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CONTENTS

SUBMITTED PAPER ABSTRACTS:

SEASONAL OCCURRENCE OF INSECTS AND MITES IN A MANITOBA FEED MILL[1]

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ABSTRACT

The seasonal distribution, and occurrence of insects and mites outside and within a southern Manitoba feed mill were determined using a bait bag technique during two summers and one winter. Of the seven sites monitored, the largest number of insect taxa, largely fungus feeders and soil inhabitants, occurred beneath the grain storage bins outside the mill. The confused flour beetle, *Tribolium confusum* J. du Val and the larder beetle, *Dermestes lardarius* L. predominated at all sites within the mill. *Tribolium confusum* was abundant in the warm or other heated areas and *D. lardarius* in the cooler warehouse. The lesser grain borer *Rhyzopertha dominica* (F.) was not found in bait bags at any site or in pheromone flight traps used in another study. The importance of year-round sanitation in all mill areas is emphasized to reduce the size of insect populations in summer when they are largest.

INTRODUCTION

Stored-product insects, mites, and fungi that live in and on stored grains and grain products, are interrelated in complex ways. These pests are of considerable economic importance because product quality may be reduced by their presence and activities (Sinha 1973; Dowdy and McGaughey 1991). The quality of grain products is of major importance and an ongoing concern to domestic and international customers. Most studies of these pests have focused on farm and commercial granaries but relatively few have examined seasonal distribution and occurrence within feed mills.

Studies on feed and flour mills have focused on the distribution and frequency of occurrence of stored-product insects and mites: in Greece (Buchelos 1981), the United Kingdom (Ministry of Agriculture Fisheries and Food 1981*a*, 1981*b*; Salmond 1956), and the United States (Rilett

[1]**Contribution No. 1547.**

and Weigel 1956; Loschiavo and Okumura 1979). In Canada, the presence of stored-product insects and mites in feed mills causes chronic pest control problems (Sinha and Watters 1985). Only a few mycological and or mycotoxicological studies have been conducted in feed mills. In the United Kingdom, Scudamore and Buckle (1987) reviewed the occurrence and significance of molds and mycotoxins in cereals and animal feed stuffs, and in the USA, Russell *et al.* (1991) have studied the incidence of molds and mycotoxins in commercial animal feed mills in seven midwestern states. Despite high control costs and the known adverse affects caused by these organisms upon product quality (Mills 1993), little research has been conducted in feed mills on the ecological relationships occurring among stored product insects, mites, and fungi.

The overall objectives of the present work were 1) to determine the seasonal distribution, occurrence, and possible relationships among insects and mites within a feed mill in southern Manitoba using simple detection techniques and 2) to devise management strategies for monitoring and reducing arthropod occurrence. In this paper, we report on insect and mite occurrence throughout the year; fungi and mycotoxin results are reported elsewhere.

METHODS

Bait bags. The bags were 20 × 10 cm and made of welded plastic mesh of 1.5 mm aperture, folded and sealed to form a pouch for food materials (Pinniger 1975; Subramanyam 1992; Subramanyam *et al.* 1992). Bags contained 30 g each of broken wheat, broken peanuts, and kibbled carobs and were stored at -15°C for at least a week before use to kill any insects in the baits. Single bags remained at sampling sites for 14 days and were then replaced by new ones. Insects and mites present within the bags were extracted by the Berlese funnel method (Sinha 1964), once returned to the laboratory in sealed plastic bags.

Moth traps. Traps for adult moths consisted of three rolls of sticky-fly paper suspended from girders above site 6 (Fig. 1) within the mill; they were removed and replaced by new traps every 14 days. Numbers of moths and flies present on the sticky traps were counted immediately after removal.

Mill sampling locations. Every 14 days from 12 June 1991 to 1 November 1992, dust and debris, and previously placed bait traps and moth traps, were removed from seven sites within the mill (Fig. 1).

Temperature and humidity data. Maximum-minimum temperature and sling psychrometer readings were taken by a mill employee just before noon each day in the mixing and pelleting room (site 3). The instruments were located 1.5 m above ground level on a wall away from direct sunlight, hot machinery, and drafts from doors.

RESULTS AND DISCUSSION

Bait bags. Of the seven sites examined, the largest number of insect taxa occurred beneath the grain storage bins outside the mill (site 1, Table 1). Some of the insects collected are typically found in soil (Carabidae, Collembola) and were occasionally present in large populations (e.g. 5000 Collembola). The insects occurring in site 1, including Collembola, Cryptophagidae, Lathridiidae, Staphylinidae, *Typhaea stercorea* (L.), and Diptera larvae, were similar to those found on rain-wetted old grain in the United Kingdom by Hunter *et al.* (1973). They found that the wet grain association was characterized by fungus feeders, supplemented by larvae of Diptera in the wettest regions.

The confused flour beetle, *Tribolium confusum* J. du Val and the larder beetle, *Dermestes lardarius* L., occurred at all sites (Table 1). *Dermestes lardarius* was trapped more often in undisturbed areas such as above the electrical control house in the mixing and pelleting room (site 3), and near pallets in the warehouse (sites 6 and 7). Mean $\pm$ standard errors of pooled adults and larvae from sites 3, 6, and 7 were 4.1 ± 1.1, 5.0 ± 2.4, and 3.2 ± 1.2 respectively, per sampling period. More *Tribolium confusum* than dermestids were collected at locations within the mill with populations present year round within the grinding room (site 2), the pit (site 4) and the tallow room (site 5) with a mean and standard error of 6.9 ± 1.6, 22.7 ± 7.0 and 6.3 ± 1.4 adults, respectively, collected per sampling period. Within the hot (38°C) tallow room, the numbers of *T. confusum* adults trapped were consistent all year (6.3 ± 1.4 per sampling period), whereas in the grinding room and pit, large peaks of trapped adults occurred during the summer months. Within the mixing and pelleting room, there were wide fluctuations in the number of *T. confusum*. *Dermestes lardarius* occurred with *T. confusum* from June to October 1991 in bait bags placed in an undisturbed area above the electrical control house. From October 1991 to January 1992 the area above the electrical control house was under renovation and bait bags were covered with debris and frequently lost. From January to October 1992 the bait bag location was in a frequently cleaned area at ground level. *Tribolium confusum* occurred in the bags in low to moderate numbers whereas *D. lardarius* was rarely seen. The highest *T. confusum* populations were in the grinding room, in the pit, and in the tallow room, which are the warmest areas of the mill. The highest populations of *D. lardarius* occurred in the warehouse.

The mold mite, *Tyrophagus putrescentiae* (Schrank) was the most common mite species found in the bait bags (Table 1). Highest populations were obtained in the grinding room and in the warehouse at site 7. The optimum temperatures for growth and development of this mite are 24-32°C; it generally requires high relative humidities for development and feeds on fungi occurring on grain (Sinha 1973). Mites were generally absent in the parts of the mill with operating machinery or, if present, were not attracted to the bait bags.

Moth traps. No adult moths were detected in the mill; *D. lardarius* adults and adult Diptera (Muscidae) were regularly caught in the sticky traps. This observation supports the conclusions of Sinha and Watters (1985) who reported few moth infestations in prairie feed mills although three common insects in feed mills in other parts of Canada are the moths *Nemapogon granella* (L.), *Plodia interpunctella* (Hbn.), and *Ephestia kuehniella* Zeller.

Temperature and humidity results. Maximum temperatures in the mill, reflected in readings from the mixing and pelleting room (site 3), ranged from 25-38°C and minimum temperatures from 8-33°C over the experimental period. Corresponding maximum and minimum relative humidities ranged from 31-87% and 10-47%, respectively (Fig. 2). Lowest relative humidities occurred during January and February of 1992. Apart from several unusually hot days in May, the summer of 1992 was the coolest in 100 years in southern Manitoba.

Ecological considerations. Pinniger and Wildey (1979) listed 38 insect species detected in bait traps including *T. confusum, D. lardarius, O. surinamensis, T. castaneum, Attagenus* spp., and *R. dominica*. In this study, the list of insect species was restricted primarily to *T. confusum* and *D. lardarius* although many other insect species are often found in feed mills in Canada (Sinha and Watters 1985); further work is needed to ascertain and compare patterns of species occurrence in this and other prairie feed mills.

Stored-product insects are attracted to the food source but may or may not remain in the bait bag. Cogan and Wakefield (1987) found in laboratory trials that only 3.4% of 450 *T. castaneum* adults released were retained. However, adults often lay eggs and larvae develop in grain within the bags. Pinniger (1975) considered the bait bag technique useful as an inspection tool to determine the presence of a particular pest species in a storage situation, to determine the range and relative levels of pest species present in different parts of an environment or at different times of the year and to assess the effectiveness of control programs. In this work, bait bags were useful for determining the predominant insect species present in different mill areas, for indicating seasonal population fluctuations and for monitoring sanitation procedures.

Tribolium confusum and *D. lardarius* were attracted to bait bags and the *Tribolium* usually remained in them (Loschiavo and Okumura 1979; Pinniger 1990). It is considered that the traps attracted arthropods mainly from their immediate vicinity. The developmental and adult longevity times and optimal developmental temperatures are different for the two species (Howe 1960; Jacob and Fleming 1984; Sinha and Watters 1985). The developmental time for *T. confusum* is 20-54 days and for *D. lardarius* it is 45-60 days; corresponding adult longevity times are 730-1080 days and 60-90 days, respectively. Optimal developmental temperatures are 30-33°C (at 70% RH) for *T. confusum* and 18-20°C for *D. lardarius*. For *T. confusum* the physical limits for successful development and multiplication are 20-38°C at 10-100% RH. For *D. lardarius*, the optimal egg-laying temperature is 20°C (at 65% RH), the shortest oviposition period occurs at 27.5°C, and egg laying ceases at 30°C.

Development of *T. confusum* was likely favoured by the warm temperatures and suitable relative humidities in the mixing and pelleting room and in other working or artificially heated areas of the mill (Fig. 2). Movement of *T. confusum* to the bait bags would also increase in these warmer areas. *Tribolium confusum*, a secondary grain feeder attacking damaged, broken milled products and grain dust (Sinha and Watters 1985), would have been able to obtain adequate food for its development within these areas. Number of *Dermestes lardarius* adults, on the other hand, were largest in the warehouse (sites 6 and 7), an area occasionally open to the outside environment and without operating machinery. The warehouse also contained stocks of prepared foods rich in proteins. High protein substances are known to be essential for egg-laying by *D. lardarius* (Hinton 1945). Debris from high protein products were thus a likely source of sustenance for this insect. The high temperatures in the mixing and pelleting room could have adversely affected egg laying by *D. lardarius* (Fig. 2).

Sinha and Watters (1985) described the prevalence of stored-product arthropods in feed mills in the Prairie Provinces during 1969-1981 based on 413 Agriculture Canada inspection reports. They found *T. confusum* to be the most frequently encountered species. Also present were *D. lardarius, Oryzaephilus surinamensis* (L.), *Tribolium castaneum* (Herbst), *Attagenus* spp. and other insects. The most commonly associated species were *T. confusum, T. castaneum, Trogoderma inclusum* (Lec.), and *Attagenus* spp. Fields *et al.* (1993), using Lindgren multiple funnel pheromone flight traps, monitored the presence of *Rhyzopertha dominica* (lesser grain borer, Coleoptera: Bostrichidae) in the vicinity of feed mills in western Canada during 1990-91 and also during 1992. During May-September 1991, 412 *R. dominica* and 5 *Cryptolestes ferrugineus* (Stephens) (rusty grain beetle) adults were found outside the mill (site 1) under examination but only 12 *R. dominica* and 2 *C. ferrugineus* during April-September 1992. No *R. dominica* were trapped inside the mill using the pheromone traps (location 2) during 1992 (Paul Fields personal communication).

Insect prevention and control procedures. Rilett and Weigel (1956) monitored the insects occurring in 11 feed and flour mills near Buffalo, New York during the winter of 1954-55 and found significant residual populations. One mill however was practically free of insects. This result was largely achieved by completely cleaning each crack and crevice containing refuse every two weeks and not allowing dust or other material to stand over two weeks. The authors concluded insect control must be continued throughout the entire year, even if the number of insects is small in winter, for it is the expansion of these residual breeding stocks carried over in favourable environments within the mill that may help to account for the increase in mill insects during the summer.

Insects in a feed mill are a concern because they constitute a potential reservoir for infesting grain elevators, flour mills, food manufacturing premises and farms, either by flight and/or in feed. Dermestid larvae are a serious concern in animal feed and human food because they may cause gastrointestinal distress due to their irritating hairs (Patton 1931; Phillips and Burkholder 1984). Dermestids can act as vectors of disease - producing organisms in certain types of food products (Hinton 1945). The appearance of dermestids in bags of pet food also causes concern to shopkeepers and customers. *Tribolium confusum* can also be a concern as it is a vector of the tapeworm *Hymenolepis dimunuta* (Rudolphi 1819; Blanchard 1891), a cosmopolitan parasite of rats, other rodents, and man in many parts of the world. The insects could carry the parasite to farm animals in feed from mills. The *T. confusum* vector situation is not of concern in the present study because of rigorous regular rodent prevention and control procedures and an absence of rodent faeces in the mill, indicative of a successful rodent management program.

From this study using bait bags as insect detection devices, populations were found in the mill throughout the year. Because of the close proximity of the grinding room, mixing and pelleting room, and tallow room, adjacent walls need to be checked for cracks, holes, and open pipechase connections and, if necessary, sealed to restrict insect dispersal. Also, all cracks or apertures need to be examined under bright illumination and cleaned of debris at regular intervals. Year-round sanitation in all internal and external mill areas is important to reduce the size and impact of summer insect populations. In the mill under examination, insect prevention and control consisted of rejection of infested stocks entering the mill and frequent removal of dust and debris by sweeping. No insecticides were used as control measures in the mill; insects were not abundant although they were continually present and posed a potential problem.

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Table 1: Total number of arthropods at bait bag sampling sites and total number of arthropods from all 7 sampling sites in the feed mill between June 12, 1991 and October 28, 1992.

ARTHROPODS	SITES[1]							TOTAL NUMBER[2]
	1	2	3	4	5	6	7	
Stored product insects Coleoptera								
Cryptolestes (larvae)	1		11					12
Cryptolestes turcicus (Grouvelle) (adult)	1							1
Cryptophagidae (adults)	6						2	8
Dermestes lardarius (L.) (adults)	4	1	2	1		17	14	39
Dermestes lardarius (L.) (larvae)	60	89	120	79	96	149	92	685
Lathridiidae (adults)	12					1	2	12
Tenebroides mauritanicus (L.) (adults)		4		1				5
Tribolium confusum J. du Val (adults)		249	111	773	226	5		1364
Tribolium confusum J. du Val (larvae)	18	471	214	230	289	67	15	1304
Typhaea stercorea (L.) (adults)	7							7
Psocoptera (adults)	9	7	16	5	4	1		42

Table 1 con't: Total number of arthropods at bait bag sampling sites and total number of arthropods from all 7 sampling sites in the feed mill between June 12, 1991 and October 28, 1992.

ARTHROPODS	SITES[1]							TOTAL NUMBER[2]
	1	2	3	4	5	6	7	
Predators/parasitoids								
Coleoptera								
Carabidae (adults)	27							27
Carabidae (larvae)	28							28
Hymenoptera								
Braconidae (adults)			1					1
Parasitic wasp (adults)	1			1				2
Others								
Collembola (adults)	5588			2	39			5629
Diptera (adults and larvae)	6062	1			2		1	6066
Coleoptera								
Nitidulidae (adults)	5							5
Nitidulidae (larvae)	281	56	21	3	25			386
Staphylinidae (adults)	14			1				15

Table 1 con't: Total number of arthropods at bait bag sampling sites and total number of arthropods from all 7 sampling sites in the feed mill between June 12, 1991 and October 28, 1992.

ARTHROPODS	SITES[1]							TOTAL NUMBER[2]
	1	2	3	4	5	6	7	
Stored product mites (adults and nymphs)								
Acarus siro (L.)	10						5	15
Lepidoglyphus destructor (Schrank)	3	1						4
Tyrophagus putrescentiae (Schrank)	31	2010			8	30	711	2790
Tydeidae		10						10
Predators								
Predatory mites [*Blattisocius keegani* Fox, *Cheyletus eruditus* (Schrank), *Androlaelaps* sp.]	117	9						126

Footnote 1: 1 = beneath exterior bins; 2 = grinding room; 3 = mixing and pelleting room; 4 = pit below mixing and pelleting room; 5 = tallow room; 6 = warehouse centre; 7 = warehouse inner south wall.
Footnote 2: Total organisms present in remaining 235 out of 252 original bait bags; missing bags were either buried by construction debris or thrown out during mill sanitation procedures.

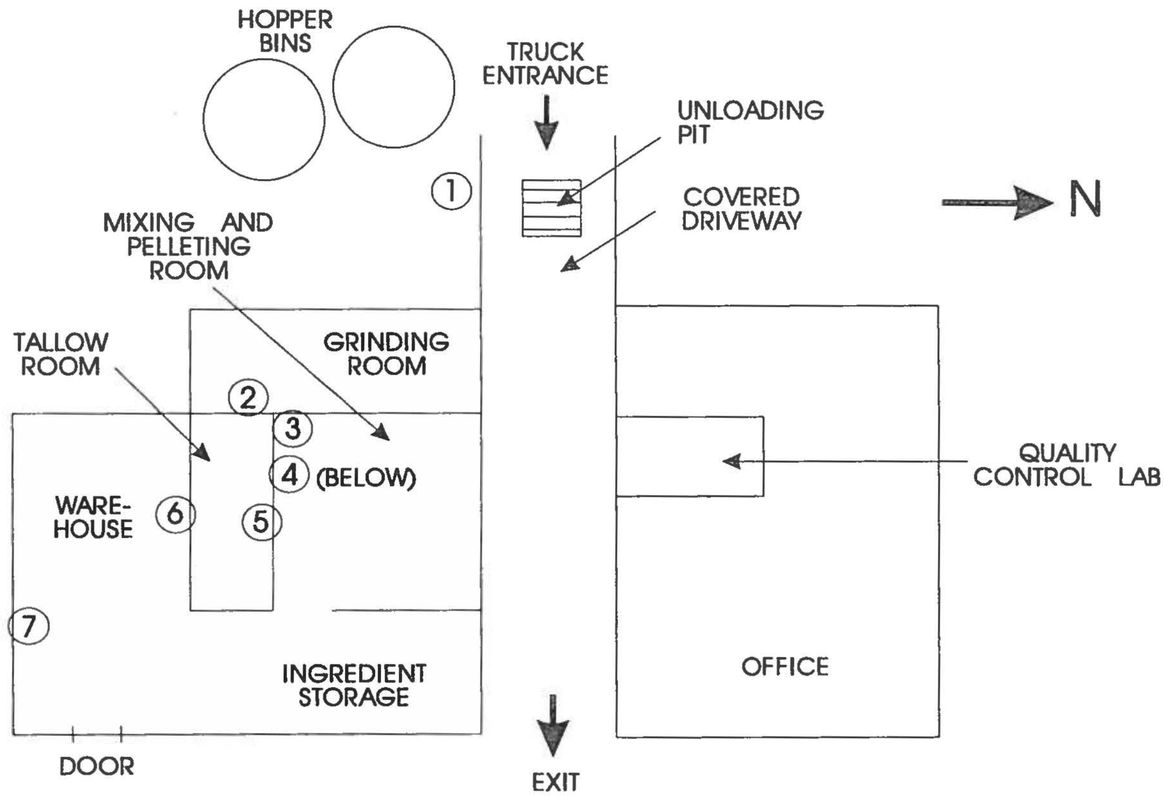
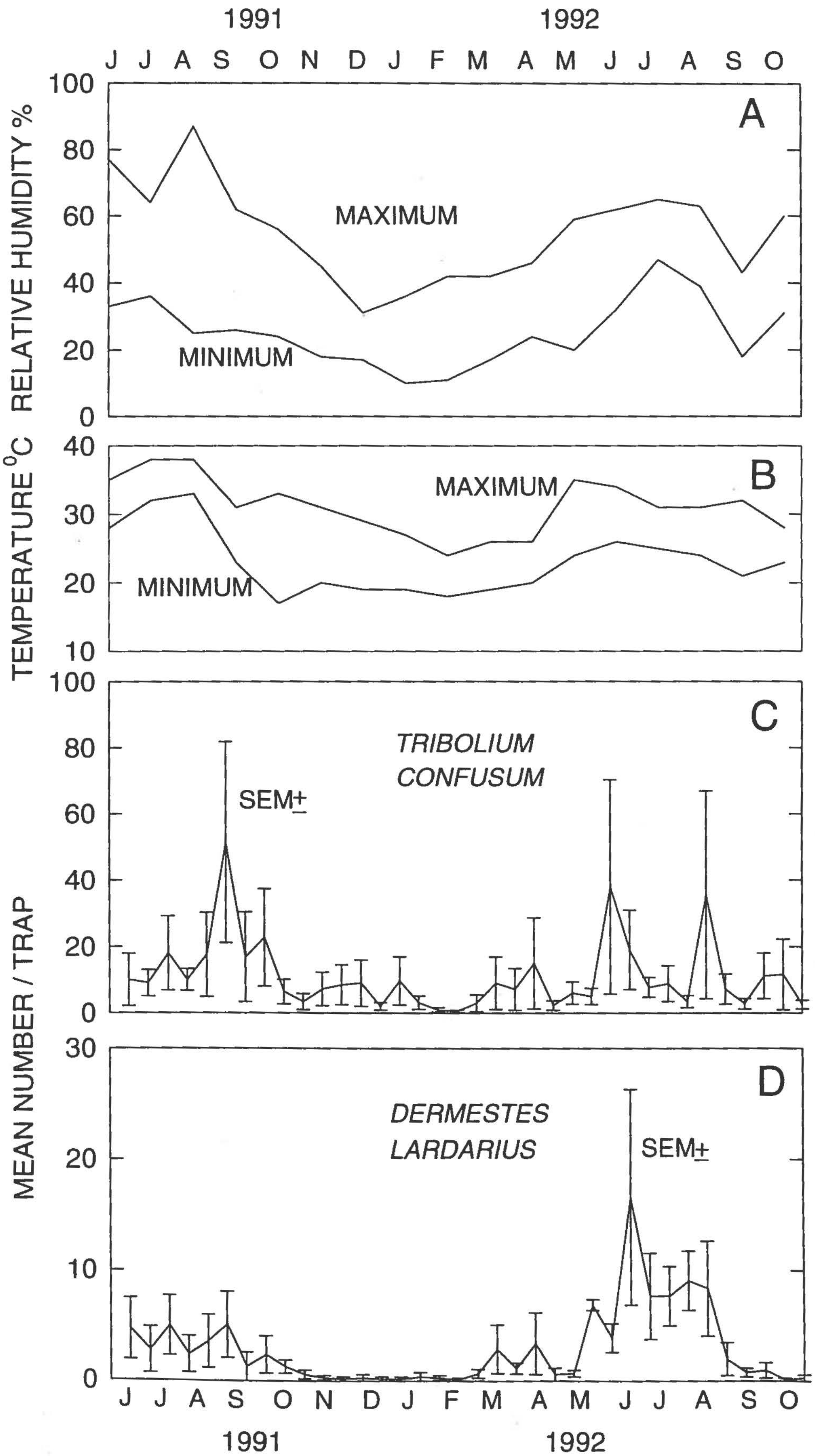


Fig. 1. General layout and sampling sites around the feed mill: 1) outside the mill between hopper storage bins and wall; 2) grinding room between the mill and wall; 3) mixing and pelleting room near wall; 4) the lower level (pit) of the mixing and pelleting room between the bottom of the elevator leg and the wall; 5) tallow room between heated tank and wall; 6) warehouse centre under pallets of bagged feed; 7) warehouse alongside the outer wall near the bagged feed. Moth traps were suspended from the rafters of the warehouse above site 6. *Location of maximum-minimum thermometer.

Fig. 2. Max/min monthly fluctuations in **A**, relative humidity and **B**, temperature in the mixing and pelleting room (site 3) of the feed mill during June 1991 - October 1992 with corresponding seasonal patterns of adult and larval populations of **C**, *Tribolium confusum* and **D**, *Dermestes lardarius* collected in bait bags from 7 locations over 14-day periods.



1991
1992
J J A S O N D J F M A M J J A S O
RELATIVE HUMIDITY %
A
MAXIMUM
MINIMUM
TEMPERATURE °C
B
MAXIMUM
MINIMUM
MEAN NUMBER / TRAP
C
TRIBOLIUM
CONFUSUM
SEM±
D
DERMESTES
LARDARIUS
SEM±
J J A S O N D J F M A M J J A S O
1991
1992

COMPARISON OF INSECT ABUNDANCE UNDER SPRINKLER AND FLOOD IRRIGATION SYSTEMS IN ALFALFA (*Medicago sativa* (L.)) GROWN FOR SEED

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ABSTRACT

Insect populations were monitored in alfalfa (*Medicago sativa* (L.))(=Lucerne) grown for seed using sprinkler or flood irrigation for two years at Site 1 (1984 and 1985) and six years at Site 2 (1984-89). Lygus bugs (*Lygus spp.)* and plant bugs (*Adelphocoris lineolatus* (Goeze)) were more abundant under flood irrigation. Alfalfa weevil (*Hypera postica* (Gyll.), pea aphids (*Acyrthosiphon pisum* Harris), ladybird beetles and damsel bugs (*Nabis alternatus* Parshley) tended to be more abundant under sprinkler irrigation. Lacewings (*Chrysopa oculata* Say) and minute pirate bugs (*Orius tristicolor* White) numbers exhibited no discernable trends. For all insects monitored, correlations between insect numbers for the two irrigations methods were positive and generally highly significant for all years, indicating that the insects numbers increased and decreased in unison for both irrigation methods. Since the irrigations were applied at different time, the correlations indicate that the irrigation methods did not influence population trends, although irrigation did influence population numbers.

INTRODUCTION

In southern Alberta, alfalfa (*Medicago sativa* (L.)) is grown under a variety of irrigation systems (flood, wheel roll, pivot) for seed production on about 9,500 ha. The highest seed yields of alfalfa are obtained when the crop is irrigated as required up to the early bloom stage, then restricted to reduce vegetative growth and to promote pod formation and seed set (Krogman and Hobbs 1977). Different species of insects respond differently to changes in environmental conditions (Leigh *et al.* 1969), and may also respond differently to the changes in a crop ecosystem brought about by water management. However, there are few studies documenting the effects of irrigation on pest populations, even though moisture status is known to affect insect numbers. In Utah, Davis (1976) reported that sprinkler irrigated alfalfa fields had fewer alfalfa weevil larvae than flood irrigated ones. However, studies in Florida found no appreciable differences in alfalfa weevil and aphid population levels in irrigated and non-irrigated fields (Minnick and Ruelke 1980).

Insects may become pests when they have not been before by adapting to changing water management practices, or more likely, by being preadapted to the new conditions. Harpaz (1986) reported that in an semi-arid area of Israel during the 35 years since the implementation of large-scale irrigation schemes, alfalfa aphids have become a serious problem in the new environment. With expanding irrigation and continuous growth of alfalfa large aphid populations now persist throughout the long dry summer season, which was formerly almost aphid-free.

In 1978, an Integrated Pest Management (IPM) program was introduced into the alfalfa seed-growing area near Brooks, Alberta, in order to develop and integrate the various components into a system that would benefit producers (Schaber and Richards 1979). Crop protection will assume an ever more important role in the attainment of high levels of agricultural production as the cost of inputs increases (Perfect 1986). However, the effect of irrigation methods on pest insect abundance in alfalfa is largely unknown.

Several pest insect species, if not controlled, reduce seed yield (Schaber and Entz 1988; Schaber *et al.* 1993). The alfalfa weevil, *Hypera postica* (Gyllenhal), is an early season pest, occurring during the prebloom to early bloom period (late May to late June). The alfalfa plant bug, *Adelphocoris lineolatus* (Goeze) and *Lygus* spp. can be both early- and late-season pests, often occurring during the bloom to seed-maturing stage (late June to early August). The pea aphid, *Acyrthosiphon pisum* (Harris), is more often a pest late in the season when bloom is declining and seed is maturing (August) (Schaber and Entz 1991; Schaber and Entz 1994) .

Although alfalfa seed producers are aware of the possibility of damage by alfalfa weevil, plant bugs, and *Lygus* spp., they are unaware of the population levels of these insects under different irrigation systems. The objective of this study was to assess the abundance of the populations of these insects in the crop canopy of alfalfa in sprinkler and flood irrigated fields during the growing season.

MATERIALS AND METHODS

Plots were established in 2-year-old stands of seed alfalfa at two sites with a Typic Cryoboroll sandy loam soil near Brooks, Alberta. Part of each field was sprinkler irrigated and the remainder flood irrigated. At each site, five plots (30 x 30 m) were established on each of the sprinkler irrigated and flood irrigated areas. The plots at each Site were more than 100 m from the edge of the field in an area where the two fields of different irrigation method abutted. From this point the plots were established at a distance of 30 m into the respective fields. Water was applied as needed by the producers between early May and late July. The plots received the same management by the producer as the rest of the field. All plots in each irrigation treatment received the appropriate amounts of water during the growing season to bring the crop to harvest as determined by the seed producer. The sprinkler irrigation system was used two to four times per year applying about 6 - 8 cm of water per application, whereas the flood irrigated areas were usually flooded twice during the season. Insects were sampled in 1984 and 1985 at Site 1, cv Vernal, and 1984-89 at Site 2, cv Algonquin. Insect abundance was estimated by taking five straight (90 degree) sweeps per plot with a 38-cm net each week at approximately the same time of day (between 10 am and 3 pm) from mid-May to the end of August. Each plot had a stake place in the middle of the plot. The first insect sampling began from this stake in a northerly direction, and each week a different direction was sampled. Insect samples from each plot were placed in paper bags, transported to the laboratory, and placed in a freezer at -40°C until time of sorting, identifying and counting. All plots were sampled in the same order by the same individual, at about the same time of day throughout the growing season.

For each site, year and insect species, the mean number of insects collected per plot over the sampling period were determined, the means were then logarithmically transformed to stabilize the variance, and t-tests were performed to evaluate differences in insect populations between the sprinkler and flood irrigated fields. In the initial analyses, alfalfa plant bugs (*Adelphocoris lineolatus* (Goeze)), lygus bugs (*Lygus spp.*), and alfalfa weevil (*Hypera postica* Gyll.) were separated into two classes of immatures (lygus bug, nymphal instars 1 to 3, and 4 + 5; alfalfa weevil, instars 1 + 2, and 3 + 4). However, the results from the statistical analyses were similar for both instar groupings in all cases, so the t-tests were performed using combined data. For each year and site, the number of insects in each field was obtained for all insect species and each sampling date. Correlations of insect numbers between fields were then calculated to compare insect population trends in the sprinkler and flood irrigated fields over the sampling season. All analyses were performed using SAS (SAS Institute Inc., 1989).

RESULTS

The numbers of lygus bugs were significantly higher under flood irrigation than sprinkler irrigation for five out of eight site-years (Table 1). Plant bug numbers showed a similar but less obvious trend for four out of eight site-years. The numbers of pea aphids were significantly higher under sprinkler irrigation for three out of eight site-years, and had at least twice as many counts under sprinkler irrigation than flood irrigation for three of the remaining site-years. Alfalfa weevil counts were significantly higher under sprinkler irrigation than flood irrigation 50% of the time, and sprinkler irrigation means were ranked higher for seven out of eight site-years. Ladybird beetles were more numerous in sprinkler irrigated fields than in flood irrigated one for five out of eight site-years. Damsel bug numbers at Site 2, were also significantly higher under sprinkler irrigation than flood irrigation for three of the six years, whereas, at Site 1 the numbers were higher under flood irrigation (Table 2). Lacewing and pirate bug numbers exhibited no discernable trends.

There were significant correlations between insect numbers for the two irrigation methods 80% of the time for the eight site-years (Table 3). For the two years where data were available for both sites (1984 and 1985), there were significant correlations 94% of the time, indicating that insect populations were increasing and decreasing in both irrigation systems in unison. In the majority of cases where significant correlations were not noted for specific insects, the insect populations were quite low (Table 1 and 2).

The figures derived by plotting insect numbers vs time showed that insect populations were not dramatically influenced by the method of irrigation at the time of water application. In other words, although the insect numbers are not immediately affected by the method of irrigation, the method of irrigation may have a longer-term effect on populations of some insects.

DISCUSSION

The significant differences in the abundance of some insect species between fields may be due to irrigation method. Sprinkler irrigation requires more applications per year than flood irrigation to apply a similar amount of water, and thoroughly wets the crop canopy for about 12 h at each pass, in addition the soil remains saturated for 3 - 4 days following each pass, influencing canopy temperature and humidity for this period of time. Thus, the humidity regime within the canopy could differ substantially between the two irrigation methods, and this difference in humidity under the two irrigation systems might also differentially affect the incidence of fungal diseases.

The alfalfa weevil, whose numbers were significantly higher in the sprinkler irrigated plots (Table 1), lays its eggs in the alfalfa stem about 5 - 7.5 cm above the ground. The eggs require high moisture levels to hatch, and in the flood irrigated areas these moisture levels may not have been sufficiently high for long enough for the eggs to complete development. Studies in Florida have found no appreciable differences in alfalfa weevil population levels in irrigated and non-irrigated fields (Minnick and Ruelke 1980). However, in that area summer rains are considerable, and irrigation seemed to have little influence on insect populations.

Sprinkler irrigation has been demonstrated to reduce plant canopy air temperature by as much as 3 to 9°C (Hobbs 1973). The extent of cooling was dependent upon the weather prevailing during irrigation. In sprinkler irrigated alfalfa fields the temperature in the canopy remains cooler for longer periods of time because of the more frequent applications, and this might favour some species of insect and adversely affect others.

Under a flood irrigation system, the water would disturb the physical surroundings of insects very little compared to a sprinkler system, which would tend to disturb the insects, as well as their physical surroundings, at each pass. Our findings are in contrast to those of Davis (1976) who found consistently fewer alfalfa weevil larvae in a sprinkler irrigated than in flood irrigated alfalfa field. He reported up to 40% mortality of alfalfa weevil larvae which he attributed to the inability of newly hatched larvae to reach the growing plant tips under sprinkler irrigation. Differences in climate and the timing of irrigation between Utah and Alberta, in relation to the growth of the alfalfa plants and the development of alfalfa weevil, may account for this disparity.

Lygus bugs were more numerous in flood irrigated plots (Table 1). Lygus and plant bugs are highly mobile insects that disperse readily from disturbed to undisturbed areas (Schaber *et al.* 1990). Thus in the flood irrigated fields they would not be disrupted by the physical disturbance of sprinklers.

Aphids were found in higher numbers in the sprinkler irrigated than in flood irrigated plots (Table 1). This result is comparable to that of Minnick and Ruelke (1980) in Florida. There, aphid population levels were similar, but tended to be higher in irrigated plots than in non-irrigated ones. These insects are generally favoured by humid conditions which prevail for longer periods under sprinkler than flood irrigation.

Beneficial insects showed minimal preferences for irrigation method. Ladybird beetle numbers were more prevalent under sprinkler irrigation than flood irrigation for five out of eight site-years, whereas pirate bug numbers were more prevalent under flood irrigation for two out of eight site-years. Leigh *et al.* (1974) also found pirate bugs to be more prevalent in plots of cotton that had higher soil moisture levels. The higher numbers of predator insects in one irrigation method or the other may reflect host insect populations, rather than a direct response to the particular irrigation method.

The correlation coefficients were all positive and many were highly significant, which indicates that the insect population counts within the two irrigation methods increased and decreased in unison (Table 3). The correlation coefficients do not reflect the absolute number of insects in the irrigated fields, but they do indicate that the irrigation methods did not influence population trends for insects with highly significant correlations. Nevertheless, irrigation methods do influence the number of insects present over the long term, as is shown by the mean population counts for the two irrigation methods in Tables 1 and 2.

This information on the abundance of insects under various irrigation regimes will aid IPM specialists, alfalfa seed producers, and extension personnel in the understanding of pest insect populations found in alfalfa fields. Seed producers might be able to reduce the likelihood of attacks on their alfalfa by some pest species of insects with the use of a sprinkler irrigation system, but they might at the same time increase the likelihood of another pest insect becoming abundant. Additional research needs to be done to determine what factors are responsible for the differential effect of the type of irrigation on the abundance of pest and beneficial insects in seed alfalfa fields.

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Table 1. Insect counts (mean ± SE) of four pest insects per five sweeps for two sites, six years, and two irrigation methods.

		SITE 1		SITE 2					
Insect	IM[1]	1984	1985	1984	1985	1986	1987	1988	1989
Lygus bugs	S	152.5±5.9a[2]	118.7±7.1a	67.5±3.5a	126.5±4.6a	65.1±5.0a	36.4±2.1a	111.8±17.8a	31.2±1.8a
	F	91.3±7.5b	167.3±9.1b	79.8±4.6b	194.6±10.0b	65.0±3.9a	67.6±9.2b	176.1±23.2b	44.0±2.3b
Plant bugs	S	11.1±2.1a	5.9±1.4a	3.4±0.5a	2.3±0.4a	1.0±0.4a	1.5±0.3a	8.3±1.4a	37.4±6.4a
	F	40.9±3.3b	15.2±1.9b	3.0±0.5a	3.1±0.4a	2.8±0.7b	1.7±0.3a	7.4±1.2a	42.8±7.8a
Alfalfa weevil	S	423.3±37.7a	126.7±6.3a	114.1±4.3a	350.5±45.1a	90.1±17.1a	17.4±2.8a	8.4±1.4a	38.2±8.4a
	F	288.7±19.7b	147.0±14.0a	83.1±6.4b	218.3±19.0b	82.3±22.7a	12.4±3.5a	6.0±1.7a	13.4±2.3b
Pea aphid	S	7411±984a	8196±919a	1938±166a	11315±594a	323±30a	1602±151a	1176±167a	3272±374a
	F	4541±1130a	8289±464a	1324±221b	14022±1085b	312±23a	919±80b	789±147a	2122±192b

1. Irrigation Method: S = sprinkler irrigation; F = flood irrigation.

2. a,b - For a given insect and year, irrigation method means followed by the same letter are not significantly different (P = 0.05, t = test).

Table 2. Insect counts (mean ± SE) of four predatory insects per five sweeps for two sites, six years, and two irrigation methods.

		SITE 1		SITE 2					
Insect	IM[1]	1984	1985	1984	1985	1986	1987	1988	1989
Damsel bugs	S	27.9±3.8a[2]	13.8±1.5a	44.7±1.6a	26.6±2.1a	4.0±0.5a	18.1±1.1a	29.2±2.3a	1.8±0.4a
	F	41.4±3.0b	16.7±1.6b	32.1±1.7b	18.3±1.2b	5.2±1.1a	19.0±2.0a	21.2±2.2b	1.8±0.3a
Ladybird beetles	S	59.1±5.5a	4.8±0.9a	17.7±1.2a	12.8±1.5a	2.6±0.6a	12.0±1.4a	15.6±3.1a	4.8±1.0a
	F	21.3±6.5b	2.6±0.3b	12.0±1.2b	5.3±0.9b	3.0±0.7a	11.5±1.2a	4.6±0.9b	6.3±1.2a
Lacewings	S	4.7±0.5a	1.3±0.3a	5.3±0.6a	3.3±0.7a	0.3±0.1a	1.1±0.3a	4.8±0.8a	7.0±1.5a
	F	2.2±0.6b	0.8±0.2a	4.2±0.7a	2.1±0.4a	0.3±0.1a	1.1±0.2a	4.4±0.7a	7.4±0.8a
Pirate bugs	S	23.7±1.0a	42.7±2.5a	82.1±3.3a	47.5±2.7a	53.4±2.1a	48.7±3.3a	59.4±6.3a	39.9±2.3a
	F	24.0±1.5a	53.7±3.3b	111.7±5.5b	50.1±2.3a	68.6±3.4a	46.8±4.1a	65.6±3.1a	40.6±2.0a

1. Irrigation Method: S = sprinkler irrigation; F = flood irrigation.

2. a,b - For a given insect and year, irrigation method means followed by the same letter are not significantly different ($P = 0.05$, t = test).

Table 3. Correlations (r) of insect counts between irrigation methods for two locations, six years, and eight insects.

Insect	**1984**	**1985**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
L35A[+]	.70*	.94**	.76**	.99**	.95**	.48	.45	.93**
PB35A	.87**	.88**	.62**	.65*	.42	.28	.88**	.74**
AW24A	.93**	.97**	.90**	.97*	.72*	.10	.85**	.96**
Aphids	.61*	.87**	.89**	.96**	.93**	.78**	.90**	.99**
DAM	.98**	.82**	.91**	.86**	.79**	.91**	.90**	.87**
LAD	.92**	.29	.85**	.92**	.88**	.93**	.12	.96**
LAW	.92**	.40	.83**	.71*	.59	.58	.57	.99**
PIR	.77**	.93**	.99**	.65*	.97**	.52	.21	.96**

*, ** indicate significant correlations between insect numbers for the two irrigation methods at P=0.05 and P=0.01, respectively.

+ L35A = lygus nymph stages 1-5 + adults; PB35A = alfalfa plant bug nymph stages 1-5 + adults; AW24A = alfalfa weevil larval instars 1-4 + adults; DAM = all stages of damsel bugs; LAD = all stages of all species of ladybird beetles; LAW = all stages of all species of lacewings; PIR = all stages of the minute pirate bug.

PINE ROOT COLLAR WEEVIL (*Hylobius radicis* BUCHANAN, COLEOPTERA: CURCULIONIDAE) IN MANITOBA

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ABSTRACT

The pine root collar weevil, (*Hylobius radicis* Buchanan), occurs on light sandy soils throughout the pine forests of southeastern Manitoba. During the last 30 years the introduced Scots pine, (*Pinus sylvestris* L.) has become a significant host for the pine root collar weevil in Manitoba. In 1982 and 1983 general and detailed survey plots were established to measure the extent and impact of an infestation in Scots pine plantations in Grand Beach Provincial Park. Since 1982 approximately 62% of the trees in three Grand Beach plantations have been lost due to weevil activity. The large planting of Scots pine in southeastern Manitoba, during the 1980's, will have to be intensely monitored to prevent significant losses to the expanding industry.

INTRODUCTION

The pine root collar weevil, (*Hylobius radicis* Buchanan), occurs generally on light sandy soils throughout the pine forests of southeastern Manitoba. The known range in Manitoba extends at least as far north as Belair Provincial Forest (approximately 50° 35′ latitude, 96° 35′ longitude) (Knowles et al. 1984). The larvae feed on the larger roots and around the root collar of a variety of pine species. In Manitoba, the native hosts include white pine, (*Pinus strobus* L.), red pine, (*Pinus resinosa* Ait.), and jack pine, (*Pinus banksiana* Lamb.) (Ives and Wong 1988). During the last 30 years the introduced Scots pine, (*Pinus sylvestris* L.) has also become a significant host for the pine root collar weevil in Manitoba. The extent and severity of damage caused by the pine root collar weevil has been considerably greater on Scots pine, versus native pines and has significantly affected the survival of this species in Manitoba.

Damage to host trees is done predominantly by larvae feeding in the root collar area on the inner bark and surface of the wood, which destroys the cambial tissue. There is considerable resin flow into the surrounding soil associated with the larval wounds. Attacked trees usually show reduced stem diameter growth and structural weakening, breaking easily at the soil line.

Repeated, prolonged attack by the pine root collar weevil can cause complete girdling and tree mortality. Trees between 2.5 and 10 centimetre (cm) basal diameter are most vulnerable (Finnegan and Stewart 1962). Trees below 2.5 cm in diameter are seldom attacked and larger trees can harbour larvae for many years without displaying external symptoms. The most obvious symptoms of root collar weevil attack are needle chlorosis and thinning of the crown. Once these symptoms are visible the tree is near death.

The pine root collar weevil may overwinter as an adult, larva or pupa (Ives and Wong 1988). Adult emergence from overwintering sites in the duff layer takes place in late April. Oviposition can occur from May to September, with the peak period occurring in mid June. Most of the larvae that hatch over the course of the summer also overwinter in this stage (Finnegan and Stewart 1962). Overwintering larvae pupate the following July or August. Pupation takes place either in the resin soaked soil or in the bark. Newly emerged adults feed for a short period, generally on lower branches by day and higher in the crown at night (Wilson and Millers 1983). These individuals overwinter in the duff and commence mating and oviposition the following summer. Eggs are laid at the root collar in bark wounds resulting from adult feeding or in the surrounding soil. Mating and oviposition may extend over two summers. An adult female will lay approximately 30 eggs (Finnegan and Stewart 1962). The life span of an individual weevil can last up to four years.

Examination of the Scots pine planting records indicates that the outbreak history of the pine root collar weevil in Manitoba is closely tied to the planting of this tree species. Approximately 4.5 million Scots pine have been planted by federal and provincial forestry agencies in Manitoba since 1904 (Manitoba Forestry Branch planting records). The earliest planting of Scots pine was in the Spruce Woods Provincial Forest (approximately 49° 50´ latitude, 99° 30´ longitude) in southwestern Manitoba. From 1904 to 1975, approximately 2.5 million Scots pine were planted in this area (Manitoba Forestry Branch planting records). Much of the Spruce Woods planting of scots pine was successful as this area is outside the range of the pine root collar weevil, probably due to the absence of natural jack pine. Approximately 1.3 million Scots pine were planted within the range of the pine root collar weevil (southeastern Manitoba). An additional 700,000 have been planted in various other locations throughout the province.

From 1946 to 1957, 665,000 Scots pine seedlings were planted in the Sandilands Provincial Forest (approximately 49° 20´ latitude, 96° 20´ longitude) in southeast Manitoba. The first known epidemic of pine root collar weevil on Sots pine occurred from 1955 to 1959 in Sandilands Provincial Forest (Prentice and Hildahl 1961.). Average tree mortality within the infested plantations was approximately 50%, with some plantations being a complete loss (Prentice and Hildahl 1961). Following this outbreak, the planting of Scots pine was largely discontinued within the southeast portion of the province during the period 1958 to 1968. From 1969 to 1977 about 873,000 Scots pine were again planted in Manitoba of which 300,000 were within the range of the pine root collar weevil (Manitoba Forestry Branch planting records). In 1982 a root collar weevil epidemic was discovered in Grand Beach Provincial Park (approximately 50° 35´ latitude, 96° 35´ longitude) and again in the Sandilands Provincial Forest in 1987. In 1982 a general survey to measure the extent of the infestation was done in three Scots pine plantations in Grand Beach Park. The general survey was repeated in 1988. In addition to the general survey, in 1983 detailed observation plots were established in four Scots pine plantations in Grand Beach Provincial Park to further monitor the progress and impact of the pine root collar weevil. This paper reports on the progression and impact of the root collar weevil in Grand Beach Provincial Park.

METHODS

1. General Survey:

In autumn of 1982 a general survey to determine incidence of pine root collar weevil was done in three Scots pine plantations (established in 1971) in Grand Beach Provincial Park. Parallel transect lines were placed 20 meters (m) apart throughout each plantation. The plantations ranged in size from 2.5 hectares (ha) to 8 ha. All trees within a one metre swath along the transect line were assessed. Trees were rated as healthy, infested (based on external symptoms of needle chlorosis and/or crown thinning) and dead. The general survey was repeated six years later in the autumn of 1988. In each plantation there was some planted red pine and volunteer jack pine. These species were also assessed for the presence of root collar weevil in both surveys.

2. Detailed Plot Assessment:

In the spring of 1983 four permanent sample plots were established in the three 1971 plantations and in a 1975 Scots pine plantation infested with root collar weevil in Grand Beach Provincial Park. Each plot was 900 m^2 (30 m x 30 m) in size. The condition of all trees within the plots were rated as healthy, suspect infested (displaying external symptoms of needle chlorosis and/or crown thinning), and dead due to weevil attack. Other insect, disease or abiotic conditions which affected trees were also recorded. Tree diameters were measured at five year intervals beginning in 1983. Tree heights were measured once a year, at the end of the growing season. Initially, plots were assessed once a month from April to October inclusive. As the change in condition from month to month was not found to be significant, in 1986 and 1987 the assessments were done bimonthly from April to October. Beginning in 1988, the frequency of assessment was further reduced to three a year, April, July and October. In 1992 plots were assessed twice, in May and again in August. In 1993 assessments were done once in October.

RESULTS

1. General Survey:

There was a considerable increase in the overall impact of the root collar weevil on all three plantations between 1982 and 1988. The progression of the infestation is shown in Tables 1 and 2. Total number of trees sampled in the general survey were 390 in 1982 and 626 in 1988.

2. Detailed Plot Assessment:

The total number of trees sampled in the four detailed assessment plots was 588 (360 Scots pine, 136 jack pine, 90 red pine, and two balsam fir, (*Abies balsamea* (L.) Mill.). The impact due to weevil was greatest in plots one and three where Scots pine was the primary tree species planted. A total of 215 trees died over the course of the study in all four plots (Figure 1). The total number of trees killed from other causes remained small (<5%) and constant over the course of the study compared to trees killed by the root collar weevil. Other causes of mortality included poaching, Armillaria root rot (*Armillaria obscura* (Pers.) Herink) and unknown causes. Scots pine experienced the greatest losses, 204 trees in total, of which 184 trees were killed by weevil. Of the 215 trees killed in the study, root collar weevil killed 184 Scots pine and four jack pine.

The cumulative weevil induced mortality on Scots pine over the eleven-year period for all plots combined was 51.1%, while the annual percent mortality ranged from 0% in 1992 to 11.7% in 1983 (Figure 2). By plot, the cumulative mortality caused by weevil ranged from 40.5% to 60.6% (Figure 3). The mortality level in plot 1 was slightly less in the initial years as it was younger (planted in 1975) than the other plantations. Figure 4 shows the annual percent mortality for all four plots. There was considerable variation in the percentage of trees killed annually. When plots were analyzed individually the peak percentages of weevil induced mortality experienced each year for the various plots was variable and all plots have seen a marked decrease in weevil activity since 1990.

DISCUSSION

The current study has shown pine root collar weevil can significantly impact scot pine plantations grown within its range in Manitoba. Since 1982 approximately 62% of the trees in the three Grand Beach plantations surveyed have been lost due to weevil activity. These plantations are now 22 years old and will require substantial reforestation to achieve desired stocking levels. Planting of Scots pine by provincial forestry staff was discontinued from 1958 to 1968 following the 1955-59 root collar weevil infestation, but gradually increased again from 1969 to 1984.

Since 1969 many Scots pine Christmas tree plantations and woodlots have been established within the range of weevil activity in Manitoba. Over the past 10 years, approximately 700,000 Scots pine seedlings have been planted in woodlots and Christmas tree plantations in southeastern Manitoba (Pineland Nursery records). The Christmas tree industry has steadily grown over the last decade in Manitoba. In 1991 (the last census date available for number planted) 54,000 Scots pine were planted in southeastern Manitoba and an estimated 20,600 trees were ready for harvest (Prairie Research Associates Inc., 1992). In 1992, 10,000 plantation grown Christmas trees sold for approximately $135,000.00 (Cdn.), indicating there is a significant value at risk in Manitoba (National Forestry Database, 1993).

General surveys by Manitoba Natural Resources has found weevil damage on several

Christmas tree growers' properties in 1992 and 1993. A program by provincial forestry staff and woodlot and Christmas tree growers associations is required to educate growers on the visual symptoms and management measures to prevent a wide scale resurgence of the root collar weevil in Manitoba. The large planting of Scots pine in southeastern Manitoba, during the 1980's, will have to be intensely monitored to prevent significant losses to the expanding industry.

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Table 1: General Survey of Pine Root Collar Weevil in Three Scots Pine Plantations in Grand Beach Provincial Park in 1982[1]

	Tree Condition			
Plantation#	Healthy	Infested	Dead	Infested+Dead
1 - 71	60%	20%	20%	40%
2 - 71	66%	26%	8%	34%
3 - 71	74%	14%	12%	26%
Average	67%	20%	20%	40%

[1] No jack pine or red pine displayed any symptoms of weevil attack.

Table 2: General Survey of Pine Root Collar Weevil in Three Scots Pine Plantations in Grand Beach Provincial Park in 1988[1]

	Tree Condition			
Plantation #	Healthy	Infested	Dead	Infested/Dead
1 - 71	41%	7%	52%	59%
2 - 71	46%	4%	50%	54%
3 - 71	27%	4%	69%	73%
Average	38%	5%	57%	62%

[1] One jack pine (<1% of the total sampled) was infested and no red pine showed signs of attack.

Figure 1. Cumulative tree mortality for all study plots. Total number of plot trees was 588 and includes Scot's, jack and red pine.

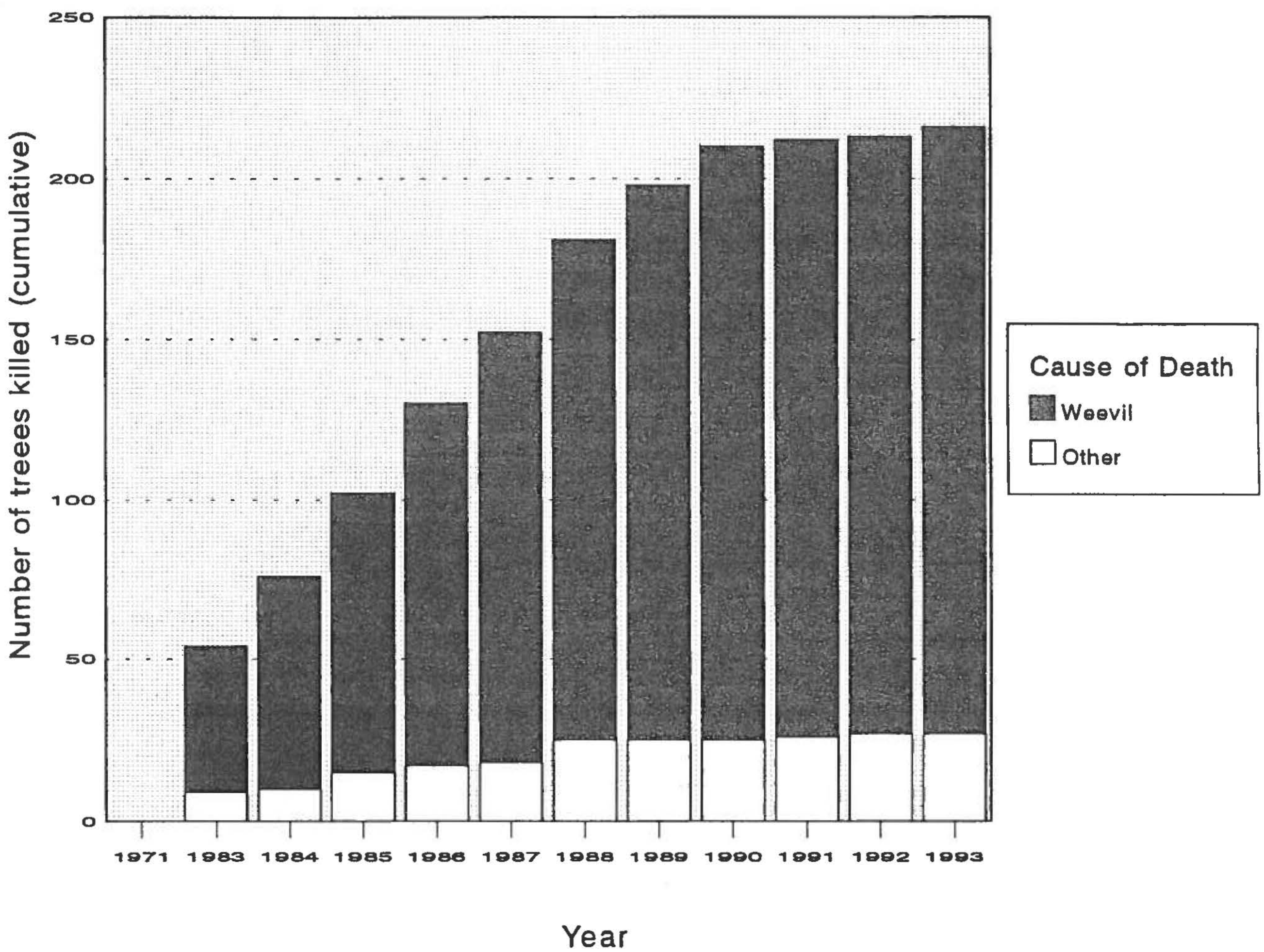


Figure 2. Cumulative and yearly Scots pine mortality (%) caused by the pine root collar weevil for all study plots.

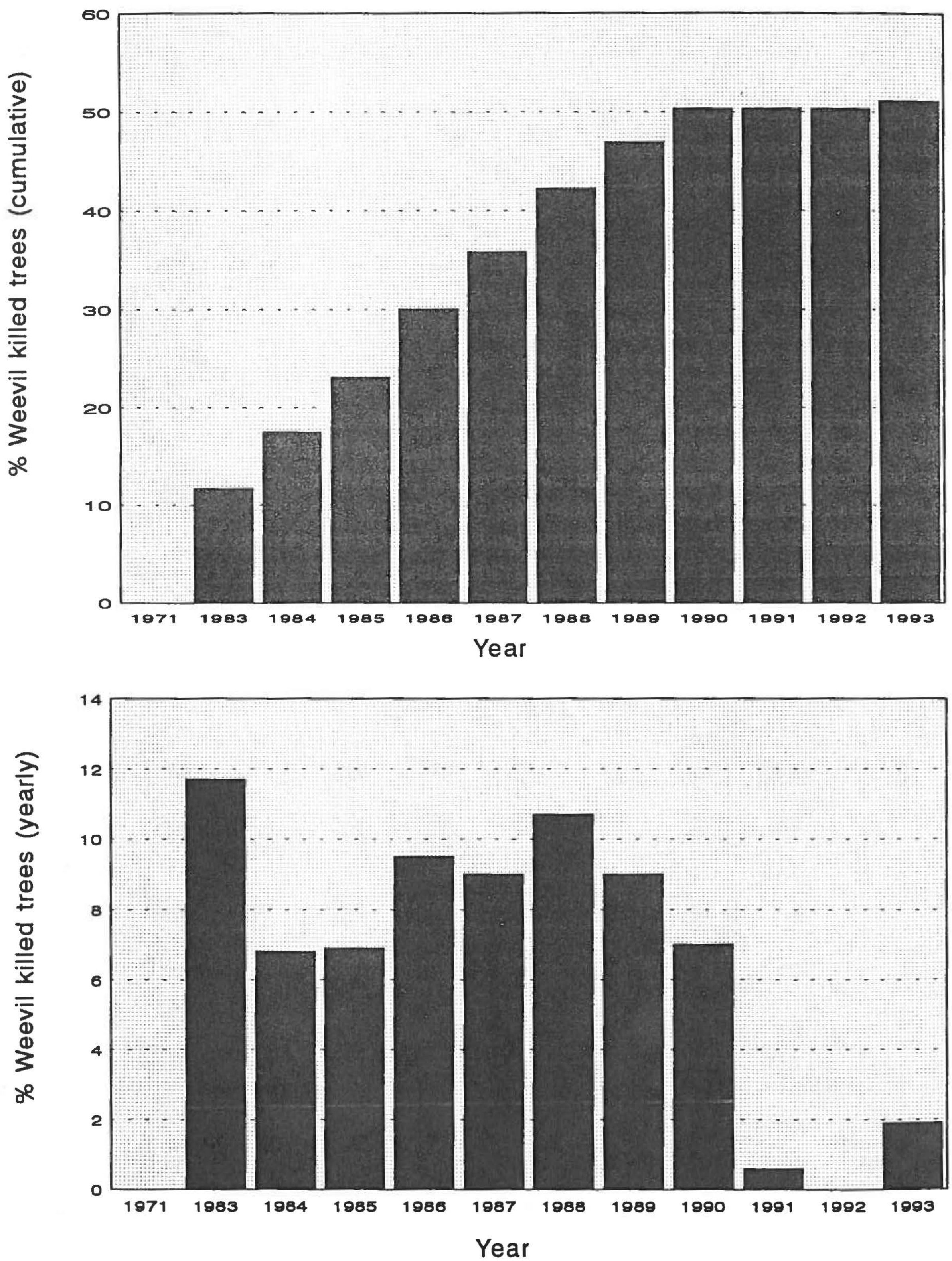


Figure 3: Cumulative Scots pine mortality (%) caused by the pine root collar weevil in each plot.

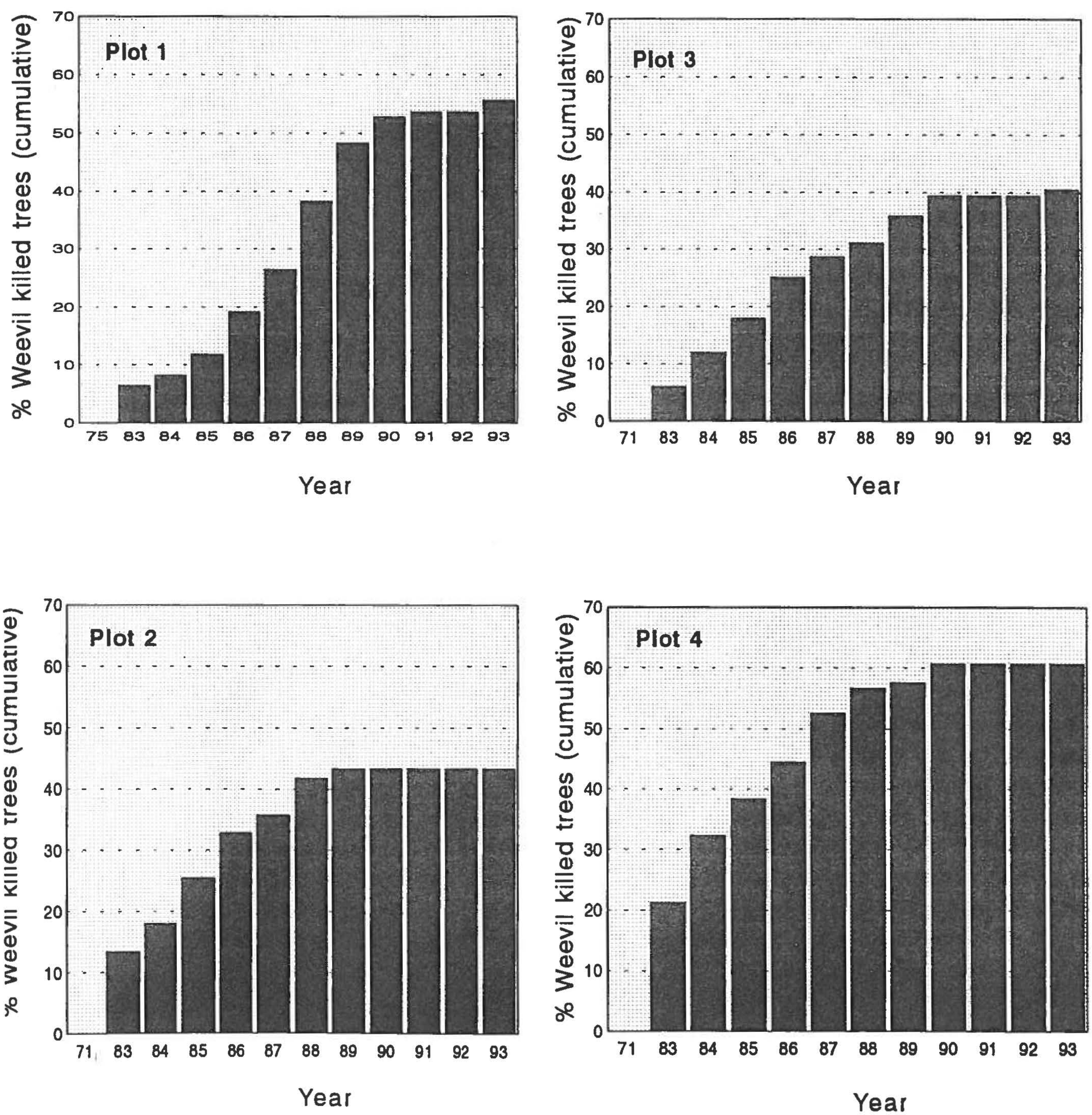
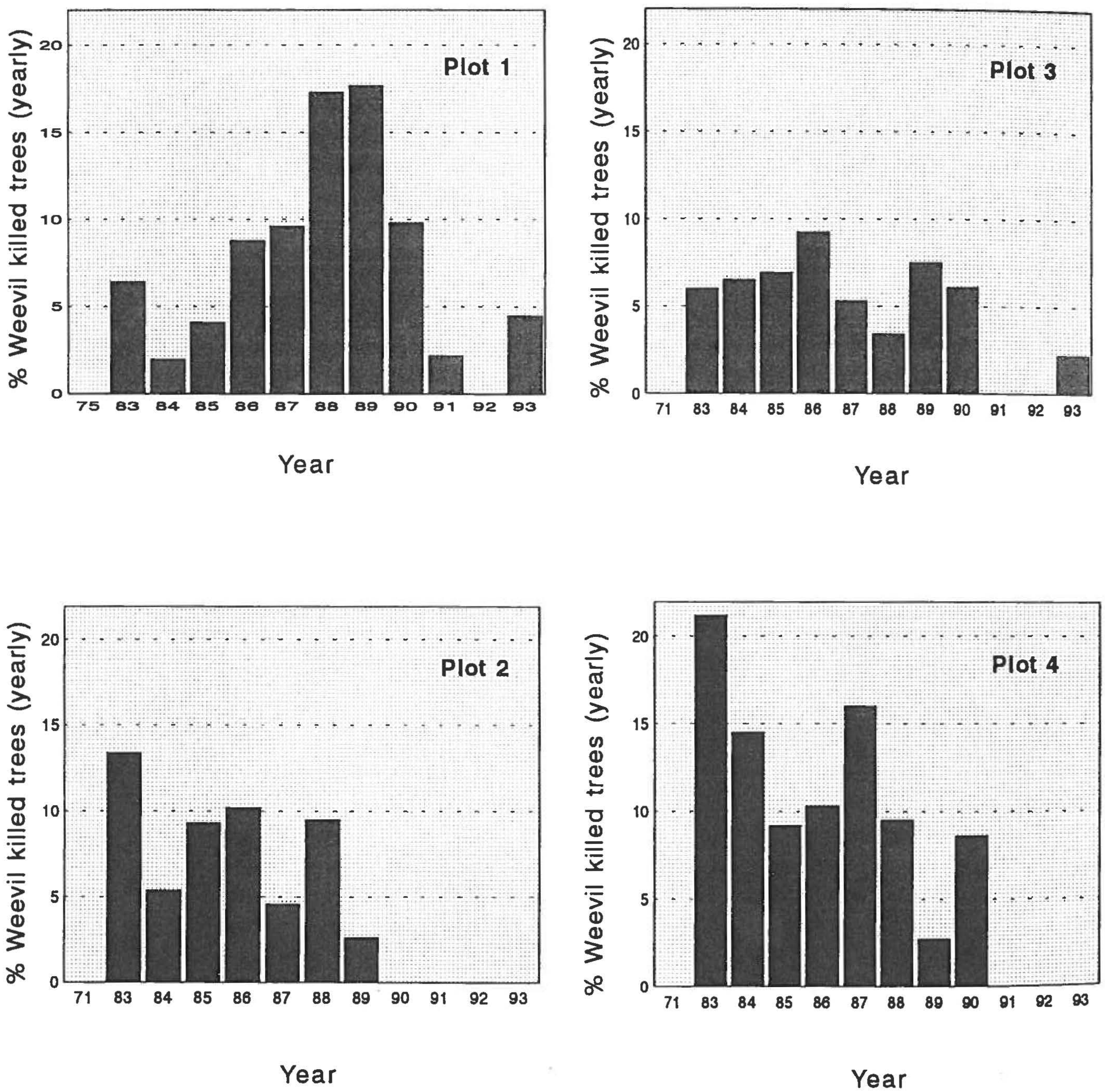


Figure 4. Yearly Scots pine mortality (%) cause by the pine root collar weevil in each study plot



ABSTRACTS OF PAPERS PRESENTED TO THE ANNUAL MEETING , 1993

GUEST SPEAKER

TAKING MEASURE OF EARTH'S MEGADIVERSITY. T.L. Erwin, National Museum of Natural History, Smithsonian Institution, Washington DC, 20360, U.S.A.

Climate change through the millennia may have affected residents of the Permian Seas and vertebrates of Pangaea; later, it may have affected dinosaur evolution by terminating non-flying forms just before thinking became one of their traits; it certainly impacted the ranges of many Canadian species of terrestrial arthropods during the Pleistocene. But overall, there are more insects species now than during the Carboniferous, and likely more than at the beginning of the Cretaceous. Climate changes overlaying fractal changes in the architecture of available substrates drive insect evolution and increase in species from the outside, while interactions among the myriad of living forms on earth's substrates drive it from the inside. Biodiversity,whether it be 5, 10 or 30 million species, is at its apogee today in part because of the climate changes of the past. The problem for future insect biodiversity is not climate, but rather the removal of fractal space from the environment through landscape conversion. This needs to be conservation's priority from the insect point of view, not climate change per se, as it is with us.

SYMPOSIUM

Biodiversity and Climate Change

CHANGES IN INSECT BIODIVERSITY IN RESPONSE TO PLEISTOCENE CLIMATE CHANGE. Allan C. Ashworth, Department of Geosciences, North Dakota State University, Fargo, North Dakota, 58105, U.S.A.

At the end of the Pleistocene major climate change in the temperate zones of both the northern and southern hemispheres resulted in the fragmentation of insect populations. Conceptually, isolation of populations might have been expected to have resulted in greater rates of speciation and extinction. The fossil record of Coleoptera, however, indicates that neither speciation nor extinction rates were higher during this time. The response of the Coleoptera was a massive reorganization of communities following extirpation and dispersion. In southern Chile, a region far removed from the great ice sheets of the northern and southern hemispheres,

climate change had a profound effect on the beetle fauna. Independent evidence from ice-cores in Antarctica, and pollen records in Chile, indicates that the transition from the glacial to the interglacial climate was rapid, and represented an increase in annual temperature of 4-5°C. At about 14,000 yr B.P. the glacial fauna, representing moorland habitats, was replaced by the present interglacial fauna, representing forest habitats. The number of Coleoptera species identified in fossil assemblages increased five-fold. The complete transition from a moorland to a forested environment occurred within 1500 years. Changes in biodiversity on a similar scale are documented in the fossil records of Coleoptera faunas that lived marginal to the ice sheets in North America and Europe at the end of the last glaciation. Reorganizations of the fauna, similar to that documented for the end of the last glaciation, occurred repeatedly during the Pleistocene in response to numerous climatic changes. Evidence from older Coleoptera fossil assemblages is that species have been constant during the Pleistocene leading to the speculation that stasis, paradoxically, is promoted by environmental instability.

CLIMATIC EFFECTS ON BIODIVERSITY IN PLANKTONIC CRUSTACEANS, FISH AND TREES IN CANADA. K. Patalas, Department of Fisheries and Oceans, Freshwater Institute, 501 University Crescent, Winnipeg, Manitoba, R3T 2N6.

The three systematically remote groups of organisms have demonstrated a striking similarity in their patterns of species diversity. All of them show close correlation with the climate. All of them show similar patterns related to the area of Canada they occupy. The vast majority of species in these three groups of organisms are semi-endemic - they occupy a very small portion of Canada. There are only a few species in each group which are spread over larger areas. The temperature tolerance (based on the area of their present occurrence) has been estimated for each of these 370 species. The area they occupy within the zone of tolerable climate was interpreted as their capacity for dispersion. A model for prediction of the effect of climate warming on biodiversity in general and on the behaviour of the particular species within these three groups will be presented.

AQUATIC INVERTEBRATES AND PALEOCCLIMATIC INFERENCE. B.J. Hann, Department of Zoology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

Species abundances and distributions are influenced by both the physical environment and other species. Which predominates, when, and how much of the time? Are climatic perturbations manifested in the biotic fossil record preserved in lakes? Lakes and wetlands represent important repositories of paleolimnological information. Use of the biological record contained in them for paleoclimate reconstructions requires careful attention to differentiate *patterns* of correlated biotic change in space and time from *causative* processes. Based on data from Cladocera, chironomids, and other aquatic invertebrate groups, it is argued that previous

attempts to delimit invertebrate paleoclimate indicator taxa are based on insufficient taxonomic, geographic, ecological and stratigraphic information.

ECOLOGICAL DIVERSITY: DOES CURRENT ECOSYSTEM MANAGEMENT IMPAIR FUTURE ECOSYSTEM FUNCTION? N. J. Holliday, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2

Recent evidence suggests that earth's climate has repeatedly undergone rapid major shifts from warm to cold and from cold to warm. Thus, regardless of anthropogenically caused climatic changes, the biosphere periodically undergoes drastic reorganization, in which biomes shift and change in their characteristic ecosystems and communities. The "raw material" from which the organisms in such new communities must be assembled is the previous species pool. Species in that pool may stay in situ or colonize new regions, they may retain previous characteristics, evolve and possibly speciate, or become extinct.

Different scales of ecological diversity will be examined to determine how relevant they are to determining whether current communities are adequate sources of the species pool for the future. Measures of α, β, and γ diversity will be discussed. Diversity measures will then be applied to data from agricultural and forest ecosystems to determine whether ecosystem management by humans affects the potential of the current communities to provide an adequate species pool for the future.

SUBMITTED PAPERS

IMPLEMENTING A MANAGEMENT PROGRAM FOR THE INDIAN MEALMOTH (Lepidoptera:Pyralidae) IN A MANITOBA SEED PACKAGING PLANT. Blaine Timlick and Paul Fields, Agriculture Canada Research Station, Winnipeg, Manitoba, R3T 2M9.

The Indian meal moth, *Plodia interpunctella* (Hubner) is a common pest of food warehouses and seed packaging plants. Current eradication techniques include fumigation (methyl bromide, phosphine) and contact insecticides (malathion, pyrethrin). The combination of using low temperatures, diatomaceous earth and pheromone traps provides a less toxic method to reduce and monitor the insects, and leaves a system in place which can be operated and maintained with minimum effort.

In the laboratory, duration of exposure to various temperatures of acclimated and non-acclimated prepupae from diapausing and non-diapausing groups are used to determine a mortality curve. The use of acclimated sentinel insects within the plant at the time of the freeze out will also be used to determine the effect of the actual freeze out. Previous data on Indian meal moth cold tolerance show that acclimated diapausing Indian meal moth should be controlled with exposures to -5°C for 20 days.

The mortality of the meal moth using diatomaceous earth is also determined by examining application rates and the effect of packaging of treated sweet corn. Preliminary results indicate that 500 ppm will control Indian meal moth and that packaging is not a significant factor.

STABILITY OF ICE-NUCLEATING BACTERIA AND FUNGUS AS A MEANS OF REDUCING THE COLD-HARDINESS OF INSECT PESTS. P.G. Fields, S. Pouleur* and C. Richard* Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, R3T 2M9 and *2560 Boul. Hochelaga, Ste. Foy, Quebec, G1V 2J3.

Low temperature control of stored-product insects is limited in part because of the cold-tolerance of these pests (Fields 1992, J. stored Prod. Res. 28:89). Ice-nucleators have been shown to be an effective means to reduce insect cold-hardiness (Lee *et al.* 1993, J. Insect Physiol. 39:1). However to be effective in the field, ice-nucleators must maintain their activity until the onset of low temperatures. Wheat was treated with several concentrations of the bacteria *Pseudomonas syringae* (ice nucleating activity at -5°C = 10.7) or the fungus *Fusarium avenaceum* (ice nucleating activity at -5°C = 7.8).

After the treated wheat had been held at 30°C, 70% RH for 0, 1, 2, 4, 8 or 16 wk, *Cryptolestes ferrugineus* adults, a major stored-product insect pest, were held on the wheat for 1 day at -10°C, before the mortality was assessed. Control mortality (0 ppm) was between 10 and 23 %. Insects held on wheat treated with 100 ppm of *P. syringae* had mortalities greater than 80%. There was a slight decrease in activity over the 16 wk test. Insects held on wheat treated with *F. avenaceum* at 500 and 1000 ppm had greater mortalities (23 to 38%) than the controls, but lower concentrations did not decrease insect cold-hardiness. After 8 wk *F. avenaceum* did not decrease cold-hardiness. Given that *P. syringae* had 1000 times more nucleators than *F. avenaceum,* it is not surprising that *P. syringae* reduced cold-hardiness more than *F. avenaceum.*

NECTAR QUALITY OF HYBRID CANOLAS AND IMPLICATIONS FOR HONEY BEES. S.F. Pernal and R.W. Currie, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

Nectar of canola plants, *Brassica napus* L., was sampled from three field plots, located at Winnipeg, Portage la Prairie and Rosebank, Manitoba. Each plot contained eight cultivars developed by a cytoplasmic male sterility (CMS) breeding system, nine cultivars developed by a dominant self-incompatibility (SI) breeding system and four open-pollinated cultivars. During three successive weeks while the crop was in bloom, nectar was collected from plants using tapered filter paper wicks (4 X 10 mm). At the Winnipeg plot, nectar was collected at 08:00, 11:00, 14:00 and 16:00 hrs, but at Portage la Prairie and Rosebank, nectar was collected only at 14:00 hrs. For analysis, the dried floral nectar was redissolved by vortexing wicks and boiling in 5 ml of distilled water. A colorimetric technique, known as the Dreywood-Anthrone reaction, was modified to accommodate the use of microassay plates and allowed total carbohydrate of samples to be determined. Absorbances of samples were read on a microplate reader set to 630 nm, and compared to a standard series to quantify total sugar content. Results indicate that no significant differences in total sugar content exist among hybrid and non-hybrid cultivars of canola. In addition, sugar production from floral nectaries is lowest at 08:00 hrs and appears to increase until late afternoon, for all varieties examined. Peak sugar production also coincides with times during which pollinators are most actively foraging. Preliminary analysis of simple sugar composition indicates that relatively equal proportions of glucose and fructose exist in all nectars examined. These data suggest that hybrid canola varieties, as a whole, are equally as attractive to honey bees (*Apis mellifera* L.) as non-hybrids.

IMPLICATIONS OF FOREST MANAGEMENT FOR BUTTERFLY DIVERSITY IN JACK PINE (*PINUS BANKSIANA* LAMB) STANDS IN THE SANDILANDS PROVINCIAL FOREST. B.G. Elliott and N.J. Holliday, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

Differences in species (α) diversity and ecosystem (β) diversity in plantations and in naturally regenerated stands of jack pine *Pinus banksiana* Lamb were investigated. Four age classes were selected: 4, 15, 25 and 40 years after establishment.

Butterfly populations were sampled using two methods in replicated sites of each stand type-age combination. The first was accomplished by walking transects within each site and collecting butterflies with a sweep net. The second method involved the use of traps similar in construction to standard blowfly traps, baited with a fermenting molasses/banana/beer/sugar mixture.

Preliminary sampling was done in 1992 and consisted only of transect sampling. This yielded a total of 243 specimens representing 34 species. The trend in the preliminary year was for butterflies to be more numerous and speciose in sites of intermediate age. In 1993 sampling was more intensive and consisted of both transect sampling and bait trapping. Yield was 984 specimens representing 48 species, 21 of which were not collected the previous year. Over both years the total number of species collected was 54. The same general trend was observed with sites of intermediate age again having butterfly populations being both more numerous and speciose.

Species (α) diversity and ecosystem (β) diversity results will be discussed for the 1993 data only. Data from 1992 are insufficient for accurate estimates of these measures of diversity.

THE IMPACT OF A SPRUCE BUDWORM INFESTATION (1979-1991) ON THE BOREAL FOREST OF EASTERN MANITOBA. K.R. Knowles, D.S. Desrochers, R.A. Khan, and A.R. Westwood, Forestry Branch, Manitoba Natural Resources, 300-530 Kenaston Boulevard, Winnipeg, Manitoba, R3N 1Z4.

A spruce budworm, (*Christoneura fumiferana* [Clem.]), infestation has persisted in eastern Manitoba since 1979. An aerial and ground survey was carried out in 1991 within an area encompassed by the Abitibi-Price Inc. Forest Management License to determine the volume loss of timber and 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) timber volume loss 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 volume loss to 295,623 m^3 or 18% of the spruce/fir component. This volume of lost timber could have potentially contributed approximately $30 million to Manitoba's gross domestic product. The impact on the timber supply and costs of suppression are briefly discussed.

OVERWINTERING OF NATIVE ELM BARK BEETLES, *HYLURGOPINUS RUFIPES* (COLEOPTERA: SCOLYTIDAE), IN AMERICAN ELM IN MANITOBA. P.L. Mason and N.J. Holliday, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2

Two riverbank stands of American elm near Dauphin, Manitoba were selected. In fall 1992, bark beetle entrance holes were counted on the north, south, east, and west aspects of the trunks of 33 trees at four different heights, 0 to 25 cm, 55 to 80 cm, 110 to 135 cm, and 165 to 190 cm. In April 1993, 11 of these trees were felled and overwintering tunnels and beetles in the bark counted. Eighty-five to 100 percent of the beetles in the sampled areas on a tree were found in the 0 to 25 cm height range. As the diameter at breast height increased, the density of overwintering holes, tunnels, and beetles increased at the 0 to 25 cm height, but not for the other heights. There was no apparent effect of aspect. Other tree characteristics, such as bark roughness, number and size of branches, and area of root flare, did not significantly affect the density of holes. However, bark roughness was correlated with diameter at breast height, and the number of branches was correlated with height above the ground.

THE DEVELOPMENTAL PARAMETERS OF A PREDICTIVE MODEL FOR THE EUROPEAN BORER IN NORTH DAKOTA. M.W. Hoard, and M.J. Weiss, Department of Entomology, North Dakota State University, Fargo, North Dakota, U.S.A.

The developmental parameters of post-diapause development and larval development were investigated using the European corn borer *Ostrinia nubilalis* (Hübner). An enclosure study near Carrington, N.D. was used to isolate diapausing lst and 2nd flight European corn borer larvae. These larvae and their subsequent progeny were used to test for ecotypic variation in the two developmental parameters. These data are being used to establish a predictive model for the European corn borer in North Dakota.

CARABID BEETLES AS PREDATORS OF EGGS OF THE TWO-STRIPED GRASSHOPPER *MELANOPLUS BIVITTATUS* (SAY). J.M. Songa and N.J. Holliday, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

Pitfall traps were set along field margins in the spring of 1992 and 1993, to determine the abundance of potential predators of eggs of the two-striped grasshopper *Melanoplus bivittatus*. Grasshopper egg densities were determined by quadrat sampling along the field margins. Egg densities in 1993 were lower than in 1992. The most frequently caught potential predators were staphylinids, arachnids and several species of carabid beetles. Carabids were the most common group during the two seasons, and *Pterostichus corvus* (Lec.) was the most prevalent species. Catches of *P. corvus* were highest in locations with high densities of eggs of *M. bivittatus*. Feeding preferences of *P. corvus* and *P. femoralis* (Kirby) were studied in the laboratory in a two-choice test of grasshopper eggs and cat food. Both *P. corvus* and *P. femoralis* ate a higher percentage of grasshopper eggs than cat food. Of the two species, *P. corvus* ate more eggs. In aquaria, we studied the preferred depth of feeding by *P. corvus* on grasshopper eggs; eggs were placed on the soil surface, and at 2.5 and 5 cm below it. The number of eggs eaten at the surface was significantly lower than at the other depths, but there was no significant difference between numbers eaten at the 2.5 and 5 cm depths. A control study with no beetles, showed that there was no significant difference in the efficiency of recovery of eggs from the various depths: efficiency was higher than 98% at all depths. *P. corvus* appears to be a promising predator of grasshopper eggs, since it is abundant, can locate and feed on grasshopper eggs at depths at which they occur in the field, and appears to be most abundant in sites with high numbers of eggs of *M. bivittatus*.

GUT PROTEINASE ACTIVITY IN INSECT PESTS OF CANOLA. R.T. Rymerson and R.P. Bodnaryk, Agriculture Canada Research Station, 195 Dafoe Road., Winnipeg, Manitoba, R3T 2M9.

The gut proteinases of three insect pests of canola have been characterized by assessing the proteolytic activity of homogenates of midguts plus their contents at various pHs and with several proteinase inhibitors. The midgut preparation from larvae of *Mamestra configurata* L. had maximum proteolytic activity at pH 10.5 and was inhibited by 45-60% by serine proteinase inhibitors. The homogenate from larvae of *Plutella xylostella* L. had the highest proteolytic activity at pH 10 and was inhibited by 56-75% by serine proteinase inhibitors. Therefore, the two lepidopteran larvae appear to use serine proteinases in digestion. The midgut preparations from adults of *Phyllotreta cruciferae* exhibited the greatest proteolytic activity at pH 5, were stimulated by L-cysteine, and were inhibited by 33-61% by cysteine proteinases inhibitors. Aspartic proteinase inhibitors also decreased proteolytic activity by 27-50%. Therefore, *P. cruciferae* appears to use cysteine and aspartic proteinases in digestion.

ECONOMIC INJURY TO FLAX BY *MACROSIPHUM EUPHORBIAE* IN MANITOBA. I.L. Wise and R.J. Lamb, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, R3T 2M9.

Macrosiphum euphorbiae (Thomas) is a pest of many crops in North America. In Manitoba, this aphid has been found on commercial vegetable and field crops but has only been considered a pest on potatoes. After outbreaks of the aphid on flax during the 1980's, a study was initiated to determine if the aphid is causing economic yield losses, what crop stage is most affected, and what level of injury warrants aphid control. In field plots, chemical applications were made from first flower to the yellow boll stage, and the effects of these treatments on aphid density and flax yield were estimated. These results were compared to results from field cages in which aphids were introduced to flax at various crop stages. The optimum time to apply insecticide was influenced by aphid phenology and differential sensitivity of crop stages to aphid feeding. A single application of an aphicide was most effective if applied from the flower to green boll stages. Significant ($P < 0.05$) linear correlations between aphid densities and yield were established at the full flower and early green boll stages. The calculations of economic injury levels were determined from the yield reductions that were necessary to offset control costs and from the yield losses caused by aphid feeding. The economic injury levels for the 3 year study were 3 aphids/stem at full flower and 8-10 aphids/stem at the green boll stage. Field cage studies corroborated these results, revealing a 10% yield loss with a peak density of 10 aphids per plant. It is recommended that aphid sampling be done at the end of flowering using 8 aphids/stem as the economic threshold. Sampling the crop at this stage provides sufficient time to arrange for spraying and prevents unnecessary applications when aphid populations collapse naturally at earlier crop stages.

PHOTOPERIODISM AND THE PHENOLOGY OF THE APHID, *MACROSIPHUM EUPHORBIAE*, IN FLAX. R.J. Lamb, I. Wise and P.A. MacKay*, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, R3T 2M9, and *Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

The potato aphid, *Macropsiphum euphorbiae* (Thomas), is sometimes a serious pest of flax in Manitoba. Flax can be seeded later than most other crops and still yield well, although it matures late. Aphid populations in flax collapse by August 14, which has consequences for aphid control, particularly in late-seeded flax. We examine two factors that might explain the timing of the population collapse: crop maturity and aphid photoperiodic response. In field plots seeded on three successive dates, the aphid populations collapsed simultaneously although the last-seeded plots were immature. This observation rules out crop maturity as an important factor. Laboratory studies revealed that the critical photoperiod for the Winnipeg population of the potato aphid is about 15.25 h at 20°C. This daylength is reached on 1 August, in time for the population to switch to produce winged emigrants which would fly to the winter host by mid August. Field cage studies and samples from field plots showed that large numbers of winged aphids and some sexual morphs were produced beginning in the first week of August. This observation supports the hypothesis that population growth of the potato aphid in flax is terminated by the photoperiodic response of the aphid in southern Manitoba. Therefore, control of the aphid population in flax should be unnecessary after the first week of August.

TRICHOME-BASED RESISTANCE IN *CRUCIFERS* TO FLEA BEETLES, *PHYLLOTRETA SPP.* (COLEOPTERA:CHRYSOMELIDAE). P. Palaniswamy and R.P. Bodnaryk. Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, R3T 2M9.

A number of wild, Mediterranean *Brassica spp.* with leaf trichome densities ranging from 0 to 5300 trichomes/cm^2 were tested in the laboratory for resistance against flea beetle feeding. In choice and no-choice tests using leaf discs or whole leaves from seven species (*B. villosa* Biv., *B. villosa* Biv. subsp. *drepanensis* (Caruel), *B. rupestris* Rafin, *B. rupestris* Rafin, subsp. *hispida*, *B. macrocarpa* Guss, *B. incana* Ten. and a *B. incana* Ten. X *B.rapa* cv. Makelsberg cross), only the species in *B. villosa* complex that had a trichome density of >2000/cm^2 were found to be highly resistant to flea beetle feeding. All other species with low trichome densities (< 30/cm^2) suffered severe damage. Behavioral observations indicated that the *B. villosa* plants were as attractive to flea beetles as all other *Brassica* species tested, but the beetles would not feed on *B. villosa* leaves except on areas of leaves where trichomes were inadvertently damaged. Trichomes acted as a physical barrier to flea beetle feeding by preventing them from firmly settling on leaf surface, a prerequisite to initiate feeding. Electrophysiological tests also indicated that *B. villosa* leaves are as stimulatory as other *Brassica* species tested thus confirming that trichomes, not other factors such as chemical repellents or feeding deterrents, are responsible for the resistance in *B. villosa* plants.

Minutes of the 49th Annual Business Meeting of the Entomological Society of Manitoba

13:30 h, November 5, 1993

Freshwater Institute
Winnipeg, Manitoba

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

ATTENDANCE

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

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

Members:
N. Holliday
P. MacKay
B. Fingler
T. Galloway
B. Preston
S. Loschiavo
R. Brust
L. Gavloski
M. Smith
D. Dixon
R. Lamb
S. Pernal
S.C. Jay
J. Gosselin
J. Buth

1. R. Westwood recorded minutes of the meeting.

2. **Agenda** (Appendix A) **Motion:** T. Galloway/N. White. That proposed agenda be adopted. CARRIED

3. **Minutes of the 48th Annual Meeting Motion:** N. Holliday/P. MacKay. That the minutes of the 48th Annual Business Meeting of the Entomological Society of Manitoba, held 6 November 1992 and published in Volume 48 of the Proceedings of the ESM, be accepted. CARRIED

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

5. **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).

6. **Committee Reports**

   a. Finance Committee (Appendix G).

   b. Publicity, Newsletter (Appendix H).

   c. Social (Appendix I).

   d. Education and Youth Encouragement (No report).

   e. ESC Common Names (Appendix J).

   f. Archivist (Appendix K).

   g. Manitoba Environmental Council (Appendix L).

   h. Honourary Members (No report).

   i. Student Awards (Appendix M): 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 N).

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

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

m. E.S.C. E.S.M. Membership (Appendix Q).

n. Fund Raising (Appendix R).

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

P. Distinguished Research Scientist Lecture Committee (Appendix T).

7. **1992-1993 Election Results 1993-1994 (Appendix T)**

Congratulations to B. Fingler, president-elect and J. Gosselin, member-at-large.

Motion: N. Holliday/P. MacKay. That the ballots be destroyed. CARRIED

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

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

APPENDIX A

ENTOMOLOGICAL SOCIETY OF MANITOBA
49TH ANNUAL BUSINESS MEETING

November 5, 1993

AGENDA

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

2. Acceptance of Agenda.

3. Minutes of last Annual Meeting (Nov. 6, 1992).

4. Business arising from the minutes.

5. Reports - Executive, Trustees

a. President	R. Gadaski
b. Treasurer (Auditor)	L. Grenkow
c. Editor of the Proceedings	R. Westwood
d. Regional Director to ESC	P. Fields
e. Endowment Fund Board	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
q. Distinguished Lecture Series	

7. 1992-93 Election Results.
   Scrutineer Committee L. Grenkow

8. Transfer of Office

9. Other Business

10. Adjournment

APPENDIX B

PRESIDENT'S REPORT

This was a good year for the Society. The Proceedings, with Richard Westwood as Editor, has continued to evolve into a respected scientific publication. An area of concern only a few years ago, the Proceedings is developing into one of the major strengths of the Society. I firmly believe that there is a need for such regional representation. The challenge before us now is to promote the size of readership of this publication and to maintain the level of scientific content. This will require the efforts of all of us.

The overall strength of the Society of course is its members. Nowhere have I experienced such a willingness for people to be involved, to accept responsibilities, and to work hard and productively.

Don Dixon, the chairperson of the 1994 ESC/ESM Joint Annual Meeting Committee, deserves special mention. He and his committee have dedicated 2 years now to developing the program for next year's National meeting. It will undoubtedly be a roaring success. Our thanks.

JoAnne Buth as chairperson of the Finance committee and the Endowment Fund Board, along with Larry Grenkow our Treasurer and Joel Gosselin our Fund Raising chair, have maintained the financial viability of the Society. This despite strong downward financial pressures and some recent Society initiatives. This group can have a sobering influence.

Noel White, one of the perennial champions of the ESM, took responsibility for developing the first Guest Lecturer Series. A wonderful event, thoroughly enjoyed by all attending.

All Committee chairs and Executive staff deserve our thanks. They are the heart of our Society. Lynn Manaigre as Secretary and Autumn Robbie-Draward as Editor of the Newsletter and Chair of the Publicity Committee have two of the most important positions and perhaps the most difficult. More than most I've relied on their advice and ability.

Steve Pernal has notched another year as Chair of the Social Committee, and as usual has provided us with a wide variety of most interesting and entertaining events. Good science and a good social climate seem to work well together. Paul Fields, a very active member of the ESC and the ESM, has provided us with three very successful years as Regional Director to the ESC. He will hand over the reins this fall.

Finally, the culmination of our year's activities is the annual general meeting, chaired by Neil Holliday. Biodiversity and Climate Change was the symposium theme. Dr. Terry Erwin of the National Museum of Natural History was the keynote speaker with an address entitled "Taking Measure of Earth's Megadiversity. Well done to all.

I've enjoyed my term as President of the Society and I thank the Executive and the membership for their help in making this a successful year. I look forward to working with Rob Roughley, our incoming President, and his new Executive.

R.M. Gadawski
President, 1992-1993

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, 1993 and the statement of income and expenses for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I consider necessary 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, my verification of these revenues was limited to the amounts recorded in the records of the organization and I was not able to determine whether any adjustments for unrecorded receipts from these sources might be necessary to income or surplus balances.

In my opinion, except for the effect of any adjustments, if any, which I might have determined to be necessary had I been able to satisfy myself concerning the completeness of the cash revenues referred to above, these financial statements present fairly the financial position of the company as at August 31, 1993 and the results of its operations and the changes in its financial position for the year ended in accordance with generally accepted accounting principles.

Winnipeg, Canada
September 28, 1993

Original signed by Doug Nicholson
Certified General Accountant

ENTOMOLOGICAL SOCIETY OF MANITOBA, INC.
BALANCE SHEET
AUGUST 31, 1993

ASSETS

	1993	1992
Cash advances (note 2)	$ 350	$ 350
Cash in bank (note 3)	(67)	8,085
Investments (note 4)	30,000	27,000
	$30,283	$35,435

LIABILITIES

Liabilities	nil	nil

SURPLUS

Surplus	$30,283	$35,435

APPROVED BY THE BOARD

_____________Director
_____________Director

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

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
NOTES TO THE FINANCIAL STATEMENTS
AUGUST 31, 1993

1. SIGNIFICANT ACCOUNTING POLICIES:

Income and expenses are recorded on the cash basis of accounting. There are no accruals of 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	L. Manaigre	100
Newsletter	A. Robbie-Draward	200
Editor	R. Westwood	25
		$350

3. CASH IN THE BANK:

Savings account	$ 476
Current account	(543)
	$(67)

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
18105406	3,000.00
7053893	2,006.48
14577420	1,993.52
	$30,000.00

ENTOMOLOGICAL SOCIETY OF MANITOBA, INC.
STATEMENT OF INCOME AND EXPENSES
YEAR ENDED AUGUST 31, 1993

	1993	1992
REVENUE (note 1)		
Annual meetings	$1,736	$1,815
Donations	450	550
Fundraising committee	407	1,860
Interest income	2,950	3,351
Members fees	1,578	1,632
Miscellaneous	-	64
Proceedings	576	390
Student awards	103	200
Social committee	314	-
Youth encouragement/public education	200	200
	8,314	9,992
EXPENSES (note 1)		
Awards and scholarships	1,287	1,414
Distinguished speakers	1,115	-
Fundraising committee	13	819
General	1,044	1,013
Meetings	4,172	3,193
Newsletter	620	612
Other committees	-	24
Proceedings	4,250	815
Representation to ESC	425	-
Social Committee	540	808
	13,466	8,698
EXCESS (DEFICIT) OF INCOME OVER EXPENSES	$(5,152)	$1,294
Surplus, beginning of the year	35,435	34,141
SURPLUS, END OF THE YEAR	$30,283	$35,435

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

ENTOMOLOGICAL SOCIETY OF MANITOBA, INC.
TREASURER'S SUPPLEMENT TO THE AUDITORS REPORT
FOR THE YEAR ENDING AUGUST 31, 1993

1. GST:

Instead of being reported as ESM general revenue, in 1992-1993, the GST refund of $169.28 was returned to the appropriate committees. It was recorded as revenue for the committee or was deducted from their expenses.

2. ANNUAL MEETING:

Attendance at the November 1992 Scientific Program declined from the previous year. Forty-one regular members and fourteen students attended the meetings, and thirty-one regular members and nine students attended the banquet, compared to the November 1991 Annual meeting when forty-nine regular members and twenty students attended. Thirty-nine regular members and fourteen students purchased tickets to the 1991 banquet.

3. MEMBERSHIP:

For the year up to March 1, 1993, twenty-one members left the society and ten new members joined (seven student and three regular). As of March 1, 1993 the society had 129 members.

4. INTEREST INCOME:

Income declined due to a drop in interest rates. For GIC's that matured and were being renewed the interest rates dropped from an average of 10% to 6%.

5. PROCEEDINGS:

Projected revenues of $2365 from Volume 48 of the Proceedings of the Entomological Society of Manitoba were not received until after the 1992-1993 fiscal year. The cost of mailing Volume 48 of the Proceedings was $225.50 and was not paid until after the fiscal year.

6. DISTINGUISHED LECTURE SERIES:

Funds in the amount of $169.28 for the accommodation for Dr. D. Schwert (speaker at the Distinguished Lecture Series) were refunded to the Society by the Graduate Students Association after the end of the fiscal year.

7: NEWSLETTER:

The 1991-1992 fiscal year summer issue (#19, Volume 3) expenses of $130.00 were paid in the 1992-1993 fiscal year.

8: SOCIAL COMMITTEE:

Expenses for the 1992-1993 fiscal year that were paid for in the previous fiscal year included $400.00 to purchase an airline ticket for Dr. R. Carde, and $150.00 deposit to the Malibu Conference Centre for the September 1992 society luncheon.

9: TREASURER'S EXPENSES:

Auditor	$668.75
President/Secretary/Treasurer postage	165.92
Secretary photocopying	28.70
Bank service charge	148.95
New cash box	37.61
Safe deposit box	32.10
New cheques	13.42
Minister of Finance corporations fee	10.00

The of auditing the 1992-1993 fiscal year (to appear in the 1993-1994 auditors report) will be $588.50.

APPENDIX D

REPORT OF THE PROCEEDINGS EDITOR

Volume 48 (1992) of the Proceedings of the Entomological Society of Manitoba was completed on August 31, 1993 and mailed to Society members, subscribers and as gifts or exchange to selected institutions in September 1993. A total of 250 copies of Volume 48 were printed. The cost to subscribers for Volume 48 of the Proceedings was $8.00 Canadian. This cost has remained the same during the past ten years. The cost of producing the Proceedings is approximately $10.00 per copy and subscription costs will increase to that level for Volume 49.

Approximately 130 copies were mailed to society members, 45 to subscribing institutions and 50 were mailed to institutions that exchange their journal with ours or receive the Proceedings as a gift. Volume 48 was 125 pages in length and was changed to a 8.5 X 11 inch format. The cover was changed from green to tan and the Society logo was included in a stylized diagram.

Volume 48 contained 4 referred scientific papers which made up 91 of the 125 pages. Publishing authors paid only for reprints, as the Society does not charge page costs for papers printed in the Proceedings. The funds that the Society sets aside to help authors unable to fund their own papers was not utilized in 1992. The peer review process worked well and I am indebted to the reviewers for their time and expertise to ensure the scientific content of the Proceedings is of the highest quality. Five papers were submitted for Volume 48, four being accepted and one rejected.

As most members are aware the Proceedings has been revamped with Society business placed in the back of the publication and refereed papers and our annual meeting paper abstracts placed at the beginning. A notice to contributors and information on the Society have also been added. My first year as Editor of the Proceedings has been challenging and rewarding. I continue to seek new ideas and methods to improve the quality of our publication and any Society member who wishes to comment on the content or format of the current publication should do so in writing attention to myself.

Richard Westwood,
Proceedings Editor
November 1, 1993

APPENDIX E

REPORT OF THE REGIONAL DIRECTOR TO THE ENTOMOLOGICAL SOCIETY OF CANADA

The Annual Meeting of the Governing Board of the Entomological Society of Canada was held in Sault Ste. Marie on 26 and 29 Sept. 1993. 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 ESC has incurred deficits for several years ($53,000, $42,000, $36,000, $15,000; 1991 to 1994). These deficits were incurred in part because the CFBS dues, $17,000 and expenditures by the ESC membership dues bring in only $21,000 but costs of running the ESC are approximately $74,000. The Finance Committee recommended that the Regional Directors' travel expenses not be paid, this was not passed by the Governing Board. I would expect that the ESC would be near a balanced budget by 1995, with the withdrawal from the CFBS and the increased page charges.

2. The ESC/ESM 1994 Joint Annual Meeting is to held in Winnipeg from 15 to 20 October, symposia on insect movement, forestry and insect-host interactions and workshops on biodiversity and graduate studies are planed. Details will be published in the ESM newsletter and the ESC bulletin.

3. The ESC voted to withdraw from CFBS, however 1 year notice of withdrawal is required. The 1994 dues ($17,000) will be paid by the ESC. Members who wish to still remain members of the CFBS can do so by contacting M.B. Fenton at Dept of Biology, York University, FAX 416-736-5698.

4. The book project "Diseases and Insects Pests of Vegetable Crops in Canada" will appear in 1994.

5. There are continual problems with getting enough nominations for the Hewitt Award and the Gold Medal (not awarded in 1993). Regional Directors were encouraged to bring up this problem at the regional meetings. Nominations are due 31 December.

6. Al Ewen, editor of the Canadian Entomologist, asked that a replacement be found for him by at least 31 March 1994 if the position of editor was to continue on a volunteer basis. The Governing Board felt that the editor should remain as a volunteer position and Peter Kevan has agreed to become the new editor.

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 1992-93 fiscal year, $2,950.00 of investment income was generated from a principal amount of $30,000.00. Interest rates have declined, resulting in a corresponding decrease in investment income. Revenue in 1993-94 will be slightly lower due to re-investment of two certificates at lower rates.

Investment will continue to decline as the certificates currently invested at rates above 10% are re-invested at rates between 6-8%.

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
7053706	3,024.33	8.000	Dec. 15, 1997	241.95
8421072	1,775.67	7.500	Jan. 26, 1998	133.18
7058513	2,003.96	6.375	Sept.16, 1998	127.75
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
18105406	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 5, 1993
Larry Grenkow
JoAnne Buth, Chair

APPENDIX G

ANNUAL REPORT OF THE FINANCE COMMITTEE

The Finance Committee met on October 15, 1993 to review the Society's financial status.

In 1992-93, expenses exceeded revenue by $5,152.00. The cost of printing the Proceedings was higher than anticipated and revenue for Volume 48 will not be received until the 1993-94 fiscal year. In addition, the Guest Lecture expenditure was $1,115.00.

The committee reviewed each of the committee budgets and prepared an overall budget for the society. An accounting of the revenue and expenses for 1992-93 and projections for the next two fiscal years is attached. Of note is the projected revenue for 1994-95 does not include revenue from the ESC/ESM Joint Annual Meeting.

Entomological Society of Manitoba

BUDGET ITEMS	1992-93 ACTUAL	1993-94 ACTUAL & PROJECTED	1994-95 PROJECTED
Endowment Fund	$30,000.00	$30,000.00	$30,000.00
REVENUE			
Membership dues	1,578.00	1,500.00	1,500.00
Proceedings	576.00	2,865.00[1]	1,000.00
Social Committee	314.00	0.00	0.00
Youth/Education Committee	200.00	200.00	200.00
Donations	450.00	450.00	0.00
Fund Raising Committee	407.00	650.00	500.00
Student Awards and Scholarship	103.00	100.00	100.00
Meetings: ESM AGM	1,736.00	1,969.00[2]	0.00
ESC-ESM (94-95)	0.00	0.00	1,600.00
Newsletter	0.00	0.00	0.00
Investment Income	2,950.00	2,800.00	2,600.00
Miscellaneous: GST Rebate	0.00	239.37	0.00
TOTALS	$8,314.00	$10,773.65	$5,900.00
EXPENSES			
General Society Expenses	$1,044.00	$1,000.00	$1,000.00
Proceedings	4,250.00	2,500.00	2,500.00
Newsletter	620.00	640.00	650.00
Social Committee	540.00	500.00	500.00
Youth/Education Committee	0.00	300.00	200.00
Fund Raising Committee	13.00	50.00	50.00
Student Awards and Scholarships	1,287.00	1,300.00	1,300.00
Meetings: ESM AGM	4,172.00[3]	3,063.00	0.00
ESC-ESM (94-95)	0.00	500.00	500.00
Other Committees: Membership	0.00	50.00	50.00
Guest Lecture	1,115.00	0.00	0.00
TOTALS	$13,466.00	$10,253.00	$6,750.00
Net Gain (Loss) for Year Ending August 31st	($5,152.00)	$520.65	($850.00)

[1] includes revenue from Volume 48 (1992)
[2] includes refund of accommodation expenses of $169.28 from D. Schwert
[3] includes airfare for speaker for the 1993 meeting

October 30, 1993
Robert Currie, Randy Gadawski, Larry Grenkow,
Allen Wiens and Barry Fingler, Chair

APPENDIX H

ANNUAL REPORT OF THE NEWSLETTER AND PUBLICITY COMMITTEE

In 1993, the committee published four issues (Volume 20, Numbers 1 to 4) of the ESM Newsletter. Two copies of each issue were forwarded to the ESM Archivist and to the National Library in Ottawa.

The Newsletter is a forum whereby information is circulated to Society members. The committee is interested in personal opinions, short articles, news of research projects, announcements of meetings, workshops courses and other events, request for information, news of personnel or visiting scientists, literature reviews or announcements.

I would like to thank all members who have participated in the publication of the Newsletter. It is a difficult task gathering interesting information, and I am grateful to those individuals who willingly complied with my requests for articles or their time.

I challenge all ESM members to take ownership of the 1994 Newsletter by contributing often.

A. Robbie-Draward
Chair, Newsletter and Publicity Committee, 5 November 1993

APPENDIX I

ANNUAL REPORT OF THE SOCIAL COMMITTEE

The Entomological Society of Manitoba met for two luncheons during 1993, both held at the Travelodge Hotel Astoria. On January 27, Kevin Anderson from Manitoba Hydro spoke about "The Computer Virus Threat" to 19 members. On September 15th, 43 members listened to Pat MacKay and Bob Lamb reveal their Australian adventures in a talk entitled "Pat and Bob Down Under".

The New Members' Social was held at the Malibu Conference and Banquet Centre on March 6, 1993. Thirty-six people were in attendance, including four of the Society's nine new members: Young Cho, John Christie, Jason Diehl and John Gavloski. Dr. Peter Harris, from

Agriculture Canada in Lethbridge, Alberta, talked about his searches for biological control agents in "Safaris for Weed Eaters".

In conjunction with the Scientific Program Committee for the Annual Meeting, the Social Committee arranged for Pat MacKay and Bob Lamb to host the Meet the Speakers Mixer on November 4, 1993, at their home. Approximately 35 people attended the mixer, and had the pleasure of meeting Dr. Terry Erwin, the meeting's keynote speaker. The banquet following the Annual General Meeting was held on November 5th, at the Southwood Supper Club in Winnipeg. Following the banquet, Bill Bremner and Marilyn Latta presented a slide show and interpretive talk entitled "Yellowstone - From Fire to Fire" to the 46 people in attendance.

S.F. Pernal
Chairs, Social Committee, November 5, 1993

APPENDIX J

YOUTH ENCOURAGEMENT AND PUBLIC AWARENESS COMMITTEE

No report.

Catherine Salki, Chair

APPENDIX K

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 L

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 M

REPRESENTATIVE TO THE MANITOBA ENVIRONMENTAL COUNCIL ANNUAL REPORT 1993 FISCAL YEAR

In the spring provincial budget, the operating grant of the Manitoba Environmental Council along with several other organizations was not renewed by the Province of Manitoba. This removed the Council from the list of agencies that are authorized to use government mailings. It also removed access to government facilities by Council members to hold meetings. The membership of the Council was allowed to lapse by the Minister from 65 in November 1992 to 12 as the terms of members expired.

This has not necessarily meant the end of the Council. The Executive Committee has recommended the appointment of 14 members whose term expired in October, including myself.

This action was done to ensure there would be potential for on-going involvement by these individuals in activities that are appropriate to the form the Council will take in the next few months. The Council continues to operate from funds left over from last year. This has enabled the Council to maintain an office on an interim basis until the funds become exhausted.

The fate of the Council rests solely with the Minister of Environment. He has indicated his desire to appoint an advisory group of 6 members who will oversee all functions currently addressed by the Council. This group may include present or previous Council members or be comprised of individuals not associated with any environmental organization. The Minister has expressed an interest in maintaining the network the Council has established over the past 20 years for use as an advisory body by the new Council. However, the consensus amongst Council members is that this concept would not be viable unless an independent focus and operational core were sustained. Another suggestion by the Minister was for members to have departmental access through arrangements with his staff. This option was perceived by some members to be more viable in rural vs. urban regions where fewer organizations that address environmental issues exist.

The lack of interest by the Minister in deciding the fate of the Council has made it incapable of effectively responding to environmental issues. Although, the present Environment Act provides legal status to the Council to deal with environmental issues at the ministerial level, the Minister's unwillingness to reappoint members has made its status academic. In conclusion, the opportunity to re-establish the Council as a valuable watchdog and advisor to the government still exists. However, time is rapidly running out.

Ian L. Wise

APPENDIX N

ESM STUDENT AWARDS COMMITTEE

The Committee reviewed the nominations received for the Student Achievement Award and the SWAT Student Award. Mr. Trevor Ogwal was selected as the recipient of the Student Achievement Award. Mr. Edward Mondor has been selected to receive the SWAT Student Award. The Student Achievement Award will be presented at the Banquet following the Annual Meeting.

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

APPENDIX O

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 P

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 Q

SCIENTIFIC PROGRAM COMMITTEE REPORT

The 49th Annual Meeting of the Entomological Society of Manitoba was held on 4 and 5 November 1993 at the Freshwater Institute. There were a total of 42 full registrants and 20 student registrants.

A symposium, "Biodiversity and Climate Change", was held on the morning of 4 November. The symposium was moderated by Dr Rob Roughley, and the four speakers were Dr Allan Ashworth, North Dakota State University, Dr Kazimierz Patalas, Freshwater Institute, Dr Brenda Hann, Department of Zoology, University of Manitoba and Dr Neil Holliday, Department of Entomology, University of Manitoba.

The submitted paper session on the afternoon of 4 November, was chaired by Dr Neil Holliday, and consisted of 12 papers, five of which were entered in the student paper competition. The judges for the student paper competition were Dr S. C. Jay, Dr R. J. Lamb and Mr A. MacKay. The names of the paper competition winners were announced at the banquet.

On the morning of Friday 5 November, Dr Terry Erwin, Smithsonian Institution, Washington, DC, gave the keynote address "Taking Measure of Earth's Megadiversity". Dr Erwin's talk was open to non-registrants and was attended by about 100 people.

A well-attended informal mixer was held on the evening of 4 November at the home of Dr Pat MacKay and Dr Bob Lamb. The annual banquet was organized by Steve Pernal (Local Arrangements Chair) and took place at the Southwood Supper Club. Entertainment was provided by Bill Bremner and Marilyn Latta who gave a slide presentation "Yellowstone - Fire to Fire".

The Committee wishes to thank all the speakers for their excellent contributions to the meeting. Special thanks go to the hosts of the mixer, to those responsible for arrangements at the Freshwater Institute, to those who staffed the registration desk, and to the secretarial staff of the Department of Entomology for their assistance.

S. F. Pernal
R. W. Currie
J. Gosselin
R. E. Roughley
N. D. G. White
A. P. Wiens
N. J. Holliday, Chairperson

APPENDIX R

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 S

FUND RAISING COMMITTEE

This report is for the period September 1, 1993 to August 31, 1994. Requests for donations were sent to 48 companies for the November 4, 1993 Annual General Meeting of the Entomological Society of Manitoba. To date, 9 companies have donated $50.00 each and one company has donated $100.00. Fundraising efforts will be concentrated on the joint Entomological Society of Canada and the Entomological Society of Manitoba meeting being held in October 1994. Over 110 companies are being solicited and additional revenues will be made possible from sales of pens, pins and t-shirts. The sale of insect drawers is progressing well and is expected to generate over $300.00. Expected revenues and expenses are as follows:

Revenues:

1994 ESM/ESC	
Corporate donations	$600.00
Sales - insect drawers	$300.00
Sales - pins, T-shirts	$200.00
Total	$1100.00

Expenses:

Postage for 2 mailers	$100.00	
Printing and set-up	$200.00	
Misc. expenses	$100.00	
Total	$400.00	Difference = $700.00

Richard Westwood, Joel Gosselin, Chair

APPENDIX T

JOINT ANNUAL MEETING (ESM-ESC) COMMITTEE

The Organizing Committee for the 1994 joint ESC-ESM Annual Meeting was formed as an ad-hoc committee in 1992. The joint meeting will be held during Oct. 15-19. 1994 at the Delta Winnipeg Hotel.

The Organizing Committee is comprised of the following individuals:

Science Programme	Paul Fields (chair)
	Rob Anderson
	Rob Currie
	Swami Pachagounder

Local Arrangements	Don Dixon (chair)
Finance	Joanne Buth
Tour Programmes and	
Banquet and Receptions	Pat MacKay
Meeting Accommodation	Don Dixon
Audio Visual	Dave Holder
Conference Photographs	Roy Ellis
Finance Soliciting	Joel Gosselin (chair)
	Richard Westwood
Registration	Neil Holliday
Printing	Barry Fingler
Publicity	Autumn Robbie-Draward

The Science Programme committee has been particularly busy since the last ESM Annual Meeting and has organized an exciting and ambitious programme around the general meeting theme of "Insect Movement". Three symposia have been arranged with themes of Insect Movement, Insect-Host Interactions and Insect Pest Management and Forest Pest Management in Rural and Urban Environments.

To date, two workshops have been planned, one on "Biodiversity" and the second on "Getting Through Grad School".

A tour of the Ducks Unlimited Conservation Centre at Oak Hammock Marsh is being planned for Sunday, Oct. 16.

Additional information on the meetings will be published in the ESC Bulletin and the ESM Newsletter.

The committee would like to extend thanks to Linda Glowacki for the art work associated with the 1994 Joint Annual Meeting logo.

D. Dixon
Chair - Joint Annual Meeting Committee

APPENDIX U

ENTOMOLOGICAL SOCIETY OF MANITOBA

Distinguished Research Scientist Lecture Committee

The first Distinguished Research Scientist Lecture sponsored by the ESM was held on Thursday, 6 May 1993.

The lecture was given by Dr. Donald P. Schwert, Department of Geosciences, North Dakota State University, Fargo, giving an outstanding presentation entitled "A Faceted Eye's Perspective on Ice Age Environments".

The talk was held at 7 p.m. in the Fletcher Argue Building, University of Manitoba and was followed by a reception at the Faculty Club.

Expenses were covered by the ESM ($595) with donations from the Graduate Student Association ($200) and the University of Manitoba Faculty Association ($320). [Lodging, airfare equivalent, per diem, catering and Faculty Club rental, honorarium]. Only thirty people attended the lecture even though extensive efforts were made to advertise the event.

Committee Guidelines for this new Standing Committee of the ESM were prepared and accepted by the Executive. Thanks are offered to T. Mason and Dr. Rob Currie for facilitating funding through the GSA and UMFA.

S. Pernal, B. Elliot, R. Roughly
N. White, Chair
November 1993

APPENDIX V

SCRUTINEER'S REPORT 1992-93 ELECTION

Successful President-Elect	Barry Fingler
Successful Member-at-Large	Joel Gosselin
Number of ballots returned	65
Number of spoiled ballots	0

R. Roughley, Chair

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 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

The Entomological Society of Manitoba gratefully acknowledges the generous support of their annual meeting by the following companies:

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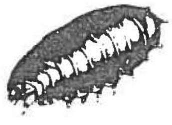
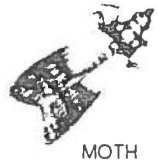

SOWBUG


BED BUG


WHITE CUTWORM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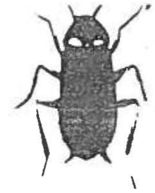
CRICKET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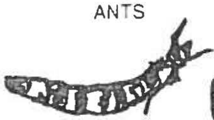
LARVAE

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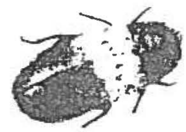

LARDER BEETLE

A St. Jean, Manitoba hotel keeper refused to let his son have a dog. Like most boys, he found a way around the problem by keeping a small puppy hidden in a grain shed. One morning when he went out for his usual visit he found his puppy dead and chewed to pieces by rats. Unfortunately for the rats, they had irritated a boy named Napoleon Louis Poulin who would later found Poulin's Exterminators in 1940. This incident eventually helped write a piece of Canadian history in that Alberta is the only "rat-free" province in Canada as a result of Poulin's Exterminators' efforts and talent.

Over the years these humble beginnings have mushroomed into the **OLDEST AND LARGEST PEST CONTROL COMPANY IN WESTERN CANADA** with branch offices in **BRANDON, WINNIPEG, REGINA, SASKATOON, CALGARY, LETHBRIDGE, EDMONTON, AND VANCOUVER**. Our services have expanded far beyond the realm of rat control to include insect, rodent, bird, fly and odour control as well as weed control, tree spraying, soil sterilization and fumigation for both commercial and residential premises. Each location has a retail store with a wide variety of pest control and lawn and garden products for the home, cottage, farm or industry "do-it-yourself-er".

Napoleon Louis' son, Don, is now the Chief Executive Officer of the company who remembers his father's teachings well and maintains the same high calibre standards that his father did so many years ago. This has enabled Poulins to maintain an outstanding reputation as the leader within the Pest Control industry.

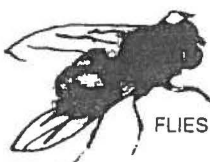
Our staff of over fifty employees are always pleased to offer free information, advice, and estimates regarding the various services we provide. This includes pest control maintenance programs for all sizes of companies (as well as residential) which is backed up by our written guarantee.

We offer 24 hour emergency service in all of our branches, and are very proud of our licensed, bonded, trained Service Technicians throughout Western Canada.

There's no pest problem we can't handle because:

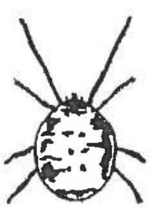
"there's no foolin' with POULIN'S"!


FLOUR BEETLE


FLIES

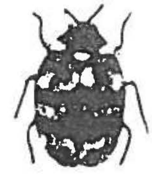

BEES & WASPS


SPIDER

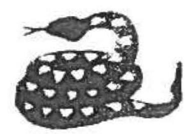

MITES


FLEAS


LARVAE


CARPET BEETLE


TREE SPRAYING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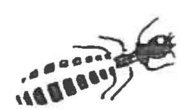
EARWIG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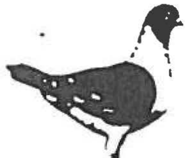
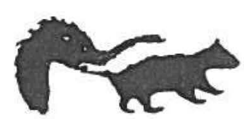
ODOR CONTROL


SPARROWS, PIGEONS AND STARLINGS


BATS


GOPHER


MICE AND RATS


SKUNKS AND RACOONS