" *amurensis* (Mordvilko)*,1
" *geranii* Gillette and Palmer[1,2]
" *parviflori* Hill (complex of species)
" *pawtincae* Hottes[1,2]
" *rossi* Hottes and Frison*,1,2
" *rubi* (Kaltenbach)[1,2]
" *rubicumberlandi* Knowlton and Allen
" *rubitoxica* Knowlton[1,2]
" *stachyophila* Hille Ris Lambers[1,2]
" *stolonis* Robinson[1,2]

Amphorophora tigwatensa Hottes
" *urtica* Essig
Anoecia corni (Fabricius)
" *cornicola* (Walsh)
Antalus albatus Adams[*,1]
Anuraphis cachyros Barbagello and Stroyan
" *catonii* Hille Ris Lambers[*,1]
" *farfarae* (Koch)[*,1]
" *pyrilaseri* Shaposhnikov[1]
" *subterranea* (Walker)[*,1]
Anuromyzus cotoneasteris Shaposhnikov
Aphidura delmasi Remaudière and Leclant
" *ornata* Hille Ris Lambers[*,1]
Aphis acetosae Linnaeus[*,1]
" *achyranthi* Theobald [*,1,2]
" *agastrachyos* Hille Ris Lambers[1,2]
" *amoraciae* Cowan[1,2]
" *asclepiadis* Fitch[1,2]
" *astragalina* Hille Ris Lambers[1,2]
" *barbarae* Robinson[1,2]
" *brohmeri* Börner[*,1]
" *brunnea* Ferrari
" *bulleri* Robinson and Rojanavongse[1]
" *cacaliasteris* Hille Ris Lambers
" *caliginosa* Hottes and Frison[1]
" *ceanothi* Clarke[1,2]
" *cephalanthi* Thomas[1,2]
" *chloris* Koch[1,2]
" *citricola* van der Groot[*,1,2] (=*A. spiraecola* Patch)
" *confusa* Walker[1]
" *coreopsidis* (Thomas)[1,2]
" *cornifoliae* Fitch[1,2]
" *coweni* Palmer[1,2]
" *craccae* Linnaeus[1,2]
" *craccivora* Koch[1,2]
" *crinosa* Paik[*,1]
" *cytisorum* Hartig[1,2]
" *decepta* Hottes and Frison[1,2]
" *duckmountainensis* Rojanavongse and Robinson[1,2]
" *epilobiaria* Theobald[1,2]
" *epilobii* Kaltenbach[1,2]

Aphis equiseticola Ossiannilsson
" *esulae?* (Börner)
" *etiolata* Stroyan*,1
" *euphorbiae* Kaltenbach
" *fabae* Scopoli[1,2]
" *fabae solanella* Theobald[1,2]
" *farinosa* Gmelin[1,2]
" *feminea* Hottes*,1
" *folsomii* Davis*,1
" *forbesi* Weed[1,2]
" *fraserae* Gillette and Palmer[1,2]
" *galiiscabri* Schrank*,1
" *gallowayi* Robinson[1]
" *genistae* Scopoli[1,2]
" *glycines* Matsumura[1,2]
" *gossypii* Glover[1,2]
" *gregalis* Knowlton[1,2]
" *grossulariae* Kaltenbach[1,2]
" *hamamelidis* Pepper[1,2]
" *hardyi* Eastop*,1,2
" *hederae* Kaltenbach[1,2]
" *helianthi* Monell[1,2]
" *heraclella* Davis[1,2]
" *hieracii* Schrank*,1
" *holodisci* Robinson[1,2]
" *horii* Takahashi*,1
" *hypochoeridis* (Börner)*,1
" *ichigo* Shinji*,1
" *idaei* van der Groot[1,2]
" *ilicis* Kaltenbach[1,2]
" *illinoisensis* Shimer[1,2]
" *impatientis* Thomas[1,2]
" *jacobaeae* Schrank*,1
" *knowltoni* Hottes and Frison[1,2]
" *longisetosa* Basu*,1,2
" *lugentis* Williams[1,2]
" *lupini* Gillette and Palmer[1,2]
" *maculatae* Oestlund[1,2]
" *madderae* Robinson[1]
" *maidiradicis* Forbes*,1
" *manitobensis* Robinson and Rojanavongse[1,2]

Aphis masoni Richards[1,2]
" *menthaeradicis*? Cowan
" *mirifica* (Börner)[1,2]
" *nasturtii* Kaltenbach[1,2]
" *neilliae* Oestlund[1,2]
" *neogillettei* Palmer[1,2]
" *neomexicana* (Cockerell and Cockerell)[1,2]
" *neomonardae* Rojanavongse and Robinson[1,2]
" *nerii* Boyer de Fonscolombe[1,2]
" *nigratibialis* Robinson[1,2]
" *nivalis* Hille Ris Lambers[1,2]
" *oenotherae* Oestlund[1,2]
" *oestlundi* Gillette[1,2]
" *parietariae* Theobald
" *pawneepae* Hottes[1]
" *pentstemonicola* Gillette and Palmer[1]
" *plantaginis* Geoze[*,1,2]
" *podagrariae* Schrank[1,2]
" *polygonata* (Nevsky)[*,1]
" *pomi* de Geer[1,2]
" *psammophila* Szelegiewicz[*,1]
" *pseudocomosa* Stroyan[*,1]
" *pseudohederae* Theobald[1,2]
" *pulsatillae* Ossiannilsson[*,1]
" *punicae* Passerini[*,1,2]
" *ramona* Swain[*,1]
" *ribiensis* Gillette and Palmer[1,2]
" *rubicola* Oestlund[1,2]
" *rubiradicus* Robinson[1,2]
" *rumicis* Linnaeus[1,2]
" *salicariae* Koch[1,2]
" *salviae* Walker
" *sambuci* Linnaeus[1,2]
" *sanguisorbae* Schrank
" *saniculae* Williams[1,2]
" *schneideri* Börner[1,2]
" *schuhi* Robinson[1,2]
" *sedi* Kaltenbach[1,2]
" *senecionis*? Williams
" *spiraecola* Patch
" *spiraephaga* Müller[1,2]

Aphis spiraephila Patch[1,2]
" *taraxicicola* (Börner)[1]
" *tetradymia* Knowlton[1,2]
" *thaspii* Oestlund[1,2]
" *trifolii* Oestlund
" *trigolochnis* Theobald[*,1]
" *ulicis* Walker[*,1]
" *ulmariae* Schrank[*,1]
" *urticata* Gmelin
" *vaccinii* (Börner)[*,1]
" *valerianae* Cowen
" *vallei* Hille Ris Lambers and Stroyan
" *varians* Patch[1,2]
" *verbasci* Schrank[1,2]
" *veroniae* Thomas[1,2]
" *viburniphila* Patch[1,2]
" *violae* Schouteden[*,1,2]
" *whiteshellensis* Rojanavongse and Robinson[1,2]
Aphis spp. (many slides, new species or unidentified)
" spp. (unidentified; from Mexico)
Aphthargelia symphoricarpi (Thomas)[1,2]
Aploneura lentisci (Passerini)[1]
Appendiseta robiniae (Gillette)[1,2]
Artemisaphis artemisicola (Williams)
Asiphonaphis pruni Wilson and Davis[1,2]
Asiphonella dactylonii Theobald[1,2]
Aspidaphis adjuvans (Walker)[1,2]
Aspidaphium escherichi Börner[1,2]
" *utahensis* Smith and Knowlton[1,2]
Astygopteryx spp.[*1,2] Many unidentified specimens mounted on slides.
Atarsos grindeliae Gillette[1,2]
Atheroides serrulatus Haliday[*,1,2]
Aulacorthum capilanoense Robinson[1,2]
" *cercidiphylli* (Matsumura)[*,1]
" *cirsicola* (Takahashi)[*,1]
" *ibotum* (Essig and Kuwana)[*,1]
" *magnoliae* (Essig and Kuwana)[*,1,2]
" *murdachi* (Shinji)[*,1]
" *nipponicum* (Essig and Kuwana)[*,1]
" *pterinigrum* Richards
" *solani* (Kaltenbach)[1,2]

Aulacorthum syringae (Matsumura)[*,1,2]
" *vaccinii* Hille Ris Lambers[*,1,2]
" *(Neomyzus) circumflexum* (Buckton)[1,2]
Aulacorthum spp. Many unidentified specimens mounted on slides.
Baizongia pistaciae (Linnaeus)[1]
Betulaphis brevipilosa Börner[*,1]
" *quadrituberculata* (Kaltenbach)[1,2]
Bipersona ochrocentri (Cockerell)[1,2]
Boernerina depressa Bramstedt
" *variablilis* Richards[1,2]
Boernerina (Boernerinella) occidentalis Hille Ris Lambers and Hottes[1,2]
Brachycaudus divaricatae Shaposhnikov
" *helichrysi* (Kaltenbach)[1,2]
" *lucifugus* F.P. Muller
" *mimeuri* Remaudière
" *spiraeae* Börner
" *(Acaudus) aconiti* (Mordvilko)
" " *cardui* (Linnaeus)[1,2]
" " *lychnidis* (Linnaeus)[*,1]
" " *malvae* Shaposhnikov
" " *napelli* (Schrank)[*,1]
" " *persicae* (Passerini)[*,1,2]
" " *rociadae* (Cockerell)[1]
" *(Appelia) prunicola* (Kaltenbach)[1]
" " *schwartzi* (Börner)[1,2]
" *(Thuleaphis) rumexicolens* (Patch)[*,1]
" " *amygdalinus* (Schoutenden)
Brachycaudus spp.[*,2] Many unidentified specimens mounted on slides.
Brachycolus cerastii (Kaltenbach)[*,1,2]
" *stellariae* (Hardy)
Brachycorynella asparagi (Mordvilko)[1,2]
Brachysiphoniella montana (van der Groot)[*,1,2]
Brachysiphum thalictri (Koch)[*,1]
Brachyunguis bonnevillensis (Knowlton)[1,2]
" *(Xerophilaphis) blanchardi* Remaudière
Braggia eriogoni (Cowen)[1,2]
" *uncompahgrensis* Hottes[*,1]
" *urovaneta* (Hottes)[1,2]
" *urovaneta pachysiphon* Hille Ris Lambers[*,1,2]
Braggia spp.[*,1,2] Many unidentified specimens mounted on slides.
Brevicoryne brassicae (Linnaeus)[1,2]

Brevicoryne spp.*,2 Many unidentified specimens mounted on slides.
Bursaphis solitaria Baker
Cachyphora canadensis Hille Ris Lambers
" *serotinae* (Oestlund)
Calaphis alnosa Pepper*,1
" *betulaecolens* (Fitch)1,2
" *betulella* Walsh*,1
" *betulicola* (Kaltenbach)*,1
" *castaneae* (Fitch)1,2
" *coloradensis* Granovsky*,1,2
" *flava* Mordvilko*,1
" *manitobensis* Richards
" *viridipallida*? Palmer1,2
Calaphis spp.*,1,2 Many unidentified specimens mounted on slides.
Callaphis juglandis (Goeze)*,1
Callipterinella callipterus (Hartig)1,2
" *minutissima* (Stroyan)*,1
" *tuberculata* (von Heyden)1
Capitophorus carduinus (Walker)1
" *elaeagni* (del Guercio)1,2
" *hippophaes* (Walker)1,2
" *hippophaes javanicus* Hille Ris Lambers1,2
" *horni* Börner*,1
" *hudsonicus* Robinson1,2
" *similis* van der Groot*,1,2
" *xanthii* (Oestlund)1,2
Caricosipha paniculatae Börner1
Carolinaia caricis Wilson1
" *cyperi* Ainslie1
" *rhois* Tissot1
Catamergus fulvae (Oestlund)1
" *kickapoo* (Hottes and Frison)1,2
Cavariella aegopodii (Scopoli)1,2
" *araliae* Takahashi*,1
" *archangelicae* (Scopoli)*,1
" *digitata* Hille Ris Lambers1,2
" *japonica* (Essig and Kuwana)*,1
" *konoi* Takahashi1,2
" *pastinacae* (Linnaeus)1,2
" *salicicola* (Matsumura)*,1
" *salicis* (Monell)1,2

Cavariella sapporoensis (Takahashi)[*,1]
" *theobaldi* (Gillette and Bragg)[1,2]
" *(Cavaraiella) aquatica* (Gillette and Bragg)[1,2]
Cavariella sp.[*,1]
Cedoaphis incognita Hottes and Frison[1]
Cedrobium laportei Remaudière
Cepegillettea betulifoliae Granovsky[1,2] (=*Calaphis betulifoliae*)
" *myricae* (Patch)[1,2] (=*Calaphis myricae*)
Cerataphis orchidearum (Westwood)[1,2]
" *variabilis* Hille Ris Lambers[1,2] (=*palmae* Ghesquiere)
Ceratoglyphina sp.[*,1] Many unidentified specimens mounted on slides.
Ceratovacuna japonica (Takahashi)[*,1]
" *lanigera* Zehntner[*,1]
" *nekoashi* (Sasaki)[*,1]
Ceruaphis eriophori (Walker)[1,2]
" *viburnicola* (Gillette)[1,2]
Cervaphis quercus Takahashi[*,1]
" *rappardi* Hille Ris Lambers[*,1]
" *schouteniae* van der Groot[1,2] (=*cambodiensis* Takahashi)
Chaetosiphon (Pentatrichopus) coreanum (Paik)[*,1]
" " *fragaefolii* (Cockerell)[1,2]
" " *hottesi* Stroyan
" " *minus* (Forbes)[1,2]
" *scalaris* Richards[1,2]
" *(Pentatrichopus) tetrarhodum* (Walker)[1,2]
Chaitophorus capreae (Mosley)[*,1]
" *chinensis* Takahashi[*,1]
" *eoessigi* Hille Ris Lambers[1,2] (=*longiunguis* Robinson)
" *horii beuthani* Börner[*,1]
" *kapuri* Hille Ris Lambers
" *lapponum* Ossiannilsson[*,1]
" *leucomelas* Koch[*,1]
" *macrostachyae* (Essig)[1,2]
" *nigrae* Oestlund[1,2]
" *nigricentrus* Richards[1,2]
" *nudus* Richards[1,2]
" *pakistanicus* Hille Ris Lambers
" *parvus* Hille Ris Lambers[*,1]
" *populeti* (Panzer)[*,1,2]
" *populialbe* (Boyer de Fonscolombe)[1,2]
" *populicola* Thomas[1,2]

Chaitophorus populifolii (Essig)[1,2]
" *populifolii neglectus* Hottes and Frison[1,2]
" *pusillus* Hottes and Frison[1,2]
" *pustulatus* Hille Ris Lambers
" *saliciniger* (Knowlton)[1,2]
" *salicti* (Schrank)[*,1]
" *salijaponicus niger* Mordvilko[*,1,2]
" *stevensis* Sanborn[1,2]
" *tremulae* Koch[1,2]
" *viminalis* Monell[1,2]
" *vitellinae* (Schrank)[*,1]
Chaitophorus spp.[*,1] Many unidentified specimens mounted on slides.
Chromaphis juglandicola (Kaltenbach)[1,2]
Cinara apini (Gillette and Palmer)[1,2]
" *arizonica* (Wilson)[*,1]
" *atlantica* (Wilson)[1]
" *atrotibialis* David and Rajasingh[1,2]
" *banksiana* Pepper and Tissot[1,2]
" *braggii* (Gillette)[1,2]
" *brevispinosa* (Gillette and Palmer)[1,2]
" *burrilli*? (Wilson)
" *canatra* Hottes and Bradley[1,2]
" *cedri* Mimeur
" *chinookiana* Hottes[*,1]
" *coloradensis* (Gillette)[1,2]
" *confinis* (Koch)[1]
" *costata* (Zetterstedt)[1]
" *cupressi* (Buckton)[1]
" *curvipes* (Patch)[1,2]
" *ferrisi* (Swain)[1,2]
" *fornacula* Hottes[1]
" *fresai* Blanchard[*,1,2]
" *harmonia* Hottes[1,2]
" *hottesi* (Gillette and Palmer)[1,2]
" *juniperi* (de Geer)[1,2]
" *kuchea* Hottes[*,1]
" *laricifex* (Fitch)[1,2]
" *manitobensis* Bradley[*,1]
" *medispinosa* (Gillette and Palmer)[*,1,2]
" *melaina* Boudreaux[*,1]
" *nigripes* Bradley[*,1]

Cinara obscura Bradley[1,2]
" *occidentalis* (Davidson)[*,1,2]
" *ontarioensis* Bradley[1,2]
" *oregonensis* (Wilson)[*,1]
" *pectinatae* (Nördlinger)[*,2]
" *pergandei* (Wilson)[1,2]
" *petersoni* Bradley[1,2]
" *piceae* (Panzer)[*,1]
" *pilicornis* (Hartig)[*,1]
" *pinea* (Mordvilko)[1,2]
" *pini* (Linnaeus)[*,1]
" *piniformosana* (Takahashi)[*,1]
" *piniradicis* Bradley[*,1]
" *pinivora* (Wilson)[*,1]
" *ponderosae* (Williams)[*,1]
" *pruinosa* (Hartig)[*,1,2]
" *pseudotaxifoliae* Palmer[1,2]
" *pseudotsugae* (Wilson)[*,1]
" *sabinae* (Gillette and Palmer)[*,1,2]
" *spiculosa* Bradley[1,2]
" *splendens* (Gillette and Palmer)[1,2]
" *strobi* (Fitch)[1,2]
" *stroyani* Pašek[*,1]
" *subterranea* Bradley[1,2]
" *thatcheri* Knowlton and Smith[*,1]
" *tsugae* Bradley[*,1]
" *tujafilina* (del Guercio)[1,2]
" *villosa* Gillette and Palmer[*,1]
" *watsoni* Tissot
" *winonkae* Hottes (=*tujafilina* (del Guercio))
Cinara spp.[*,1] Many unidentified specimens mounted on slides.
Clethrobius comes (Walker)[*,1]
Colopha compressa (Koch)[*,1]
" *graminis* (Takahashi)[1,2] (=*C. ulmicola* (Fitch))
Colopha? spp.[*,1]
Coloradoa absinthii (Lichtenstein)
" *achilleae* Hille Ris Lambers
" *artemisiae* (del Guercio)
" *bournieri* Remaudière and Leclant
" *inodorella* Ossiannilsson
" *palmerae* Börner

Coloradoa rufomaculata (Wilson)*,1,2
" *tanacetina* (Walker)
Cornaphis populi Gillette[1,2]
Corylobium avellanae (Schrank)[1,2]
Cryptaphis bromi Robinson[1,2]
" *geranicola* (Shinji)*,1
" *poae* Hardy*,1,2
Cryptomyzus ballotae Hille Ris Lambers
" *galeopsidis* (Kaltenbach)[1,2]
" *ribis* (Linnaeus)[1,2]
Cryptosiphum artemisiae Buckton[1]
Crypturaphis grassii Silvestri*,1
Ctenocallis israelicus Hille Ris Lambers
" *setosus* (Kaltenbach)[1,2]
Decorosiphon corynothrix Börner[1,2]
Defractosiphon brevisiphon Mamontova
" *caucasicus* Mamontova
Delphiniobium canadense (Robinson)[1,2]
" *junackianum* (Karsch)*,1
" *lycoctoni* Börner[1]
" *yezoense* Miyazaki*,1
Diphyllaphis konarae (Shinji)*,1
" *microtrema* Quednau*,1
Diuraphis noxia (Mordvilko)
" *(Holcaphis) agrostidis* (Muddathir)*,1
" " *frequens* (Walker)[1,2]
" " *holci* (Hille Ris Lambers)*,1,2
" " *tritici* (Gillette)[1,2]
Drepanaphis acerifoliae (Thomas)[1,2]
" *carolinensis* Smith[1,2]
" *choanotricha* Smith and Dillery*,1
" *granovskyi* Smith and Knowlton[1,2]
" *idahoensis* Smith and Dillery[1,2]
" *kanzensis* Smith[1]
" *keshenae* Granovsky*,1
" *knowltoni* Smith and Dillery[1]
" *monelli* (Davis)*,1
" *nigricans* Smith*,1
" *parva* Smith*,1
" *sabrinae* Miller*,1
" *saccharini* Smith and Dillery*,1

Drepanaphis simpsoni Smith[*,1]
" *spicata* Smith[1,2]
" *utahensis* Knowlton and Smith[1,2]
" *(Shenahweum) minuta* Davis[*,1]
Drepanosiphum acerinum (Walker)[*,1,2]
" *aceris* Koch
" *braggii* Gillette[1,2]
" *oregonense* Granovsky[*,1,2]
" *platanoidis* (Schrank)[1,2]
Durocapillata utahensis Knowlton[1,2]
Dysaphis apiifolia petroselini (Börner)[1]
" *brachycyclica* Shaposhnikov
" *cotoneasteris* (Shaposhnikov)
" *crataegi* (Kaltenbach)[1]
" *cynarae* (Theobald)[*,1]
" *devecta* (Walker)[1,2]
" *foeniculus* (Theobald)[1,2]
" *hirsutissima* (Börner)[1,2]
" *leefmansi* (Hille Ris Lambers)[*,1]
" *microsiphon* (Nevsky)
" *physocaulis* Shaposhnikov
" *physocaulis pyri* (Boyer de Fonscolombe)[1]
" *radicola* (Mordvilko)[1]
" *radicola meridialis* Shaposhnikov (=*meridialis* Shaposnikov)
" *ranunculi* (Kaltenbach)[*,1]2
" *tulipae* (Boyer de Fonscolombe)[1,2]
" *(Pomaphis) plantaginea* (Passerini)[1,2]
" " *sorbi* (Kaltenbach)[1,2]
Elatobium abietinum (Walker)[1]
" *trochodendri* Takahashi[*,1]
Eoessigia longicauda (Richards)
Eomacrosiphon nigromaculosus (MacDougall)[1]
Epameibaphis atricornis Gillette and Palmer[1]
" *frigidae* (Oestlund)[1]
" *utahensis* Knowlton and Smith[1]
Ericaphis ericae (Börner)
" *latifrons* (Börner)
" *leclanti* Remaudière
Eriosoma americanum (Riley)[1,2]
" *crataegi* (Oestlund)[1,2]
" *lanigerum* (Hausmann)[1,2]

Eriosoma lanigerum grossulariae Schule
" *lanigerum lanuginosum* (Hartig)[1]
" *lanigerum patchiae* (Börner and Blunck)[1]
" *rileyi* Thomas*,[1]
" *(Colophina) clematis* (Shinji)*,[1]
" *(Schizoneura) anncharlottae* Danielsson[1]
" " *sorbiradicis* Danielsson*,[1]
" " *ulmi* (Linnaeus)[1]
Eriosoma spp. (unidentified, from mountain ash)
Essigella californica (Essig)[1,2]
" *gillettei* Hottes
" *wilsoni* Hottes*,[1]
Eucallipterus tiliae (Linnaeus)[1,2]
Eucarazzia elegans (Ferrari)
Euceraphis spp. Many identified, but genus needs revision.
Eulachnus agilis (Kaltenbach)[1]
" *brevipilosus* Börner[1]
" *rileyi* (Williams)[1,2]
Eumyzus impatiensis (Shinji)*,[1]
Euthoracaphis umbellulariae (Essig)[1,2]
Fagiphagus imbricator (Fitch)*,[1] (=*Grylloprociphilus frosti* Smith and Pepper)
Fimbriaphis fimbriata Richards[1,2]
" *gentneri* (Mason)[1,2]
" *scoliopi* (Essig)[1,2]
" *wakibae* (Hottes)[1,2]
Flabellomicrosiphum knowltoni Smith[1,2]
" *tridentatae* (Wilson)[1,2]
Forda formicaria von Heyden[1,2]
" *marginata* Koch[1,2]
Formosaphis micheliae Takahashi[1,2]
Fullawaya ontarioensis (Richards)*,[1]
" *saliciradicis* Essig
Geoica lucifuga (Zehntner)[1]
" *utricularia* (Passerini)*,[1]
Georgiaphis gillettei (Maxson and Hottes)
" *ulmi* (Wilson)
Glabromyzus howardii (Wilson)[1]
" *rhois* (Monell)[1,2]
Glyphina betulae (Linnaeus)[1]
" *setosa* MacGillivray[1,2]
Greenidea ficicola Takahashi*,[1]

Greenidea (Trichosiphum) anonae (Pergande)
" " *chiengmaiensis* Robinson[1,2]
" " *nipponica* Suenaga[*,1]
" " *siamensis* Takahashi[*,1]
Gypsoaphis oestlundi Hottes[1,2]
Hallaphis ilharcoi van Harten[1,2]
Hamamelistes spinosus Shimer[1,2]
Hayhurstia atriplicis (Linnaeus)[1,2]
Hoplochaitophorus heterotrichus Quednau[1,2]
" *quercicola* (Monell)[1,2]
Hyadaphis coriandri (Das)[*,1]
" *foeniculi* (Passerini)[1]
" *tataricae* (Aizenberg)
Hyalomyzus collinsoniae (Pepper)
" *eriobotryae* (Tissot)[1,2]
" *jussiaeae* Smith
" *mitchellensis* Smith
" *monardae* (Davis)[1,2]
Hyalopteroides humilis (Walker)[1,2]
Hyalopterus pruni (Geoffroy)[1,2]
Hydaphis hofmanni Börner
Hyperomyzus lactucae (Linnaeus)[1,2]
" *pallidus* Hille Ris Lambers[1,2]
" *(Hypermyzella) rhinanthi* (Schouteden)[1,2]
" *(Neonasonovia) inflatus* (Richards)[1,2]
" " *nabali* (Oestlund)[1,2]
" *(Neonasonovia) nabali fronki* (Knowlton)
" " *ribiellus* (Davis)[1,2]
" " *sandilandicus* (Robinson)[1,2]
Hysteroneura setariae (Thomas)[1,2]
Idiopterus nephrelepidus Davis[1,2]
Illinoia alni (Mason)[1,2]
" *azaleae* (Mason)[1,2]
" *azaleae kalmiaflora* (Tissot and Pepper)
" *canadensis* (MacGillivray)[1,2]
" *corylina* (Davidson)
" *goldamaryae* (Knowlton)[1,2]
" *grindeliae palmerae* (MacGillivray)[1,2]
" *liriodendri* (Monell)[1]
" *macgillivrayae* (Hille Ris Lambers)[1]
" *morrisoni* (Swain)[1,2]

Illinoia pepperi (MacGillivray)
" *phacelia* (Essig)*,1
" *richardsi* (MacGillivray)[1,2]
" *simpsoni* (MacGillivray)[1,2]
" *spiraeae* (MacGillivray)[1,2]
" *spiraecola* (Patch)
" *wahnaga* (Hottes)[1,2]
" *(Amphorinophora) crystleae* (Smith and Knowlton)[1,2]
" " *crystleae bartholomewi* (Essig)[1,2]
" *(Masonaphis) lambersi* (MacGillivray)*,1
" " *menziesiae* (Robinson)[1,2]
" " *paqueti* (MacGillivray)[1,2]
" " *patriciae* (Robinson)[1,2]
" " *pinawae* (Robinson)[1,2]
" " *rhododendri* (Wilson)*,1,2
" " *rhokalaza* (Tissot and Pepper)[1,2]
" *(Oestlundia) davidsoni* (Mason)[1,2]
" " *maxima* (Mason)[1,2]
" " *rubicola* (Oestlund)[1,2]
Illinoia spp. Many unidentified specimens mounted on slides.
Impatientinum asiaticum Nevsky[1,2]
" *balsamines* (Kaltenbach)*,1
" *impatiens* (Shinji)[1,2]
Indomegoura indica (van der Groot)[1,2]
Iziphya americana (Baker)*,1
" *flabella* (Sanborn)*,1
" *grandipes* Richards
" *punctata* Hille Ris Lambers*,1
" *spenceri* Richards[1]
" *umbella* Richards[1,2]
" *vittata* Richards[1]
Jacksonia papillata Theobald[1,2]
Juncomyzus rhois (Takahashi)*,1
Kaltenbachiella pallida Haliday[1,2]
" *ulmifusa* (Walsh and Riley)
Kurisakia onigurumii (Shinji)*,1
Lachnus allegheniensis McCook[1,2]
" *iliciphilus* (del Guercio)[1,2]
" *pallipes* (Hartig)*,1
" *roboris* (Linnaeus)[1,2]
" *tropicalis* (vam der Groot)*,1

Laingia psammae Theobald[*,1]
Latigerina orizabaiensis Remaudière
Liosomaphis berberidis (Kaltenbach)[1,2]
" *himalayensis* Basu[*,1,2]
Lipaphis erysimi (Kaltenbach)[1,2]
" *turritella* (Wahlgren)[*,1]
Longicaudus trirhodus (Walker)[1]
Longistigma caryae (Harris)[1,2]
Macchiatiella itadori (Shinji)[1,2]
" *rhamni* (Boyer de Fonscolombe)
Macromyzus polypodicola (Takahashi)[1,2]
" *woodwardiae* (Takahashi)[*,1]
Macrosiphoniella abrotani (Walker)[1,2]
" *absinthii* (Linnaeus)[1,2]
" *artemisiae* (Boyer de Fonscolombe)[1]
" *atra* (Ferrari)
" *chamaemelifoliae* Remaudière and Leclant
" *fasciata* del Guercio
" *formosartemisiae* Takahashi[1]
" *frigidicola* Gillette and Palmer[1,2]
" *glabra*? (Gillette and Palmer)
" *grandicauda* Takahashi and Moritsu
" *helichrysi* Remaudière
" *hikosanensis* Moritsu[1]
" *leucanthemi* (Ferrari)
" *ludovicianae* (Oestlund)[1,2]
" *millefolii* (de Geer)[1,2]
" *oblonga* (Mordvilko)
" *paucisetosa* Robinson[1]
" *pennsylvanica* (Pepper)[1,2]
" *persequens* (Walker)
" *pseudoartemisiae* Shinji[1,2]
" *ptarmicae* Hille Ris Lambers
" *sanborni* (Gillette)[1,2]
" *sejuncta* (Walker)
" *subterranea* (Koch)
" *tanacetaria* (Kaltenbach)[1,2]
" *tapuskae* (Hottes and Frison)[1,2]
" *trimaculata* Hille Ris Lambers[*,1]
" *usquertensis* Hille Ris Lambers
" *yomogicola* (Matsumura)[1,2]

Macrosiphoniella yomogifoliae (Shinji)[1]
" *(Asterobium) asteris* (Walker)
" " *linariae* (Koch)
" " *yomenae* (Shinji)[1,2]
Macrosiphum aetheocornum Smith and Knowlton[1,2]
" *albifrons* Essig[1,2]
" *californicum* (Clarke)[1,2]
" *cholodkovskyi* (Mordvilko)[1,2]
" *clematifoliae* Shinji[1]
" *cockerelli* Hottes [1,2]
" *daphnidis* Börner
" *diervillae* Patch[1]
" *euphorbiae* (Thomas)[1,2]
" *funestum* (Macchiati)[1,2]
" *gaurae* (Williams)[1,2]
" *gei* (Koch)[1]
" *geranii*? Oestlund[1,2]
" *hamiltoni* Robinson[1,2]
" *hellebori* Theobald and Walton
" *jeanae* Robinson[1,2]
" *kiowanepus* (Hottes)[1,2]
" *lisae* Heie*,[1]
" *melampyri* Mordvilko
" *mentzeliae* Wilson[1,2]
" *mertensiae* Gillette and Palmer[1,2]
" *mordvilkoi* Miyazaki*,[1]
" *olmsteadi* Robinson[1,2]
" *osmaroniae*? (Wilson)*,[1,2]
" *pechumani* MacGillivray[1,2]
" *pseudocoryli* Patch[1,2]
" *pseudorosae* Patch[1,2]
" *rosae* (Linnaeus)[1,2]
" *stanleyi* Wilson[1,2]
" *subarcticum* Robinson[1,2]
" *thermopsaphis* Knowlton[1,2]
" *tiliae* (Monell)[1,2]
" *trollii* Börner*,[1]
" *verbenae*? (Thomas)
" *zionense* Knowlton[1,2]
" *(Neocorylobium) carpinicolens*? (Patch)
" " *coryli* Davis[1]

Macrosiphum corylicola Shinji[1]
" *(Unisitobion) sorbi* Matsumura*,[1]
Macrosiphum spp. Many unidentified specimens mounted on slides.
Maculolachnus sijpkensis Hille Ris Lambers[1,2]
" *submacula* (Walker)[1,2]
Mastopoda pteridis Oestlund[1,2]
Matsumuraja rubifoliae Takahashi*,[1,2]
" *rubiphila* Takahashi*,[1]
Megoura crassicauda Mordvilko*,[1]
" *lespedezae* (Essig and Kuwana)*,[1]
" *viciae* Buckton
Megouroparsus dooarsis (Ghosh and RayChaudhuri)
" *kislankoi* Smith and Heie
Melanaphis bambusae (Fullaway)
" *donacis* (Passerini)
" *sacchari* (Zehntner)[1,2]
Melanocallis caryaefoliae (Davis)[1,2] (=*M. fumipennellus* (Fitch))
Melaphis rhois (Fitch)[1,2]
Meliarhizophagus fraxinifolii Riley[1,2]
Metopeurum fuscoviride Stroyan[1]
" *kuwayamai* (Takahashi)*,[1]
Metapolophium caudatum (Pergande)
" *dirhodum* (Walker)
Microlophium carnosum (Buckton)[1,2]
Micromyzella davalliae Remaudière
" *sophiae* Remaudière
Micromyzus judenkoi Carver*,[1]
Microparsus desmodiorum Smith and Tuatay[1]
" *olivei* Smith and Tuatay[1]
" *variablilis* Patch[1] (=*desmodii* (Williams))
" *(Picturaphis) pojani* (Cermeli and Smith)
" " *venezuelensis meridensis* Cermeli and Smith
Microsiphoniella acophorum (Smith and Knowlton)[1,2]
" *artemisiae* (Gillette)[1,2]
" *oregonensis* (Wilson)[1,2]
Microsiphum millefolii Wahlgren
" *woronieckae* Judenko
Mindarus abietinus Koch[1,2]
" *obliquus* (Cholodkovsky)[1,2]
" *victoria* Essig[1,2]
Misturaphis shiloensis Robinson[1,2]

Monellia caryae (Fitch)[1,2]
" *caryella* (Monell)*[,1,2]
" *costalis* (Fitch)
Monelliopsis nigropunctata (Granovsky)[1]
" *pecanis* Bissell
" *tuberculata* Richards[1,2]
Mordwilkoja vagabunda (Walsh)[1,2]
Muscaphis mucsi Börner[1]
Myzaphis rosarum (Kaltenbach)[1]
Myzocallis agrifolicola Richards[1,2]
" *borneri* Stroyan*[,1]
" *carpini* (Koch)[1]
" *castanicola* Baker
" *coryli* (Goeze)[1,2]
" *discolor* (Monell)[1,2]
" *myricae* (Kaltenbach)[1]
" *punctatus* (Monell)[1,2]
" *(Lineomyzocallis) bellus* (Walsh)[1]
" " *exultans* Boudreaux and Tissot[1]
" " *frisoni* Boudreaux and Tissot
" " *granovskyi* Boudreaux and Tissot
" " *longiunguis* Boudreaux and Tissot
" " *melanocera* Boudreaux and Tissot[1,2]
" " *multisetis* Boudreaux and Tissot[1]
" " *occultus* Richards[1,2]
" " *spinosus* Boudreaux and Tissot
" " *walshii* (Monell)[1,2]
" *(Neomyzocallis) asclepiadis* (Monell)[1,2]
" *(Nippocallis) kuricola* (Matsumura)*[,1]
Myzodium knowltoni Smith and Robinson[1,2]
" *modestum* (Hottes)[1,2]
Myzus asteriae Shinji*[,1]
" *boehmeriae* Takahashi*[,1]
" *cerasi* (Fabricius)[1,2]
" *cerasi umefoliae* (Shinji)*[,1]
" *lythri* (Schrank)[1,2]
" *mumecola* (Matsumura)*[,1]
" *mushaensis* Takahashi*[,1]
" *nicotianae* Blackman
" *ornatus* Laing[1,2]
" *varians* Davidson

Myzus (Galiobium) langei (Börner)
" *(Nectarosiphon) ascalonicus* Doncaster[1,2]
" " *certus* (Walker)
" " *ligustri* (Mosley)[1,2]
" " *persicae* (Sulzer)[1,2]
" " *polaris* Hille Ris Lambers
Nasonovia compositellae nigra Hille Ris Lambers
" *ribisnigri* (Mosley)[1,2]
" *(Capitosiphon) crenicorne* (Smith and Knowlton)[1,2]
" *(Eokakimia) wahinkae robinsoni* (Richards)[1,2]
" " *wahinkae wahinkae* (Hottes)[1,2]
" *(Kakimia) alpina* (Gillette and Palmer)[1,2]
" " *aquilegiae* (Essig)[1,2]
" " *borealis* Heie[1,2]
" " *carolinensis* Heie[1,2]
" " *castelleiae* (Sampson)[1,2]
" " *cynosbati* (Oestlund)[1,2]
" " *grossa* Heie[1,2]
" " *heucherae* (Thomas)[1]
" " *houghtonensis cerei* (Gillette and Palmer)[1,2]
" " *houghtonensis occidentalis* Heie[*,1]
" " *houghtonensis russellae* Heie[1,2]
" " *houghtonensis similis* Heie[1,2]
" " *muesbecki* (Knowlton and Allen)[*,1]
" " *polemonii* (Gillette and Palmer)[*,1,2]
" " *sampsoni* Heie[1,2]
" " *smithi* Heie[1,2]
" " *stroyani* Heie[1,2]
" " *tiarellae* Heie[*,1]
" " *vockerothi* (Richards)[1,2]
" " *williamsi* (Smith and Parron)[1,2]
" *(Ranakimia) purpurescens* (Oestlund)[1,2]
Nearctaphis bakeri (Cowen)[1,2]
" *californica* Hille Ris Lambers
" *clydesmithi* Hille Ris Lambers[1]
" *crataegifoliae* (Fitch)[1,2]
" *kachena* (Hottes)[1,2]
" *sensoriata* (Gillette and Bragg)[1,2]
" *yohoensis* Bradley[1,2]

Nearctaphis spp. Many unidentified specimens mounted on slides.
Neocalaphis magnoliae (Essig and Kuwana)*,1
Neoprociphilus aceris (Monell)[1,2]
Neosymydobius ajuscoi Remaudière
" *albasiphus* (Davis)*,1
" *butzei* Remaudière
" *chrysolepis* (Swain)[1,2]
" *mimicus* Hottes[1,2]
" *quercihabitus* Miller*,1
Neotoxoptera formosana (Takahashi)*,1
Neuquenaphis bulbicauda Hille Ris Lambers
Oaktulosphaira vitifoliae (Fitch)[1,2] (Phylloxeridae)
Obtusicauda anomella (Knowlton and Allen)
" *artemisiphila* (Knowlton and Allen)
" *coweni* (Hunter)[1,2]
" *essigi* Soliman*,1,2
" *filifoliae* (Gillette and Palmer)
" *frigidae* (Oestlund)
" *zerothermum*? (Knowlton and Allen)
Oestlundiella flava (Davidson)[1,2]
Ovatus crataegarius (Walker)[1,2]
" *insitus* (Walker)[1]
" *valuliae* (Robinson)[1,2]
Pachypappa lactea (Linnaeus)[1]
" *populi* (Tullgren)*,1
" *pseudobyrsa* (Walsh)*,1
" *sacculi*? (Gillette)[1,2]
" *tremulae* (Linnaeus)[1,2]
Paducia antennata (Patch)[1]
Paoliella harteni Ilharco[1,2]
" *papillata* (Hall)
" *terminaliae* (Hall)[1,2]
Papulaphis sleesmani (Pepper)[1]
Paracletus cimiciformis von Heyden
Paramyzus heraclei Börner
Patchia virginiana Baker
Pemphigus betae Doane[1,2]
" *bursarius* (Linnaeus)
" *junctisensoriatus* Maxson
" *monophagus* Maxson[1,2]
" *nortonii* Maxson

Pemphigus populi Courchet
" *populicaulis* Fitch
" *populiglobuli* Fitch
" *populinigrae* (Schrank) (=*Pemphigus filaginis?* Boyer de Fonscolómbe)
" *populiramulorum* Riley
" *populitransversus* Riley
" *populivenae* Fitch
" *spirothecae* Passerini[1,2]
" *vesicarius* Passerini
Pentalonia nigronervosa Coquerel[1,2]
Periphyllus aceris (Linnaeus)
" *americanus* (Baker)[1,2]
" *brevispinosus* Gillette and Palmer[1,2]
" *californiensis* (Shinji)[1,2]
" *coracinus* (Koch)[1,2]
" *granulatus* Koch[1] (=*Periphyllus hirticornis* Walker)
" *lyropictus* (Kessler)[1,2]
" *negundinis* (Thomas)[1,2]
" *singeri* (Börner)[1,2]
" *testudinaceus* (Fernie)[1,2]
Phleomyzus dearborni Smith[1]
" *passerini* (Signoret)[1]
Phorodon humuli (Schrank)[1,2]
" *(Paraphorodon) cannabis* Passerini
Phyllaphis fagi (Linnaeus)[1,2]
Pineus coloradensis (Gillette) (Adelgidae)
Pineus spp.[*,1] (Adelgidae) Many unidentified specimens mounted on slides.
Placoaphis siphunculata Richards
Pleotrichophorus chrysanthemi (Theobald)
" *decampus* (Knowlton and Smith)[1,2]
" *elongatus* (Knowlton)[1,2]
" *filifoliae* (Palmer)
" *glandulosus* (Kaltenbach)[1]
" *gnaphalodes*? (Palmer)[1]
" *gregarius* (Knowlton)[1,2]
" *hottesi* Hille Ris Lambers[1,2]
" *longinectarius* (Gillette and Palmer)[1]
" *longipes* (Gillette and Palmer)[*,1]
" *oestlundi* (Knowlton)[1,2]
" *packi* (Knowlton)[1,2]
" *patonkus patonkus* (Hottes and Frison)[1,2]

Pleotrichophorus patonkus patonkusellus Corpus-Raros and Cook
" *pseudoglandulosus* (Palmer)[1,2]
" *pseudopatonkus* Corpuz-Raros and Cook
" *pycnorhysus* (Knowlton and Smith)[1,2]
" *quadritrichus* (Knowlton and Smith)[1,2]
" *spatulavillus*? (Knowlton and Smith)[1]
" *sporadicus* (Knowlton)[1,2]
" *tetradymiae* Smith and Knowlton[*,1]
" *villosae* Robinson[1,2]
" *zoomontanus* (Knowlton and Smith)[1,2]
Plocamaphis amerinae (Hartig)[1,2]
" *coreana* (Okamoto and Takahashi)[*,1]
" *flocculosa* (Weed)[1,2]
" *martini* Richards
Prociphilus alnifoliae arbutifoliae Smith
" " *fitchii* Baker and Davidson
" *americanus* (Walker)[1,2]
" *carolinensis* Smith[1]
" *erigeronensis* (Thomas)[1,2]
" *fraxini* (Fabricius)[1]
" *piniradicivorous* Smith[1]
" *(Paraprociphilus) tesselatus* (Fitch)[1,2]
Prociphilus spp.[*,2] Many unidentified specimens mounted on slides.
Protrama flavescens (Koch)[1]
" *ranunculi* (del Guercio)[*,1]
Pseudacaudella rubida (Börner)[1,2]
Pseudasiphonaphis corni (Tissot)[1,2]
Pseudocercidis rosae Richards[1,2]
Pseudoepameibaphis essigi Knowlton and Smith[1,2]
" *glauca* Gillette and Palmer[1]
" *tridentata* (Wilson)
" *xenotrichus* Knowlton and Smith (=*zavillis* Knowlton and Smith)
Pseudoepamiebaphis spp. Many unidentified specimens mounted on slides.
Pseudopterocomma canadensis Richards[1,2]
Pseudoregma bambusicola (Takahashi)[1,2]
Pterocallis albida Börner[*,1]
" *alni* (de Geer)[1,2]
" *alnifoliae* (Fitch)[1,2]
" *(Recticallis) alnijaponicae* (Matsumura)[*,1]
" " *nigrostriata* (Shinji)[*,1]
Pterochloroides persicae (Cholodkovsky)

Pterocomma bicolor (Oestlund)[1,2]
" *pilosum konoi* Hori[1]
" *populeum* (Kaltenbach)[1,2]
" *populifoliae* (Fitch)[1,2]
" *ringdahli* Wahlgren*,[1]
" *salicis* (Linnaeus)[1,2]
" *sanguiceps* Richards
" *smithiae* (Monell)[1,2]
" *tremulae* Börner*,[1]
Rhodobium porosum (Sanderson)[1,2]
Rhopalomyzus grabhami (Cockerell)[1,2]
" *poae* (Gillette)[1,2]
" *(Judenkoa) lonicerae* (Siebold)[1,2]
Rhopalomyzus spp.[1] Many unidentified specimens mounted on slides.
Rhopalosiphoninus calthae (Koch)
" *hydrangeae* (Matsumura)*,[1]
" *latysiphon* (Davidson)[1]
" *(Myzosiphon) solani* (Thomas)
" " *staphyleae* (Koch)[1,2]
" " *staphyleae tulipaellus* (Theobald)[1,2]
Rhopalosiphum cerasifoliae (Fitch)[1,2]
" *enigmae* Hottes and Frison[1,2]
" *insertum* (Walker)[1,2]
" *maidis* (Fitch)[1,2]
" *nigrum* Richards[1,2]
" *nymphaeae* (Linnaeus)[1,2]
" *padi* (Linnaeus)[1,2]
" *padiformis* Richards
" *parvae* Hottes and Frison
" *rufiabdominale* (Sasaki)[1]
" *rufulum* Richards[1,2]
" *scirpifolii* Gillette and Palmer*,[1]
Rhopalosiphum spp. *,[1] Many unidentified specimens mounted on slides.
Roepkea phlomicola Nevsky
" *marchali* (Börner)
Saltusaphis scirpus Theobald
Sanbornia juniperi Pergande[1,2]
Sappaphis piri Matsumura*,[1]
Sappocallis ulmicola Matsumura*,[1]
Schizaphis graminum (Rondani)[1,2]
" *jaroslavi* (Mordvilko)

Schizaphis rotundiventris (Signoret)
" *rotundiventris scirpi*[1] (Passerini)
" *rotundiventris scirpicola?* (Hille Ris Lambers)*,[1]
" *viridirubra* (Gillette and Palmer)[1,2]
" *(Paraschizaphis) caricis* (Schouteden)*,[1]
" " *nigra* (Baker)*,[1]
Schizaphis spp.*,[1] Many unidentified specimens on slides.
Schizolachnus pineti (Fabricius)
" *piniradiatae* (Davidson)[1,2]
Schizolachnus spp.*,[1,2] Many unidentified specimens mounted on slides.
Schoutedenia emblica (Patel and Kulkarni)[1,2]
" *lutea* (van der Groot)*,[1]
Semiaphis dauci (Fabricius)
" *heraclei* (Takahashi)[1]
Shinjia orientalis (Mordvilko)[1]
Shivaphis celti Das*,[1]
Sinomegoura citricola (van der Groot)[1]
Sipha flava (Forbes)[1]
" *glyceriae* (Kaltenbach)[1,2]
" *(Rungsia) elegans* del Guercio[1,2]
" " *maydis* Passerini[1]
Siphonatrophia gravida (Knowlton) (=*S. cupressi* (Swain))*,[1]
Sitobion adianti (Oestlund)[1]
" *akebiae* (Shinji)[1]
" *anselliae* (Hall)[1,2]
" *avenae* (Fabricius)[1,2]
" *blackmani* Chan
" *clydesmithi* (Robinson)[1,2]
" *colei* (Eastop)[1,2]
" *cyatheae* (Holman)[1]
" *cystopteris* (Robinson)[1,2]
" *dorsatum* (Richards)
" *dryopteridis* (Holman)
" *equiseti* Holman
" *eulophiae* Remaudière
" *fragariae* (Walker)[1,2]
" *ibarae* (Matsumura)[1,2]
" *lambi* (Robinson)[1,2]
" *leonidasi* Remaudière
" *manitobense* (Robinson)[1,2]
" *miscanthi* (Takahashi)[1,2]

Sitobion ptericolens (Patch)[1,2]
" *pteridis* (Wilson)[1,2]
" *rhamni* (Clarke)[1,2]
" *rosaeiformis* (Das)[1,2]
" *salviae* (Bartholomew)
" *takahashii* (Eastop)[1,2]
" *walkeri* (Robinson)[1,2]
" *woodsiae* (Robinson)[1,2]
" *yongyooti* (Robinson)[1,2]
Stagona crataegistrobi Smith[1]
" *picearubensis* Smith
" *xylostei* (de Geer)[1]
Staticobium limonii (Contarini)
Staegeriella necopinata (Börner)[*,1]
Stegophylla essigi Hille Ris Lambers[1,2]
" *querci* (Fitch)[1,2]
" *quercina* Quednau[1,2]
Stomaphis graffii Cholodkovsky
" *quercus* (Linnaeus)[1,2]
Subsaltusaphis flava (Hille Ris Lambers)[1]
" *paniceae* (Quednau)[*,1]
" *picta* (Hille Ris Lambers)[*,1]
" *virginica* (Baker)[1,2]
Symydobius americanus Baker[1,2]
" *kabae* (Matsumura)[*,1]
" *oblongus* (von Heyden)[1]
Symydobius spp. Many unidentified specimens mounted on slides.
Takecallis arundinariae (Essig)[1,2]
" *taiwanus* (Takahashi)[*,1]
Tamalia coweni (Cockerell)[1,2]
Tetraneura ulmi (Linnaeus)[1,2]
" *(Tetraneurella) nigriabdominalis* (Sasaki)[1,2]
Thecabius affinis (Kaltenbach)[1,2]
" *(Parathecabius) gravicornis* (Patch)[1,2]
" " *populimonilis* (Riley)[1,2]
Thelaxes californica (Davidson)[1,2]
" *dryophila* (Schrank)[1,2]
Therioaphis litoralis Hille Ris Lambers and van den Bosch
" *luteola* (Börner)
" *maculata* (Buckton) (=*T. trifolii maculata* (Buckton))
" *obscura* Hille Ris Lambers and van den Bosch

Therioaphis ononidis (Kaltenbach)
" *riehmi* (Börner)[1,2]
" *trifolii* (Monell)[1,2]
Thripsaphis ballii (Gillette)[1]
" *caricicola* (Mordvilko)
" *(Trichocallis) caricis* (Mordvilko)[1,2]
" " *cyperi* (Walker)[1,2]
" " *verrucosa* Gillette[1]
Tiliaphis shinae (Shinji)*,[1]
Tiliphagus lycoposugus Smith[1]
Tinocallis himalayensis Ghosh, Ghosh and RayChaudhuri[1,2]
" *khonkaensis* Danielsson and Robinson[1,2]
" *platani* (Kaltenbach)[1,2]
" *nirecola* (Shinji)*,[1]
" *saltans* (Nevsky)*,[1]
" *ulmifolii* (Monell)[1,2]
Titanosiphon artemesiae (Koch)
" *bellicosum* Nevsky
Toxoptera aurantii (Boyer de Fonscolombe)[1,2]
" *citricida* (Kirkaldy)[1,2]
" *odinae* (van der Groot)[1]
Toxoptera spp.*,[1] Many unidentified specimens mounted on slides.
Toxopterella drepanosiphoides MacGillivray and Bradley (in *Muscaphis*)
" *drepanosiphoides irae* Shaposhnikov (in *Muscaphis*)
Toxopterina vandergrooti (Börner)[1]
Trama rara Mordvilko[1,2]
" *troglodytes* von Heyden[1]
Tricaudatus polygoni (Narzikulov)
Trichosiphonaphis lonicerae (Uye)*,[1]
" *polygoniformosanus* (Takahashi)*,[1]
" *(Xenomyzus) corticis* (Aizenberg)
" " *ishimikawae* (Shinji)*,[1]
" " *tade* (Shinji)*,[1]
Tritrichosiphum thailandicum Robinson[1,2]
Tuberculatus quercus (Kaltenbach)*,[1]
" *tuberculatus* (Richards)[1,2]
" *(Acanthocallis) stigmatus* (Maysumura)*,[1]
" *(Orientuberculoides) capitatus* (Essig and Kuwana)*,[1]
" " *yokoyamai* (Takahashi)*,[1]
" *(Pacificallis) maureri* (Swain)[1,2]
" " *pallidus* (Davidson)*,[1]

Tuberculatus (Tuberculoides) annulatus (Hartig)[1,2]
Tuberculatus spp.*[,2] Many unidentified specimens mounted on slides.
Tuberocephalus momonis (Matsumura)[1,2]
" *sakurae* (Matsumura)*[,1]
" *sasakii* (Matsumura)*[,1]
Tuberolachnus salignis (Gmelin)[1,2]
Uhlmannia singularis (Börner)
Unipterus delotti Hille Ris Lambers*[,1]
Uroleucon (Lambersius) anomalae (Hottes and Frison)
" " *bradburyi* (Olive)
" " *breviscriptum* (Palmer)
" " *brevitarsus* (Robinson)
" " *cadens* Moran
" " *caligatum* (Richards)
" " *canadense* (Richards)
" " *carberriense* Robinson[1]
" " *clydesmithi* Robinson[2]
" " *coloradense* Robinson[1]
" " *crepusisiphon* (Olive)
" " *erigeronense* (Thomas)[1,2]
" " *erigeronense* complex
" " *escalantii* (Knowlton)[1,2]
" " *escalantii* complex
" " *gravicorne* (Patch)
" " *katonkae* complex
" " *luteolum* (Williams)
" " *macgillivrayae* (Olive)
" " *madia* (Swain)
" " *manitobense* Robinson[1]
" " *nevadense* Robinson
" " *nodulum* (Richards)
" " *penderum* Robinson[1]
" " *richardsi* (Robinson)[1,2]
" " *stoetzelae* Robinson[1]
" " *suzannae* Robinson
" " *tenuitarsum* (Gillette amd Palmer)
" " spp. Many unidentified specimens mounted on slides.
" *(Satula) brachychaeta* (Olive)
" *(Uroleucon) achilleae* (Koch)
" " *acutirostre* Banziger
" " *alaskense* Robinson[2]

Uroleucon (Uroleucon) ambrosiae (Thomas)
" " *ambroisae* complex
" " *arnesense* Robinson[1]
" " *astronomus* (Hille Ris Lambers)[1,2]
" " *atripes* (Gillette and Palmer)
" " *boreale* Robinson[1]
" " *chani* Robinson[1]
" " *chondrillae* Nevsky
" " *chrysanthemi* (Oestlund)[1,2]
" " *chrysopsidicola* (Olive)
" " *cichorii* (Koch)
" " *cichorii leontodontis* (Hille Ris Lambers)
" " *ciefi* (Olive)
" " *cirsii* (Linnaeus)[1,2]
" " *deltense* Robinson[1]
" " *elephantopicola* Robinson[*,1,2]
" " *eupatoricolens* (Patch)
" " *floricola* Robinson[1]
" " *formosanum* (Takahashi)[1,2]
" " *gigantiphagum* Moran
" " *hieracicola* (Hille Ris Lambers)[1,2]
" " *hypochoeridis* (Fabricius)
" " *impatiensicolens* (Patch)[1]
" " *inulicola* (Hille Ris Lambers)
" " *ivae* Robinson[1]
" " *jaceicola* (Hille Ris Lambers)
" " *lanceolatum* (Patch)
" " *leonardi* (Olive)
" " *maximilianicola* Robinson[1]
" " *monticola* (Takahashi)
" " *murale* (Buckton)
" " *nigrotibium* (Olive)
" " *nigrotuberculatum* (Olive)
" " *obscuricaudatum* (Olive)
" " *obscurum* (Koch)
" " *ochropus* (Hille Ris Lambers)
" " *olivei* Moran
" " *paucosensoriatum* (Hille Ris Lambers)[1,2]
" " *pepperi* (Olive)
" " *pieloui* (Richards)
" " *pseudoambrosiae* (Olive)

Uroleucon (Uroleucon) reynoldsi (Olive)
" " *rudbeckiae* (Fitch)[1,2]
" " *russellae* (Hille Ris Lambers)[1,2]
" " *solirostratum* (Richards)
" " *sonchellum* (Monell)
" " *sonchi* (Linnaeus)
" " *tanaceti* (Linnaeus)
" " *tussilaginis* (Walker)
" " *vancouverense* Robinson[1]
" " *zinzalae* (Hottes and Frison)
" *(Uromelan) adenophorae* (Matsumura)
" " *aeneum* (Hille Ris Lambers)
" " *amamianum* (Takahashi)
" " *bonitum* (Hottes)
" " *cameronense* (Takahashi)
" " *campanulae* (Kaltenbach)
" " *carlinae* (Börner)
" " *cephalonopli* (Takahashi)
" " *compositae* (Theobald)
" " *eoessigi* (Knowlton)[1,2]
" " *eupatorifloriae* (Tissot)
" " *giganteum* (Matsumura)[1,2]
" " *gobonis* (Matsumura)[1,2]
" " *helianthicola* (Olive)
" " *illini* (Hottes and Frison)
" " *inulicola* (Hille Ris Lambers)
" " *jaceae* (Linnaeus)[1]
" " *jaceae aeneum* (Hille Ris Lambers)
" " *jaceae henrichi* (Börner)
" " *lactucicola* (Strand)
" " *minus* (Börner)
" " *nigrocampanulae* (Theobald)
" " *riparium* (Stroyan)
" " *rurale* (Hottes and Frison)
" " *simile* (Hille Ris Lambers)
" " *solidaginis* (Fabricius)
" " *taraxaci* (Kaltenbach)[1,2]
" " *tardae* (Hottes and Frison)
" " *tuetaiae* (Olive)
Utamphorophora bossekiae (Gillette and Palmer)[1,2]
" *bromicola* Remaudière

Utamphorophora commelinensis (Smith)
" *crataegi* (Monell)*,1,2
" *humboldti* (Essig)[1,2]
" *schlingeri* (Hille Ris Lambers)
Vesiculaphis caricis (Fullaway)[1]
Wahlgreniella catherinae Nevsky
" *nervata arbuti* (Davidson)
" *nervata* complex
" *ossiannilssoni* Hille Ris Lambers
" *vaccinii* complex
Zinia veronicae Shaposhnikov
Zyxaphis canae? (Williams)
" *chrysanthemi* (Wilson)
" *chrysothamni* (Wilson)
" *filifoliae* (Gillette and Palmer)[1,2]
" *minutissima* (Gillette and Palmer)
" *oregonensis?* (Wilson)

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ABSTRACTS OF PAPERS PRESENTED TO THE ANNUAL MEETING , 1992

GUEST SPEAKER

SEX PHEROMONE COMMUNICATION IN MOTHS. T.C. Baker, Department of Entomology, University of California, Riverside CA 92521

The sexual communication system of the oriental fruit moth exemplifies that of moths in general, and is comprised of a long-distance female-emitted sex pheromone that attracts males, and a shorter-range male-emitted courtship pheromone that attracts females. Typical of lepidopterous communication, the female-emitted sex pheromone components appear to be comprised of fatty acid derivatives. Sustained upwind flight by the male is optimally evoked only if three pheromone components are emitted in the following proportions: 6% (*E*)-8-dodecenyl acetate and 3% (*Z*)-8-dodecenyl alcohol in (Z)-8-dodecenyl acetate. Males use a combination of optomotor antemotaxis and self steered counterturning in order to progress upwind to a female or a synthetic point source. If the pheromone lacks the filamentous fine structure of a normal point-source plume, as when a uniform fog or cloud of pheromone is generated, then males do not progress upwind, but rather cast widely to and fro as if they had just lost pheromone.

Also typical of the Lepidoptera, the courtship pheromone contains compounds which may possibly be taken up by males in intact form from plants, sequestered, and then emitted during an elaborate display of eversible scent brushes to gain acceptance from females for copulation. The active components are (*E*)-ethyl cinnamate and 1R,2S-(+)-(*Z*)-methyl epijasmonate. Females respond to a displaying male by walking upwind to him from *ca.* 2 cm away. This display may have evolved by means of female-choice sexual selection in which a female preference and preferred male trait become linked as a result of the mating advantage conferred upon male offspring of discriminating females. Male scent-disseminating structures and courtship pheromones in other Lepidoptera may have also evolved by this mechanism. In moths, the activity of antennal receptor cells sensitive to different pheromone components is integrated in the CNS, and results in pheromone-mediated upwind flight and casting flight. The selective adaptation of neurons responsive to the most abundant component in the blend can cause upwind flight behaviour to cease, or else for the optimal blend ratio preferred by males to shift towards one in which the major component is emitted at a higher proportion than in the natural blend. Blend quality is integrated by cells in the CNS whose phasic on and off output is sharpened by a combination of inhibition and excitation. Blend quality is also integrated in tonic-firing cells in the CNS whose long-lasting excitation persists for tens of seconds after the odour is switched off. Both of these temporally different types of firing patterns of pheromone-blend integrating cells correspond to the behaviours necessary for successful pheromone source location: upwind flight and casting flight, respectively.

SYMPOSIUM

Communication and Behavioral Modification in Insects

CUTICULAR HYDROCARBONS AS RECOGNITION CUES IN INSECT COMMUNITIES.

Ralph W. Howard, U.S. Dept. Agriculture, Agriculture Research Service, U.S. Grain Marketing Research Laboratory, 1515 College Avenue, Manhattan, Kansas 66502 U.S.A.

Insects, like other animals, depend for their growth, reproduction and survival on their ability to find food and shelter, recognize members of their species (including gender discrimination), and equally important, for being able to recognize the presence of enemies. Although many cues are used by insects in solving these problems, it is chemical cues that frequently are of the most importance. It is becoming increasingly clear that many of these semiochemicals are cuticular lipids, primarily cuticular hydrocarbons. These compounds have a very high information content and are possessed by probably all insects. The information contained in these cuticular lipids is used by insects to not only obtain information about their immediate environment, but to also transmit information to both friends and foes. This paper will present a discussion of the types of cuticular hydrocarbons used by insects and a survey of the semiochemical functions that insects use these chemicals for. As in any signalling system, ones' competitors or foes sometimes decipher the message, and a discussion will also be presented of the ways that some insects have exploited the cuticular hydrocarbon signalling system of other insects for their own ends.

JACK PINE BUDWORM MONITORING IN MANITOBA WITH PHEROMONE BAITED TRAPS.

I.L. Pines, Forest Protection, Forestry Branch, Manitoba Natural Resources, 300-530 Kenaston Blvd., Winnipeg, Manitoba, R3N 1Z4.

Jack pine budworm, *Choristoneura pinus pinus* (Freeman), is a major defoliator of jack pine in Manitoba. Outbreaks, although often short-lived, e.g. 2 to 4 years, can severely affect the growth and quality of vast areas of pine forest. Current survey sampling techniques have been unable to accurately detect outbreaks before severe defoliation has occurred. Manitoba Natural Resources has been establishing pheromone baited traps to monitor jack pine budworm moths at 12 locations throughout Manitoba, since the last outbreak in 1985. Three lure concentrations were tested at each site from 1985 - 1988. After data analysis, one concentration was selected and has been in use to date. Two insect trap types are now being assessed for their ability in attracting jack pine budworm male moths during endemic populations levels. The significance of this research in predicting outbreaks is discussed.

HOST PLANT RESISTANCE TO FLEA BEETLES, *PHYLLOTRETA SPP.* IN CRUCIFIERS: SOME FACTORS AFFECTING FLEA BEETLE FEEDING. P.Palaniswamy, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9

Laboratory studies were conducted to determine the host plant characteristics influencing the antixenosis resistance to flea beetles in crucifiers. To determine the effect of wounding plants on flea beetle feeding, cotyledons of 7-day-old seedlings of *Brassica napus*, *B.campestris* and *S.alba* were wounded mechanically by puncturing with needles or by exposing them to flea beetles to cause feeding wounds. Eight hours, 1, 2 and 9 days following wounding, these wounded seedlings were paired with unwounded seedlings and exposed to flea beetles. Estimation of flea beetle feeding damage indicated that wounded plants exhibited greater antixenotic resistance than unwounded plants in *S.alba* but not in other plant species tested. In *S.alba*, both mechanical wounding and flea beetle feeding induced resistance which lasted up to the first true leaf stage. The level of wounding was not critical in inducing antixenotic resistance. Wounding also altered the concentration of glucosinolates in seedlings.

Studies on leaf trichomes as a resistance factor revealed that trichomes act as an effective physical barrier against flea beetle feeding. Choice and no-choice feeding preference tests were done using *Brassica spp.* with varying levels of leaf trichome densities. Tests were done by three methods (clip-on cages, excised whole leaf, leaf disc) and in all tests, *Brassica villosa* (3000 hairs/sq.cm) was significantly less damaged than *B.macrocarpa* (<30 hairs/sq.cm). Behavioral observations indicated that the beetles spend very little time on the leaf with high trichome density. Studies to determine the effect of water stressed host plants on flea beetle feeding showed that the beetles prefer to feed on wilted plants.

COMMUNICATION IN HONEY BEES: THE SUITE SMELL OF SUCCESS. Robert W. Currie, Department of Entomology, Univ. of Manitoba, Winnipeg, MB, R3T 2N2.

Rapid and efficient communication is essential to the success of highly social insects. In honey bees many of the colony's functions are regulated by a suite of pheromones. The queen's mandibular gland pheromone is a 5 component blend that works in concert with worker and brood-produced pheromones to affect worker behaviour and inhibit worker activities. The full blend effectively elicits retinue formation, the attraction of workers to swarm clusters, the suppression of queen rearing and swarming and the stimulation of worker foraging. Other functions, however, do not require the complete blend. Quantitative and qualitative changes in the blend can influence the attraction of drones to queens during mating, and components of queen pheromone can act in conjunction with brood pheromones to play a role in the regulation of worker reproduction. The significance of the need for complex blends of pheromones to regulate behaviour in social insect colonies will be discussed.

SUBMITTED PAPERS

BEHAVIORAL RESPONSE OF COLORADO POTATO BEETLE LARVAE [*Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae)] TO COMBINATIONS OF TEMPERATURE AND INSOLATION, UNDER FIELD CONDITIONS. D.J. Lactin, Department of Entomology, The University of Manitoba, Winnipeg, Manitoba Canada R3T 2N2

In short-term (< 5min) trials, Colorado potato beetle larvae were released on potato leaflets under combinations of ambient temperature and insolation, and their response was observed and timed. Mean intervals required for larvae to start feeding or to move into the shade were independent of air temperature and measured insolation. Overall mean decision interval was 2.86 min (S.E. = 0.05, n = 350). Proportion of larvae moving into the shade increased logistically with both air temperature and insolation. A 1 $W \cdot m^{-2}$ change in insolation had the same behavioral effect as a 0.0838°C change in air temperature; hence the two variables were merged into a linear combination, $T^* =$ ambient temperature + $0.0838 \cdot P$, which has units of °C. A logistic model also describes proportion of larvae moving into the shade as a function of T^*.

In one-day trials in which temperature, insolation, and the proportion of larvae in sun and in shade were monitored repeatedly, distribution results agreed well with the short-term trial at $T^* >$ ca. 40°, but demonstrated increasing overrepresentation of larvae in shade as T^* diminished. This systematic bias is consistent with thermoregulation by avoiding hostile conditions, as opposed to seeking optimum conditions. Results of the short-term and long-term trials are related by a simple linear model. Free-ranging larvae accumulate in niches with 23° < T^* < 36°, and prefer $T^* = 30$°C. Evidence is adduced which suggests that T^* is potential body temperature under combinations of temperature and insolation.

SPATIAL AND TEMPORAL PATTERNS OF FEEDING DAMAGE BY THE POTATO FLEA BEETLE, *EPITRIX CUCUMERIS* (HARRIS), IN MANITOBA. S.F. Pernal and N.J.Holliday, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

In 1989 and 1990, cv. Russet Burbank potato plants were grown in cages in field plots, and densities of potato flea beetles, *Epitrix cucumeris* (Harris), and Colorado potato beetles, *Leptinotarsa decemlineata* (Say), were introduced in different multiples of naturally occurring densities. Colorado potato beetles were introduced only in the early part of the growing season, but potato flea beetles were introduced for the duration of the season. Feeding punctures created by flea beetles were counted in the lower, middle and upper terminal leaflets of plants, on a weekly basis. A behavioral model was created to determine how feeding punctures accumulated on plants, both spatially and temporally. Behavioral modelling showed that the feeding punctures in a given week were influenced by the numbers potato flea beetles present, the

stratum in which the beetles were feeding and whether the plant had been defoliated by Colorado potato beetles. Population modelling provided an indirect means of relating mean feeding punctures per plant to actual numbers of flea beetles necessary to cause them. Although this relationship was highly significant in both 1989 and 1990, its ability to predict actual potato flea beetle numbers was inconsistent. Such variability in predictions may be attributed to the accuracy of feeding puncture counts per plant.

IDENTIFICATION OF SOURCES OF HOST-PLANT RESISTANCE TO FLEA BEETLES, *PHYLLOTRETA CRUCIFERAE*. Y.B. Cho, P. Palaniswamy, and F. Matheson, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg. R3T 2M9.

Antixenosis resistance to flea beetles, Phyllotreta cruciferae (Goeze), is identified in crucifer seedlings by using a laboratory screening method. Screening was done in a plexiglass arena that rested on a plastic foam base containing seedlings (9 test entries and a standard entry) arranged in a 10 by 10 latin square design. During the summer of 1992, three species from the genus *Brassica* (*B.napus* L., *B.rapa* L. and *B.carinata* L.) were screened to identify sources of flea beetle resistance that could be incorporated into oilseed rape cultivars. The screening tests included 229 accessions and 17 selected entries of *B.napus*, 92 accessions and 4 selected entries of *B.rapa*, and 88 accessions and 26 selected entries of *B.carinata*. From these tests, 21 *B.napus*, 5 *B.rapa*, and 11 *B.carinata* lines were identified as significantly more resistant than the standard westar. Of all these species tested, only in 5 lines of *B.carinata* that the level of resistance found was equal to the level in *S.alba*. Two accessions of *B.napus* and 5 of *B.rapa* were found to be significantly more susceptible than westar. Several species of cruciferous weeds were also found to be very resistant to flea beetle feeding.

THE APPLICATION OF NMR IN METABOLIC STUDIES OF *TRIBOLIUM CONFUSUM* PARASITIZED BY *HYMENOLEPIS DIMINUTA, H. MICROSTOMA* OR *H. NANA*. A. Modha[1], M. Novak[1] and B.J. Blackburn[2], Departments of Biology[1] and Chemistry [2], University of Winnipeg, Winnipeg, Manitoba, Canada R3B 2E9.

Flour beetles, *Tribolium confusum*, uninfected or infected with *Hymenolepis diminuta, H. microstoma* or *H. nana* were fed on D-1-^{13}C-glucose for 24 hours following 3 days of starvation. In vivo ^{13}C NMR spectra of beetles infected for 30 days showed differences in the ratios of ^{13}C labelled metabolites/CH^2 groups of fatty acid chains, compared to those of uninfected controls. The most pronounced changes occurred in *T. confusum* infected with metacestodes of *H. diminuta*, where several significantly decreased metabolite ratios were found. The ^{13}C spectra obtained in vivo were compared to ^{13}C spectra of perchloric acid (PCA) extracts of beetle samples of the same origin. In addition, ^{1}H NMR and spin echo difference spectroscopy (SEDS) were used to examine the above PCA samples. The ^{1}H NMR spectra clearly showed the major

water soluble metabolites in *T. confusum*. The SEDS technique was employed to achieve the cancellation of signals from protons not attached to ^{13}C, leaving a spectrum with signals from only those protons attached to ^{13}C; this permitted further confirmation as to which metabolites were ^{13}C labelled.

IMPACT OF REGENERATION TECHNIQUES ON BIODIVERSITY IN PLANTED AND NATURAL STANDS : SPECIES DIVERSITY AND ECOSYSTEM DIVERSITY AMONG CARABID BEETLES (COLEOPTERA:CARABIDAE) IN JACK PINE STANDS. R.C. Lafrenière, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Pitfall trap catches of carabid beetles in naturally regenerated and planted jack pine, (*Pinus banksiana* Lamb.) stands were compared with respect to species occurrence and diversity. Relationships between carabid assemblages and stand age were also examined. No evidence was found that suggests that the numbers of individuals or carabid species, or their patterns of change over time, are influenced by planting.

MOISTURE CONTENT OF WHITE SPRUCE TREES DEFOLIATED BY SPRUCE BUDWORM. D.W. Ip Forestry Canada, Manitoba 200-180 Main Street, Winnipeg, MB R3C 1A6; and I.L. Pines, Manitoba Natural Resources, 300-530 Kenaston, Blvd. Winnipeg, MB R3N 1A6

Mature and overmature white spruce (*Picea glauca* (Moench) Voss) in southeastern Manitoba, severely defoliated by spruce budworm (*Choristoneura fumiferana* Clem.), were scheduled for salvage harvest. Moisture content (MC) of the defoliate trees was investigated to determine if levels were adequate for pulping. About 100 trees were randomly selected in two size classes and four defoliation classes from a 72-ha section of the harvest area. Heartwood and sapwood MC (% dry weight) was measured in 5-cm thick disks cut at 2.5 to 5.0 m intervals for small and large trees respectively. Living trees were divided into two groups, regardless of defoliation class: trees with more sapwood than heartwood had a mean MC of 117% and those with more heartwood than sapwood had a mean MC of 77%. Both of these groups contained sufficient overall moisture (>45%) for pulping. Mean MC of trees killed by spruce budworm defoliation was 48%. However, the MC of the killed trees varied with diameter and height above ground. MC was generally above 45% in stems greater than 30 cm diameter; in stem sections less than this diameter, MC fell below 45% in both large and small trees.

CHEMICAL AND BIOLOGICAL MONITORING OF RESIDUES OF INSECTICIDES USED IN THE CONTROL OF ELM BARK BEETLES IN MANITOBA. Heng Jin, G.R.B. Webster, Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2; N.J. Holliday, Department of Entomology, University of Manitoba, Winnipeg, MB R3T 2N2; and A.R. Westwood, Forestry, Manitoba Natural Resources, Winnipeg, MB R3N 1Z4.

Dutch elm disease (DED) is caused by the fungus, *Ceratocystis ulmi* (Buismi) C. Moreau, and spread mainly by native elm bark beetles, *Hylurgopinus rufipes* (Eichs) in the Canadian prairie provinces. The disease can be effectively controlled by reducing the beetle population by means of the application of insecticides on the basal 30 cm of elm trunks, the overwintering site of the adult beetles. In this paper, data are presented describing the residues of chlorpyrifos, the registered insecticide to control elm bark beetles, and cypermethrin, a possible substitute, in elm bark samples, litter, and soil at predetermined intervals after application of the insecticides. Residues in the bark were also bioassayed using elm bark beetle mortality. Analytical methodology for chlorpyrifos and its major metabolites, the four isomers of cypermethrin and their metabolites in the three matrices by both chemical and biological means will be described.

GAMMA IRRADIATION FOR CONTROL OF HESSIAN FLY. B. H. Timlick[1], N.J. Holliday[1], K. Wittenberg[2] and J. Borsa[3]. [1] Department of Entomology, and [2] Department of Animal Science, University of Manitoba, Winnipeg, Manitoba R3T 2N2; and [3] Whiteshell Nuclear Research Establishment, Atomic Energy Canada Limited, Pinawa, Manitoba R0E 1L0.

Hessian fly, *Mayetiola destructor* (Say), as diapausing larvae in the flaxseed stage, were exposed to different levels of gamma radiation from a ^{60}Cobalt source. Flaxseeds were obtained from a laboratory culture and from field- collected material. Flaxseeds, attached to wheat stems, were irradiated in groups. Before and during irradiation, flaxseeds were maintained at 2°C. Assessment of the effects of irradiation was carried out by raising the flaxseeds to 20°C and counting adults that emerged; after emergence was complete, the total number of flaxseeds was determined by dissecting the wheat stems.

In initial trials, flaxseeds were exposed to radiation doses ranging from 0.1 - 1.0 kGy. Of the flaxseeds from the laboratory culture, adults emerged from 92% (n = 584) of flaxseeds in the unirradiated control, but none survived any of the radiation doses. For field collected flaxseeds, survival in unirradiated controls was poor, but again no flies emerged from any of the irradiated treatments. In a second series of trials, dosages ranged from 0.002 to 0.15 kGy. The results of this trial confirmed that hessian flies fail to emerge at doses of 0.1 kGy or more. These results show promise for using gamma irradiation to prevent accidental export of hessian fly to Pacific rim countries in feed hay.

RELATIVE BIOAVAILABILITY OF CADMIUM FROM WATER AND SEDIMENT SOURCES TO AQUATIC INVERTEBRATES IN LITTORAL MESOCOSMS. R.S. Currie, D.C.G. Muir, W.L. Fairchild and R.E. Hecky, Department of Fisheries and Oceans. Winnipeg, MB CAN. R3T 2N6.

The bioavailability of Cd was studied in littoral enclosures (5m diameter x 2m deep) in a small Canadian Shield Lake at the Experimental Lakes Area, N.W. Ontario. Four littoral enclosures were situated in Lake 382, where whole lake additions of Cd have been undertaken since 1987 during the ice-free season. The enclosures effectively isolated the sediment and biota present within the enclosures, from exposure to the new 1991 Cd additions. Fate and bioavailability of Cd was monitored in sediment, pore water, zooplankton, caged and natural benthic invertebrates and insect emergence in the enclosures, and in the lake itself. Introduced floater mussels, *Anodonta grandis grandis*, and crayfish, *Orconectes virilis*, respectively, accumulated 4-5x and 2x more Cd when caged on the sediment in the lake, compared to inside the enclosures. Natural populations of a mayfly, *Hexagenia limbata*, and midges, Chironomidae accumulated similar amounts of Cd in the enclosures and the lake. Bioaccumulation factors for these organisms relative to sediment concentrations, were 0.7 in the lake and 0.9 in the enclosures for *H. limbata*, and 3.5 in the lake and 3.2 in the enclosures for Chironomidae. The data suggest that sediment-associated Cd is the main route of exposure to sediment dwelling organisms, whereas the water route is more important for mussels and crayfish.

Minutes of the 48th Annual Business Meeting of the Entomological Society of Manitoba

13:30 h, November 6, 1992

Freshwater Institute
Winnipeg, Manitoba

The President, Dr. N. White, presided. A quorum being present, the President called the meeting to order. Past President, Dr. R. Westwood, took the minutes as the Secretary was unable to attend.

ATTENDANCE

Executive:
N. White, President
R. Gadawski, President-Elect
R. Westwood, Past President
R. Ellis, Member-at-Large
P. Fields, Regional Director to ESC

Executive Staff:
L. Grenkow, Treasurer
A. Wiens, Editor - Proceedings
A. Robbie-Draward, Editor - Newsletter

Members:

R. Currie	N. Holliday
R. Gadawski	I. Wise
B. Fingler	W. Preston
R. Brust	D. Dixon
T. Galloway	S. Pernal
C. Salki	I. Pines
L. Manaigre	J. Gosselin
C. Jay	

1. R. Westwood recorded minutes of the meeting.

2. Prior to the commencement of the meeting a minute of silence was observed for the late Dr. Grant Robinson, an Honourary Member of the ESM.

3. **Agenda** (Appendix A) **Motion:** D. Dixon/T. Galloway. That proposed agenda be adopted. CARRIED

4. **Minutes of the 47th Annual Meeting Motion:** A. Wiens/T. Galloway. That the minutes of the 47th Annual Business Meeting of the Entomological Society of Manitoba, held 8 November 1991 and published in Volume 47 of the Proceedings of the ESM, be accepted. CARRIED

5. **Business Arising from Previous Minutes:** None.

6. **Executive Reports:**

a. President (Appendix B).

b. Treasurer (Appendix C - Financial Statements).

c. Editor - Proceedings of the E.S.M. (Appendix D).

d. Regional Director to the Entomological Society of Manitoba (Appendix E).

e. Endowment Fund Board (Appendix F).

d. Ad Hoc Committee on long-term Financial Planning (Appendix G).

R. Gadawski presented the recommendations of this committee. It was agreed that the details of the recommendation would be implemented by the executive and that the eventual makeup of a committee to bring in guest speakers should have two graduate students included in the representation (preferably one MSc and one PhD student). **Motion:** N. Holliday/R. Currie. That the membership adopt the recommendations of the Ad Hoc Committee on long-term Financial Planning. CARRIED

T. Galloway suggested that the society should support the formation of a data base on the insect and arthropod fauna of Manitoba. T. Galloway further suggested that a committee be formed by the curators of the J.B. Wallis Museum, Dept. of Entomology, University of Manitoba to oversee this project. **Motion:** T. Galloway/N. Holliday. That an Ad Hoc Committee be formed by the ESM to oversee the compilation of a data base on Manitoba insect and arthropod fauna. Committee to be chaired by the Curators of the J.B. Wallis Museum. CARRIED

6. **Committee Reports**

a. Finance Committee (Appendix H).

b. Publicity, Newsletter (Appendix I).

c. Social (Appendix J).

d. Education and Youth Encouragement (Appendix K).

e. ESC Common Names (Appendix L).

f. Archivist (Appendix M).

g. Manitoba Environmental Council (Appendix N).

h. Honourary Members (No report).

i. Student Awards (Appendix O): Winner of student paper award for the 48th Annual Meeting was R. Currie, Department of Entomology, University of Manitoba.

j. E.S.C. Scholarship (Appendix P).

k. E.S.M. Scholarship (Appendix Q).

l. Scientific Program Committee and annual meeting local arrangements (Appendix R).

m. E.S.C. E.S.M. Membership (Appendix S). General discussion indicated Secretary should prepare updated mailing list for ESM.

n. Fund Raising (Appendix T).

o. Joint Annual Meeting (ESM-ESC) Committee (Appendix U).

7. **1991-1992 Election Results 1992-1993 (Appendix V)**

Congratulations to R. Roughly, president-elect and A. Wiens, member-at-large.

Motion: T. Galloway/B. Fingler. That the ballots be destroyed. CARRIED

8. **Transfer of Office:** N. White called upon R. Gadawski to assume the office of President.

9. **Other Business**: The Treasurer indicated that the costs of the audit were increasing considerably each year. **Motion:** L. Grenkow/T. Galloway. That the executive investigate the costs of the audit with the goal of reducing amount spent annually. CARRIED

10. **Adjournment:** (15:45 h)

APPENDIX A

ENTOMOLOGICAL SOCIETY OF MANITOBA
48TH ANNUAL BUSINESS MEETING

November 6, 1992

AGENDA

1. Appointment of Secretary to record proceedings of the Business Meeting.

2. Acceptance of Agenda.

3. Minutes of last Annual Meeting (Nov. 8, 1991).

4. Business arising from the minutes.

5. Reports - Executive, Trustees

a. President	N. White
b. Treasurer (Auditor)	L. Grenkow
c. Editor of the Proceedings	A. Wiens
d. Regional Director to ESC	P. Fields
e. Endowment Fund Board	B. Fingler
f. Ad hoc Committee on Future Financial Initiatives	B. Fingler

6. Reports - Committees.

a. Finance Committee	B. Fingler
b. Publicity, Newsletter	A. Robbie-Draward
c. Social	S. Pernal
d. Education and Youth Encouragement	C. Salki
e. ESC Common Names	R. Roughley
f. Archivist	R. Roughley
g. Manitoba Environment Council	I. Wise
h. Honourary Members (ESC)	W. Turnock
i. Student Awards (ESM)	B. Galloway
j. ESC Scholarship	J. Conroy
k. ESM Scholarship	J. Conroy
l. Scientific Program and Annual Meeting local arrangements	R. Currie
m. ESC Membership	R. Westwood
n. ESM Membership	R. Westwood
o. Fund Raising	R. Westwood

p. Joint Annual Meeting ESM-ESC 1994 D. Dixon

7. 1991-92 Election Results.
   Scrutineer Committee L. Grenkow

8. Transfer of Office

9. Other Business

10. Adjournment

APPENDIX B

PRESIDENT'S REPORT

The past year has been an active one for the Entomological Society of Manitoba.

The activities of the various committees of the Society will be outlined in the Proceedings of the Annual Meeting. Some highlights include the formation of the Joint Annual Meeting Committee for the ESC-ESM meeting to be held in 1994. Don Dixon has laid the groundwork for a successful meeting and Paul Fields had begun to organize the Scientific Program.

A special ad hoc committee to analyze possibilities for use of funds beyond that committed to the Endowment Fund has been led by Barry Fingler and their recommendations will be presented at this meeting.

Our newsletter, edited by Autumn Robbie-Draward and Linda Glowacki has been very effective this year and special thanks need to be given to them for their creativity and initiative. The Youth Encouragement Committee has begun some challenging initiatives aimed at sparking the interest of grade school children in the study of insects.

The Fund Raising Committee has been very effective over the past few years under the direction of Richard Westwood and special thanks should be offered to Don Dixon and Lynn Manaigre for wrapping up our t-shirt sales in spite of many production and logistic problems. The t-shirts, sweatshirts and hats sparked a great deal of interest and continue to advertise the significance and beauty of insects.

Richard Westwood is currently in the process of developing a brochure highlighting the aims and activities of the ESM which will increase the Society's profile throughout the province.

Our social program this year has been excellent with the Social Committee initially chaired by Pat Mackay followed by Steve Pernal. We have had numerous luncheon meetings, and an enjoyable New Members Social. Steve Pernal and the entomology graduate students also organized a special series of lectures by Dr. Ring Carde in October 1992. The ESM gave a grant of $400 towards the visit of Dr. Carde to compliment the $400 given by the Entomology Graduate Student Association of the University of Manitoba.

Rob Currie and his committee have organized an outstanding Annual Meeting this year showing a great deal of initiative and creative planning.

The coming year will see a significant change in the functioning of the Society with the retirement of all our executive staff due to various job-related causes. Colin Demianyk is

resigning as Secretary, Larry Grenkow as Treasurer, and Al Wiens as Editor of the Proceedings. All three have done an outstanding job and will be greatly missed.

I want to express my sincere thanks to all the people in the Society who have volunteered their time and efforts in the past year. Chairs of the various committees this year included: Rob Roughley (Archivist, Common Names), John Conroy (ESM, ESC Scholarships), Barry Fingler (Finance, Endowment Fund, Ad Hoc Planning), Richard Westwood (Fund Raising, ESM Membership, Nominating), Ian Wise (Man. Env. Council), Steve Pernal (Social), Cathy Salki (Youth Encouragement), Rob Currie (Scientific Program) and Don Dixon (Joint Annual Meeting).

It has been a pleasure to serve as President of a Society with such vibrant and enthusiastic members.

Noel White
President, 1991-1992

APPENDIX C

AUDITOR'S REPORT

To the Directors of the
Entomological Society of Manitoba Inc.

I have examined the balance sheet of the Entomological Society of Manitoba Inc. as at August 31, 1992 and the statement of income for the year when ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I consider in the circumstances.

In common with many non-profit organizations, the organization derives some cash revenue, the completeness of which is not susceptible to conclusive audit verification. Accordingly, I am unable to determine whether any adjustments for unrecorded receipts from these sources might be necessary to income or surplus balances.

In my opinion, these financial statements present fairly the financial position of the company as at August 31, 1992 and the results of its operations and the changes in its financial position for the year ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Winnipeg, Canada
September 28, 1992

Original signed by Doug Nicholson
Certified General Accountant

ENTOMOLOGICAL SOCIETY OF MANITOBA, INC.
BALANCE SHEET
AUGUST 31, 1992

ASSETS

	1992	1991
Cash advances (note 2)	$ 350	$ 350
Cash in bank (note 3)	8,085	4,791
Investments (note 4)	27,000	29,000
	$35,435	$34,141

LIABILITIES

Liabilities	nil	nil

SURPLUS

Surplus	$35,435	$34,141

APPROVED BY THE BOARD

_____Director
_____Director

The accompanying notes form an integral part of these financial statements.

ENTOMOLOGICAL SOCIETY OF MANITOBA, INC.
STATEMENT OF INCOME AND EXPENSES
YEAR ENDED AUGUST 31, 1992

	1992	1991
REVENUE (note 1)		
Annual meetings	$1,815	$1,371
Donations	550	450
Fundraising committee	1,860	800
Interest income	3,351	3,068
Members fees	1,632	1,524
Miscellaneous	64	-
Proceedings	320	591
Student awards	200	-
Youth encouragement and public Education	200	400
	9,992	8,204
EXPENSES (note 1)		
Awards and scholarships	1,414	1,202
Fundraising committee	819	1,750
General	1,013	769
Meetings	3,193	2,035
Newsletter	612	862
Other committees	24	-
Proceedings	815	962
Social Committee	808	280
	8,698	7,860
EXCESS (DEFICIT) OF INCOME OVER EXPENSES	$1,294	$ 344
Surplus, beginning of the year	34,141	33,797
SURPLUS, END OF THE YEAR	$35,435	$34,141

The accompanying notes form an integral part of these financial statements.

ENTOMOLOGICAL SOCIETY OF MANITOBA, INC.
NOTES TO THE FINANCIAL STATEMENTS
AUGUST 31, 1992

1. SIGNIFICANT ACCOUNTING POLICIES:

Income and expenses are recorded on the cash basis of accounting. There are no accruals or receivables or payables at the year end. Fixed assets are written off when acquired and therefore, there are no annual depreciation allowances.

2. STANDING ADVANCES:

Treasurer	L. Grenkow	$ 25
Secretary	C. Demianyk	100
Newsletter	A. Robbie-Draward	200
Editor	A. Wiens	25
		$ 350

3. CASH IN BANK:

Savings account	$6,814
Current account	1,271
	$8,085

4. INVESTMENT CERTIFICATES

7053937	$2,000.00
7053706	3,024.33
8421072	1,775.67
7058513	2,000.00
7058436	3,000.00
7053805	2,000.00
12007930	2,000.00
7053871	7,200.00
7053893	2,006.48
14577420	1,993.52
	$27,000.00

APPENDIX D

REPORT OF THE PROCEEDINGS EDITOR

The Proceedings of the Entomological Society of Manitoba, as a report of the Annual General Meeting, with it's committee reports, budgets, and abstracts of scientific papers given at the meeting, in the past was of interest to regional Society members and local researchers, but often did not appeal to the wider scientific community outside of the province of Manitoba.

After the Manitoba Entomologist ceased publication, many of its subscribers continued their subscription with the Proceedings. As the scientific appeal of the Proceedings was slight, the number of subscribers began falling immediately, a decline which continued for a number of years. The number of subscribers for Volume 46 (1990) numbered only 47. However, Volume 47 (1991) again has 47 subscribers, which for the first time since the demise of the Manitoba Entomologist, represents an achievement of subscriber stability. This is due, I believe, to the scientific content: during each of the last three years scientific reports have appeared in the Proceedings; last year two reports were included. These reports undoubtedly raised the scientific profile of the Proceedings, and probably have helped stave off further decreases in subscriptions.

To encourage members to publish reports in the Proceedings, the Society provides up to $400 annually to assist authors who would be financially unable to publish a report, incidental research, or compilation of scientific data. There is a peer review process for each contribution that works well, and I would encourage members to consider the Proceedings as a possible venue for publication.

For the last five years I've worked on the Proceedings of the Entomological Society of Manitoba in some capacity; two years as assistant editor, and the last three years as editor, and as much as I've enjoyed the position, and enjoyed working with the people associated with it, I feel it is time to step down. I would like to thank the Society's Secretaries for their excellent reports, (particularly the disk versions), the Presidents and Treasurers for their active support, and the scientific contributors and reviewers for making the Proceedings more than just a local-interest publication. Finally, I'd like to thank my wife Eileen, who, when it came to send out the Proceedings, got writer's cramp writing invoices. I got to lick the envelopes.

Allen Wiens,
Proceedings Editor
October 20, 1992

APPENDIX E

REPORT OF THE REGIONAL DIRECTOR TO E.S.C.

The Annual Meeting of the Governing Board of the Entomological Society of Canada was held in Saskatoon on 26 and 30 Sept. 1992. I will not delve into all the details of the board meeting as the minutes will be published in the next Bulletin of the Entomological Society of Canada.

The items of most interest to our members are:

1. The Finance Committee expressed concern that the ESC has annual deficits of over $50,000/year. Their recommendations were to increase page charges of the Can. Ent. from $25/pg to $30/pg, Memoirs to $45/pg and increase reprint charges by 10%. They estimated this would raise $21,500. The Governing Board did not accept these recommendations, and asked the Publications Committee to investigate means of reducing costs through a major reworking to Can. Ent. and formed a Marketing Committee to raise funds.

2. The 1993 Meeting to be held in Sault Ste. Marie will focus on entomology and the public, with the plenary symposium on graduate training and symposia on ecology and natural insecticides.

3. Again the costs and advantages of being a member of the Canadian Federation of Biological Societies were discussed. For the last 3 years, the society has paid the dues for it's Canadian members ($17,000/year). Next year, it will have to be decided if we are to remain a member of CFBS and how to pay for the dues of $50/member. The results of the Canadian Zoological Society's mail ballot will not be known until the end of November, and the Canadian Botanical Society has opted out of CFBS. There will be discussion of the pros and cons of membership in CFBS in the Bulletin with a mail ballot in the summer of 1993. Although it is possible to decide on this issue at the Annual General Meeting, it was felt that the issue was too important and the AGM too narrow a venue. I was instructed to get feed back from the ESM.

4. The book project "Diseases and Insect Pests of Vegetable Crops in Canada" will appear in 1993, 8000 copies in English and 3000 copies in French.

Paul Fields
Regional Director

APPENDIX F

ENDOWMENT FUND BOARD

The Endowment Fund continues to be a major source of revenue for the Society. It provides a basis for funding the Student Scholarship ($1,000.00), the publication of the Proceedings ($700.00) and the promotion of publication of scientific papers in the Proceedings ($400.00). Also, the Fund contributes approximately $500.00 toward the costs associated with the Annual General Meeting of the Society. Therefore, the Endowment Fund is committed to about $2,600.00 annually.

In the 1991-92 fiscal year, $3,247.55 of investment income was generated from a principal amount of $27,000.00. A similar amount of revenue will be generated through the Fund in the 1992-93 fiscal year.

As noted below, GIC certificate number 7053959 matured on February 19, 1992. It was then reinvested through the addition of $3,000.00 from the Society's savings account (total $5,000.00) in a 6-month GIC at 6.50%. This certificate matured on August 17, 1992. The 5,000 plus the $160.00 accrued interest was placed in the Society's savings account. A new GIC in the amount of $3,000.00 was added to the Endowment Fund in October 1992, bringing the current total of the Fund to $30,000.00.

A description of the Endowment Fund investments follows.

Guaranteed Investment Certificates with Royal Trust

Cert. #	Amount ($)	Interest Rate (%)	Maturity Date	Annual Interest
7053937	2,000.00	9.750	Oct. 2, 1996	195.00
7053959	2,000.00	9.250	Feb. 19, 1992	185.00
7053959a	5,000.00	6.500	Aug. 17, 1992	160.00
7053706	3,024.33	10.750	Dec. 15, 1992	325.12
8421072	1,775.67	10.750	Jan. 26, 1993	190.88
7058513	2,000.00	10.500	June 9, 1993	210.00
7058436	3,000.00	10.750	Dec. 13, 1993	322.50
7053805	2,000.00	11.250	April 5, 1994	225.00
12007930	2,000.00	10.750	Oct. 11, 1994	215.00
7053871	7,200.00	10.750	Nov. 14, 1994	774.00
7053893	2,006.48	11.500	Aug. 28, 1995	230.75
14577420	1,993.52	10.750	Dec. 19, 1995	214.30
18105406b	3,000.00	7.500	Oct. 31, 1997	225.00
Total	27,000.00	Avg 10.271		3,247.55

a. upon maturity, added $3,000.00 from savings account and invested in a 6-month GIC (minimum $5,000.00 required), which matured on August 17, 1992.
b. invested at 7.50% on October 31, 1992; not included in calculations.

November 2, 1992
Randy Gadawski
Larry Grenkow
Barry Fingler, Chair

APPENDIX G

AD HOC COMMITTEE ON FUTURE FINANCIAL INITIATIVES

Over the past several years, uncommitted funds have regularly been transferred from the Society's savings account into the Endowment Fund in the form of Guaranteed Investment Certificates. This Committee was struck to explore alternative ways for the Society to utilize these uncommitted funds, estimated to be approximately $1,500.00 annually.

The Committee (P. MacKay, R. Gadawski, B. Fingler; regrets J. Conroy) met on April 8, 1992 and discussed several ideas. These included:

- increased funding of current ESM Scholarships/Awards
- establishing new Scholarships/Awards
- establishing a fund designed to assist students in attending important scientific meetings
- using the funds to invite the ESC Gold Medal Winner to the ESM Annual Meeting as a "special speaker"
- increased funding of public education initiatives, eg. Fort Whyte Centre for Environmental Education, Youth Encouragement and Public Education
- using the funds to annually invite an eminent, "high-calibre" speaker to present a seminar, possibly in the spring

The Committee recommends that the funds be used to annually invite an eminent speaker to present a seminar to the Society. This initiative would be of the most benefit to the Society as a whole, in that all members would have an opportunity to attend the seminar.

The seminar might be arranged to coincide with the New Member's Social in late March or early April. A Speaker Selection Committee might be comprised of the Past President as the Chair, a member of the Social Committee and two graduate students; one M.Sc. and one Ph.D. There also may be an opportunity to access other sources of funding to support this initiative. The Committee could meet in advance of the ESM Annual Meeting to discuss potential topics and speakers. Once the speaker is confirmed, the seminar could be advertised through the ESM newsletter, announced at the Annual Meeting and through notices posted at various universities.

October 30, 1992
R. Gadawski, J. Conroy, P. MacKay
and *B. Fingler*, Chair

APPENDIX H

ANNUAL REPORT OF THE FINANCE COMMITTEE

The Finance Committee met on October 21 to review the Society's financial status. It was determined that in 1991-92, revenue exceeded expenses by $1,294.00.

In 1991-92, the Society contributed $400.00 to assist the Graduate Students of the Department of Entomology, University of Manitoba with funding a series of seminars given by Dr. Ring Carde, University of Massachusetts. Of note also was the net revenue ($1590.00) generated by the Fund Raising Committee through solicitation of corporate sponsorship and the sale of t-shirts.

The Finance Committee had the responsibility of reviewing each of the Committee budgets and prepared an overall budget for the Society. An accounting of the revenue and expenses for 1991-92 and projections for the next two fiscal years is attached.

Entomological Society of Manitoba

BUDGET ITEMS	1991-92 ACTUAL PROJECTED	1992-93 ACTUAL &	1993-94 PROJECTED
Endowment Fund	$27,000.00	$30,000.00	$30,000.00
REVENUE			
Membership dues	1,632.00	1,600.00	1,600.00
Proceedings	320.00	1,130.00[1]	530.00
Social Committee	0.00	1,950.00	1,800.00
Youth/Education Committee	200.00	200.00	200.00
Fund Raising Committee	2,410.00	1,200.00	1,000.00
Student Awards and Scholarship	200.00	100.00	100.00
Meetings: ESM AGM	1,815.00	1,769.00	1,800.00
ESC-ESM (94-95)	0.00	0.00	1,600.00
Newsletter	0.00	0.00	0.00
Investment Income	3,351.00	3,350.00	3,350.00
Miscellaneous: GST Rebate	64.00	50.00	50.00
TOTALS	$9,992.00	$11,349.00	$12,030.00
EXPENSES			
General Society Expenses	$1,013.00	$1,000.00	$1,000.00
Proceedings	815.00	1,775.00[1]	880.00
Newsletter	612.00	790.00[2]	700.00
Social Committee	808.00	2,261.00	2,200.00
Youth/Education Committee	0.00	500.00	300.00
Fund Raising Committee	819.00	250.00	250.00
Student Awards and Scholarships	1,414.00	1,300.00	1,300.00
Meetings: ESM AGM	3,193.00	3,842.00[3]	3,300.00
ESC-ESM (94-95)	0.00	600.00[4]	1,000.00
Other Committees: Membership	24.00	0.00	0.00
Guest Lecture[5]	0.00	1,500.00	1,500.00
TOTALS	$8,698.00	$13,818.00	$12,430.00
Net Gain (Loss) for Year Ending August 31st	$1,294.00	($2,469.00)	($400.00)

[1] includes revenue and expenses for printing 2 Proceedings: Volume 47 (1991) and Volume 48 (1992)
[2] includes expenses for summer 1992 newsletter
[3] includes an increase in the incurrable deficit by $500.00 for the 48th AGM
[4] anticipated expenses toward ESC-ESM JAM
[5] subject to approval of membership

October 30, 1992
Robert Currie, Randy Gadawski, Larry Grenkow,
Allen Wiens and Barry Fingler, Chair

APPENDIX I

ANNUAL REPORT OF THE NEWSLETTER AND PUBLICITY COMMITTEE

The ESM Newsletter has published 3 issues (Volume 19, Numbers 1 to 3) during 1992. The fourth issue of 1992 will be published in November.

The ESM Newsletter layout was redesigned in 1992 to update its image. In addition, the content was expanded with regularly featured articles which include "President's Message", "Guest Editorial", "ESM Member Profile" and "Trivia Manitoba". Subsequent issues will feature letters from ESM members living outside of Manitoba entitled "Dear ESM Members:".

Due to the changes in mailing protocol, Canada Post will not allow a bulk mailing of the ESM Newsletter which has resulted in increased mailing costs for the Newsletter.I would like to thank all members who have participated in the publication of the newsletter by providing articles of interest, letters, editorials, trivia questions and themselves as subjects for the profiles. I challenge each ESM member to participate actively for the 1993 issue.

A. Robbie-Draward
Chair, Newsletter and Publicity Committee, 5 November 1992

APPENDIX J

ANNUAL REPORT OF THE SOCIAL COMMITTEE

The Entomological Society of Manitoba met for three luncheons during the past year. The first two luncheons were held at Alto's in the Norlander Inn and the third was held at the Malibu Conference and Banquet Centre. On December 17, 1991, Darren Pollock and Lisa Reichert spoke to 41 members on "Which Way to the Beech [sic]? - Two Months in Australian Rainforest". On February 11, 1992, 29 members listened to Barb Deneka talk about "The Galapagos: Darwin's Enchanted Isles". The third luncheon, on September 17, 1992, was attended by 45 members and featured Terry Galloway speaking on "New Zealand: An Entomologist's Perspective".

The New Members' Social was held in the Tartan Room of Pembina Hall at the University of Manitoba on March 21, 1992. Fifty members were in attendance, including seven

new members. George Lammers, from the Manitoba Museum of Man and Nature, addressed an attentive audience on the subject of "Dinosaurs and Manitoba".

In conjunction with the Scientific Program Committee for the Annual Meeting, the Social Committee arranged for Richard and Enid Westwood to host the Meet the Speakers Mixer on November 5, 1992, at their home. The mixer was thoroughly enjoyed by the 30 people that attended. The ESM Annual Dinner was held at the Holiday Inn Winnipeg South. The percussion ensemble "Stick Shift", led by Frederick Liessens, entertained the 44 people in attendance.

S.F. Pernal/P.A. MacKay
Chairs, Social Committee

APPENDIX K

YOUTH ENCOURAGEMENT AND PUBLIC AWARENESS COMMITTEE

The Committee wishes to thank Paul Fields, Dale Wrubleski, Ian Wise, Tricia Mason and Brian Galka for volunteering their time and energy to the Youth Encouragement and Public Awareness Committee's various presentations and projects.

A total of six schools (four in Winnipeg #1 and two in Ft. Garry #5), three Children's Centres (in St. Norbert, St. Charles and Ft. Richmond) and one Beaver Colony in E. Kildonan, requested our presentations this year. Two "Earth Savers" programs (Parks and Recreation in St. Vital and St. Boniface) asked for our involvement, and for the third year, N. Kildonan Parks and Recreation used the Department of Entomology facilities and graduate student volunteers for one of their summer programs. In addition, we had phone consultations from Family Support Centre, CFB Winnipeg, and from Ducks Unlimited. We subsequently met with representatives from the Oak Hammock Marsh Interpretive Centre to discuss how our committee could be of assistance in providing materials and ideas for their marsh diorama and other possible interactive displays.

YEPAC's activity booklet is close to being finished and will be tried out at various schools prior to general release. I regret to report that the Young Entomologists have not had contact with us again this year. I can only recommend that this aspect of our Committee's activities be given top priority by the incoming Chairperson.

Once again, I would urge all members of the Entomological Society of Manitoba to consider volunteering one or two hours of their time in this coming year (either by conducting

a field trip with our young people or by giving a slide presentation). This Committee can only remain viable if everyone cares enough to be involved.

Catherine Salki, Chair

APPENDIX L

REPORT OF THE COMMON NAMES COMMITTEE

There have been no applications from ESM members during the past year for new common names, nor has there been any requests for changes in old common names, and therefore there are no local activities to report. In July 1992, a revised version of the common names list of ESC was examined and approved. It will be published by ESC in the near future.

R.E. Roughley, Chair

APPENDIX M

REPORT OF THE ARCHIVIST

The Archives materials of the Entomological Society of Manitoba are held in Room 213 of the Department of Entomology, University of Manitoba. Two copies of the ESM Newsletter at each publication and these are added to the Archives. Any donation of any other materiel for the Archives would be welcome.

R.E. Roughley, Chair

APPENDIX N

MANITOBA ENVIRONMENTAL COUNCIL

The administrative operation of the Manitoba Environmental Council stabilized this year following major changes in funding and support personnel allocation by the province in 1991. This enabled the Council to concentrate on various environmental matters, and allocate funding on a priority basis for council member participation at a number of hearings.

The executive of the Council dealt mainly with 2 major environmental concerns in 1992. These were the Conawapa/Bipole III Environmental Impact Assessment (EIA) and the Forest Management Licenses (FML) of Repap and Abitibi-Price. A draft document containing 65 recommendations for EIA review were presented to the Conawapa Environmental Review Panel. The drafting of the document was assisted by intervenor funding that was provided by the province for the first time in order to improve an EIA process. The Council made appeals to the Minister to use the FML process to make real gains in the Endangered Species Program and to ban commercial forestry operations in provincial parks.

Council members of the executive and the various committees also participated at hearings or as a consultant in environmental matters concerning the Red and Assiniboine River water quality objectives, location of the Manitoba Hazardous Waste Management facility, implementation of the Ozone Depleting Substances Regulation, and to the Plan Winnipeg report.

The Environmental Chemicals Committee, which has 2 ESM members, dealt mostly with concerns regarding the progress by the Association for a Clean Rural Environment (ACRE) in pesticide container recycling and with the report by the Task Force on pesticide use in the City of Winnipeg. Following media attention over the shipment of shredded containers by ACRE to the United States, 2 members of the Council were appointed to the board of ACRE.

Any ESM member who wishes further information on these matters or who would like the Council to act on a specific environmental concern should contact me anytime.

Ian L. Wise

APPENDIX O

ESM STUDENT AWARDS COMMITTEE

The Committee reviewed the nominations received for the Student Achievement Award and the SWAT Student Award. Mr. Andrew MacKay was selected as the recipient of the Student Achievement Award. Mr. Don Henne has been selected to receive the SWAT Student Award. The Awards will be presented at the Banquet following the Annual Meeting.

W. J. Gallaway, Chairperson
J. Conroy, B. Fingler, W. Preston

APPENDIX P

ENTOMOLOGICAL SOCIETY OF CANADA SCHOLARSHIP COMMITTEE

The Entomological Society of Canada Scholarship Committee met and discussed five applications for the ESC Postgraduate Awards. The ESC Scholarship Committee recommended that the ESC Postgraduate Awards be made to Ms. Maya Louise Evenden and Mr. Martin Hardy.

Ms. Evenden is from Simon Fraser University and is supervised by Dr. John Borden. Her research topic will be on the use of pheromone traps for monitoring populations of western hemlock looper.

Mr. Hardy is from the University of Laval. His supervisors will be Dr. Jeremy McNeil and Dr. Johanne Delisle. His research topic will examine the effect of the quality of larval food on the reproductive biology of the spruce budworm and obliquebanded leafroller.

The ESC Scholarship Committee was disappointed with the low number of applicants (five) especially since we had seventeen last year.

John C. Conroy
ESM Representative
ESC Scholarship Committee

APPENDIX Q

ENTOMOLOGICAL SOCIETY OF MANITOBA SCHOLARSHIP COMMITTEE

The Entomological Society of Manitoba Scholarship Committee met and discussed three applications for the ESM Postgraduate Award.

The ESM Scholarship Committee unanimously recommends that the ESM Postgraduate Award be made to Mr. Robert A. Anderson, Department of Entomology, University of Manitoba. Mr. Anderson is currently working on his Ph.D. degree under the supervision of Dr. R. Brust, Department of Entomology, University of Manitoba. His thesis looks at "the factors which interrupt blood feeding by female mosquitoes and to identify important determinants of

these phenomena". The Committee members were Dr. Desiree Vanderwel, Department of Chemistry, University of Winnipeg and Professor Marianne Hardy, Department of Biology, University of Winnipeg.

John C. Conroy
Chairperson, ESM Scholarship Committee

APPENDIX R

SCIENTIFIC PROGRAM COMMITTEE PRELIMINARY REPORT

The Entomological Society of Manitoba Inc. held its 48th Annual General Meeting at the Freshwater Institute, 501 University Crescent, Winnipeg, Manitoba, on 5-6 November 1992. Dr. Tom Baker, University of California, Riverside CA, gave an exciting keynote address entitled "Communication in Moths".

A symposium moderated by Dr. Terry Galloway, was held on the topic of "Communication and Behavioral Modification in Insects" with the following invited speakers: **Ralph Howard**, USDA Manhattan, Kansas, **Irene Pines**, Forest Protection, Forestry Branch, Manitoba Natural Resources, Winnipeg, **P. Palaniswamy**, Agriculture Canada Research Station, Winnipeg and **R.W. Currie**, Department of Entomology, Winnipeg.

In the submitted paper session chaired by Dr. P. Paliniswamy, a total of ten papers were presented. The judges committee for the student paper competition consisted of Dr. S.C. Jay (Chair), B. Fingler and J. Gravloski.

An evening mixer was held at the home of Richard and Enid Westwood on Thursday, 5 November 1992 and a formal dinner-banquet, organized by Steve Pernal (Local Arrangements Chair) will be held at the Holiday Inn Winnipeg South Conference Centre, 1330 Pembina Highway. Elegant after dinner entertainment is to be provided by "Stick Shift". The Scientific Program Committee extends thanks to all the members who volunteered their time to make this meeting a success, and especially to P. Paliniswamy, A. Wiens, D. Rosenberg, A. Fox and A. MacKay.

R. Westwood
R. Gadawski
N. White
S. Pernal
D. Vanderwel
R.W. Currie, Chairperson

APPENDIX S

E.S.M. MEMBERSHIP COMMITTEE

The membership of the Entomological Society of Manitoba in December 1991 included 138 members. As of February 1992 the membership stood at 140 members, with several new members being welcomed at the New Members social in March 21, 1992. The membership of the society has remained relatively stable during the last 4 years.

Richard Westwood

APPENDIX T

FUND RAISING COMMITTEE

During the period September 1991 to August 1992 this committee continued to raise funds for the society through the sale of entomology t-shirts and soliciting corporate donations to assist with the Annual Meeting. T-shirt sales amounted to $1860.00 and corporate donations totalled $550.00 Total monies raised for the society was $2410.00 As of September 1, 1992 there remained a
t-shirt and sweatshirt inventory for further generation of approximately $1200.00 in upcoming years.

Don Dixon
Lynn Manaigre
Richard Westwood, Chair

APPENDIX U

JOINT ANNUAL MEETING (ESM-ESC) COMMITTEE

The organizing committee for the 1994 joint ESM-ESC Annual Meeting was formed as an ad-hoc committee in 1992. Arrangements have been finalized to host the joint meeting at the Delta Winnipeg Hotel, 288 Portage Ave during October 15-19, 1994.

To date, the following committee appointments have been made:

Science Program Chair - Paul Fields
Local Arrangements Chair - Don Dixon
Fund Raising - Richard Westwood
Finance/Budget - JoAnne Booth
Printing - Barry Fingler

As the meetings approach there will be an increasing need for the assistance from ESM members for a variety of organizational and support functions. With a broad level of participation from ESM members we are confident that we will be able to host an exciting and well organized meeting in 1994.

D. Dixon
Chair - Joint Annual Meeting Committee

APPENDIX V

SCRUTINEER'S REPORT 1992-93 ELECTION

Larry Grenkow served as chair of the scrutineer committee, replacing R. Roughley who ran for office.

Successful President-Elect	R. Roughley
Successful Member-at-Large	A. Wiens
Total number of ballots issued	140
Number of ballots returned	80
Number of spoiled ballots	0
Total number of ballots issued	140
Unanimous consent of ballots returned	67
Number of spoiled ballots	0
Honourary Member	S. C. Jay

L. Grenkow, P. Fields, N. White

NOTICE TO CONTRIBUTORS

Research papers in the *Proceedings of the Entomological Society of Manitoba* are fully refereed. The *Proceedings* are published once a year and manuscripts are welcome any time. The research papers section of the *Proceedings* is primarily intended to highlight entomological research of local (Manitoba) or regional (prairie provinces) interest. The following guidelines should be followed in writing and preparation of manuscripts. Guidelines are adapted from *The Proceeding of the Entomological Society of Ontario*, Volume 117, 1986.

General. Articles are normally in English and should not be offered for prior or simultaneous publication elsewhere. The Editor should be informed if manuscripts have been refused elsewhere. Authors need not be members of the Entomology Society of Manitoba to submit articles.

Text. Articles should be typed, double spaced and on one side of the paper. Margins should be 25 mm on all sides. One original and two copies of text should be submitted to the Editor. Spelling should conform to usage recommended in either the Oxford or Webster's New International dictionary. Except in tables, figures, or quotations, dates should be written in the form of 15 July, 1992, etc. Reference to illustrations should be in the form 'Figure 2' or 'Fig. 2', and references to tables should be in the form 'Table 2', etc. Citation references in the text should be in the form 'Wilson (1992) stated', '(Smith 1990)', '(Brown 1985, 1990a,b)' or '(Wilson and Brown 1984; Smith 1990)' in chronological order for multiple citations within one set of parentheses. Footnotes should be kept to a minimum and typed at the bottom of the page to which they apply. Abbreviations should be kept to a minimum and only those that are generally recognized, or defined within the text for the sake of brevity should be used. Units of measurement should be metric and abbreviated according to the Canadian national standards.

Manuscript Submission and Review. Typed manuscripts must be submitted for review purposes. After final acceptance all manuscripts should be submitted in both typed form and on floppy disk. The name(s) of the file(s) on the disk, name of the word processing language, and the type of computer used must also be included. All manuscripts are reviewed by at least two reviewers. The Editor selects those reviewers and does not disclose their names. The Editor decides to accept, reject or return for revision, manuscripts after reviewer evaluation.

Abstract. Articles greater than two typewritten pages, except scientific notes, must be preceded by a brief but informative abstract.

Acknowledgements. Acknowledgements should be short and placed in a paragraph at the end of the text.

References. All references should be listed alphabetical order of authors at the end of the article.

References not directly consulted by the author should be preceded by an asterisk. The full title for each reference must be given, plus complete pagination for all items, including books. The names of serials and periodicals should be written out in full.

Layout. The general layout of articles should follow the format for those appearing in this Volume (e.g. use of italics, use of bolding and capitals for wording etc.). Tables and figures should also follow the format for those articles appearing in this Volume. Two copies of each illustration for each reviewer should be submitted. Captions should be numbered consecutively and must be attached to each illustration.

Publication. There are no page charges for publication of articles in the *Proceedings of the Entomological Society of Manitoba*. Charges are applicable to article reprints on a cost recovery basis.

ACKNOWLEDGEMENTS

The editor wishes to acknowledge the assistance of the previous editor of the *Proceedings*, Mr. A. Wiens and the efforts of the anonymous reviewers asked to review the research papers appearing in this Volume.

ENTOMOLOGICAL SOCIETY OF MANITOBA

The *Entomological Society of Manitoba* was formed in 1945 "to foster the advancement, exchange and dissemination of Entomological knowledge". This is a professional society that invites any person interested in entomology to become a member by application in writing to the secretary. The society produces a quarterly newsletter, the *Proceedings*, and has a variety of meetings, seminars and social activities. Persons interested in joining the society should contact:

The Secretary
Entomological Society of Manitoba
c/o Agriculture Canada
Research Station
195 Dafoe Road
Winnipeg, Manitoba
R3T 2M9