PRELIMINARY REPORT ON STUDIES OF THE IMPACT OF MATACIL® FORMULATIONS ON HONEYBEES AND WILD POLLINATORS.

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INTRODUCTION

Aminocarb, a carbamate insecticide marketed under the trade name MATACIL®, has been widely used in spruce budworm, *Choristoneura fumiferana* Clem., control programs in eastern Canada. Recently a new MATACIL formulation (MATACIL 1.8F) has been developed which does not contain the solvent nonyl phenol, a component of the old MATACIL 1.8D formulation which markedly increased its toxicity to fish. MATACIL 1.8F can be applied both in oils and as water based sprays, another advantage over former MATACIL formulations. The Environmental Impact Section of the Forest Past Management Institute conducted field studies in 1981 north of Searchmont, Ontario, to evaluate immediate and short term effects of various MATACIL sprays on domestic honeybees, *Apis mellifera* L., and wild pollinators native to forest stands. The primary objective of these studies was to determine whether MATACIL 1.8F poses any greater hazard to pollinators than MATACIL formulations previously used in Canadian forest insect control programs.

EXPERIMENTAL TREATMENTS

Three separate field experiments were carried out at two week intervals in July and August of 1981. In each experiment both domestic honeybees and wild pollinators were studied in untreated control plots and plots treated with MATACIL formulations. Study plots consisted of delineated areas of natural blossom of native wildflowers selected on the basis of maximum quantity and quality of pollen and nectar sources available, to the extent assessable by visual inspection. In the first two experiments, honeybee colonies were confined to 1.5 x 4.6 m treated plots by means of screen cages (Fig. 1) and wild pollinators were studied on uncaged plots of the same size. In the third experiment, an isolated patch of blossom about 120 m^2 in area was sprayed and honeybees and wild pollinators foraging freely within this area were studied in comparison to those foraging in an untreated control area 2 km distant.

All treatments were applied using a hand held Micron 'ULVA' Sprayer (Fig. 2). According to the manufacturer's specifications, this ultra-low-volume-applicator is capable of producing a relatively narrow spectrum of droplet sizes centering around 70 μ diameter. All study plots were treated at an application rate equivalent to 350 g AI/ha, twice the seasonal maximum dosage allowable for currently registered MATACIL formulations, in order to accentuate effects and differences between the formulations tested. Test solutions were made up by diluting stock solutions (Table 1) equivalent to the most concentrated field formulations applied operationally (87.5 g AI/ha applied in a total volume of 1.17 L/ha). Sufficient Insecticide Diluent 585 or water was added to give an adequate volume of spray mix

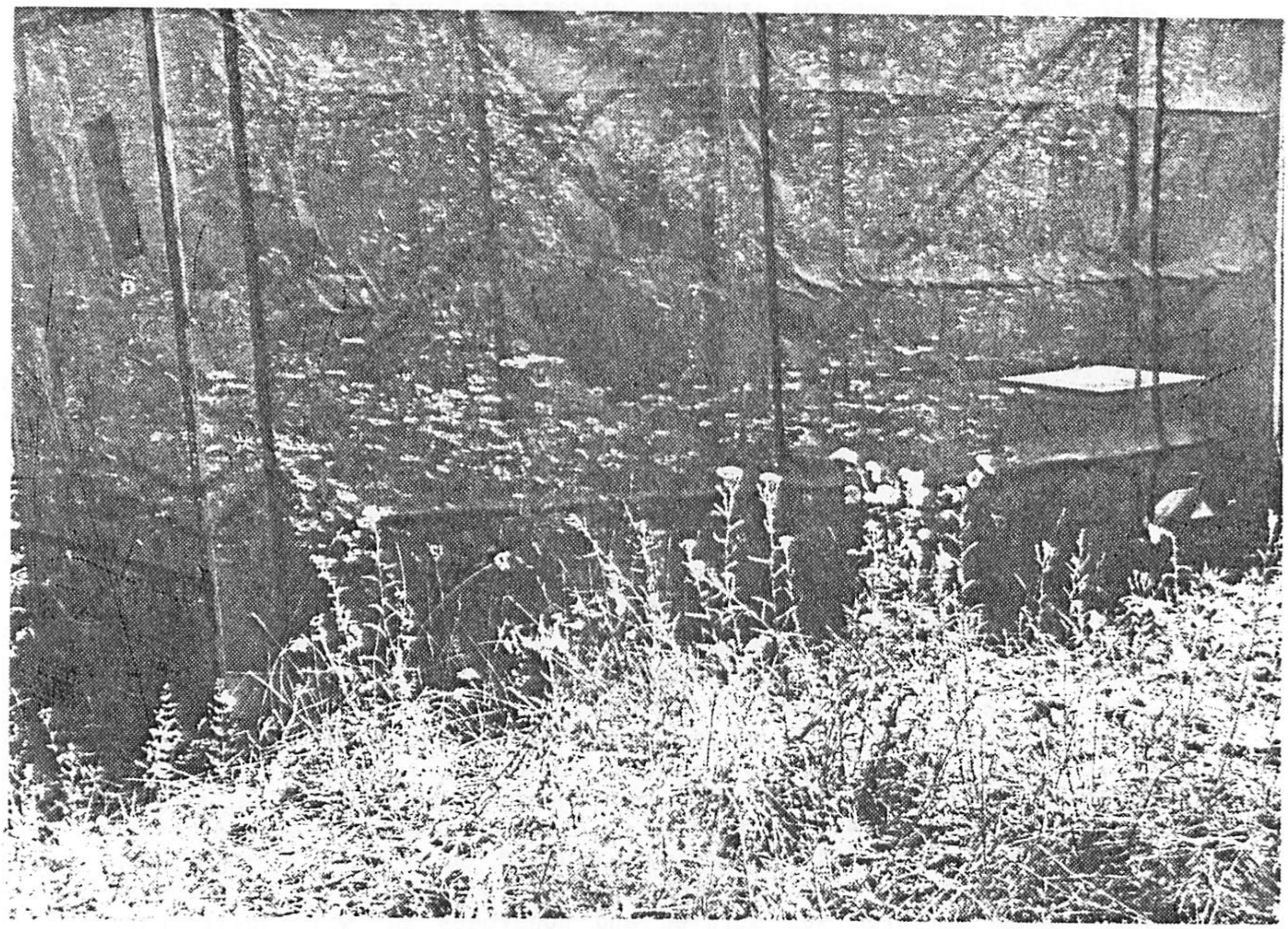

Fig. 1. Honeybee colony set up in a screen cage over an aminocarb treated plot of wildflowers,predominantly ox-eyed daisy. Searchmont,Ontario. July 1981.

Fig. 2. Experimental application of aminocarb to fireweed blossom using a Micron 'ULVA' sprayer. Searchmont, Ontario. August 1981.

Table 1. Stock solutions of MATACIL formulations used in pollinator studies, Searchmont, Ontario 1981.

MATACIL 1.8D in 585	
MATACIL 1.8D	33.3%*
Automate Red Dye	0.5%
Insecticide Diluent 585	66.2%
MATACIL 1.8F in 585	
MATACIL 1.8F	33.3%
Automate Red Dye	0.5%
Insecticide Diluent 585	66.2%
MATACIL 1.8F in water	
MATACIL 1.8F	33.3%
Atlox 3409F	1.25%
Rhodamine B Dye	0.5%
Water	64.95%

* by volume.

Table 2. Treatments applied to pollinator study plots, Searchmont, Ontario, 14 July to 12 August, 1981.

Treatment	Area treated (m^2)	Volume applied (ml)	Ratio of stock solution to carrier in applied mix	Pollinators studied
		<u>Experiment 1 - 14 July</u>		
Insecticide Diluent 585	7*	25	-	HB, WP
MATACIL 1.8D in 585	7*	25	1:5.1	HB, WP
MATACIL 1.8F in 585	7*	25	1:5.1	HB, WP
		<u>Experiment 2 - 28 July</u>		
MATACIL 1.8D in 585	7	25	1:5.1	WP
MATACIL 1.8F in 585	7*	25	1:5.1	HB, WP
MATACIL 1.8F in water**	7*	25	1:5.1	HB, WP
		<u>Experiment 3 - 12 August</u>		
MATACIL 1.8F in water	120	320	1:3.6	HB, WP

* two separate plots of this area treated for honeybee and wild pollinator studies.
** designated as MATACIL-W in Fig. 6-10.
HB - honeybee
WP - wild pollinators

(Table 2) to allow for complete coverage of the treated plots with the hand held sprayer, which emitted between 40 and 52 ml per minute depending on the viscosity of the final spray mixture. In Experiment 1, the same volume of Insecticide Diluent 585 alone as of active ingredient sprays was applied to separate plots to look for any effects attributable to this carrier oil.

EXPERIMENT 1

METHODS

Weather: Weather data was collected throughout the experimental period utilizing a Heathkit weather station as well as visual observations. Temperatures were measured at the 2 and 10 metre levels. Relative humidity, barometric pressure, wind speed and directions were also recorded. Precipitation was measured by a tip bucket rain gauge and cloud cover was estimated. Sunrise during the experimental period was 04:40 E.S.T.*

Floral composition: All flowering plants in each plot were counted and identified and percent composition calculated on the basis of flower bearing stems of each species.

Wild pollinator activity: This initial experiment was carried out on plots utilizing the native pollinator pasture of the area. Four 1.5 x 4.6 m plots were established and all pollinator visits to them over a ten minute period each hour were recorded.

Honey bees: Screen cages measuring 1.5 x 4.6 x 1.8 m were erected over patches of native wildflowers the day prior to the application of the MATACIL formulations. Honeybee colonies (with attending queen and 4 frames of brood) were placed in each cage immediately following each treatment. Each hive was fitted with an entrance dead bee box and a O.A.C. (Ontario Agriculture College) designed pollen trap. Plastic trays measuring 28 x 34 cm were placed at the inside corners of each cage to collect away from hive mortality. Hives were monitored hourly over a 12 hr period each day for three days.

RESULTS

Floral composition: Eleven species of native wildflowers were in bloom in the study plots during the experimental period. The most abundant flowering plant common to all plots was the ox-eyed daisy, *Chrysanthemum leucanthemum* Lecog and Lamotte. Heal-all, *Prunella vulgaris* L., was present in relatively low numbers on three of the four plots as was the yellow hawkweed, *Hiracium floribundum* Wimm. and Grab. The overall floral composition of all experimental plots are presented in Tables 3 and 4.

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* Eastern Standard Time is used exclusively in this report.

Table 3. Floral composition of experimental wild pollinator plots, Searchmont area, 14-16 July 1981.

Plot	Percent flower species									
	Ox-eyed daisy *Chrysanthemum leucanthemum*	Yellow hawkweed *Hiracium floribundum*	Yarrow *Achillea millefueille*	Evening primrose *Epilobium hirsutum*	Goldenrod *Solidago* spp.	Heal-all *Hiracium vulgaris*	Raspberry *Rubus* sp.	Honeysuckle *Lonicera Tatarica*	Common fleabane *Erigeron* sp.	Cinquefoil *Potentilla canadensis*
Control	75	6	2	2	1	7	–	–	7	–
585	82	3	2	–	1	11	–	–	–	–
MATACIL – F	96	3	–	–	1	–	–	–	–	–
MATACIL – D	79	–	1	1	1	15	–	1	–	2

Table 4. Floral composition of experimental honeybee cages, Searchmont area, 14-16 July 1981.

Plot	Percent flower species					
	Ox-eyed daisy *Chrysanthemum leucanthemum*	Yellow hawkweed *Hiracium floribundum*	Yarrow *Achillea millefueille*	Goldenrod *Solidago* spp.	Heal-all *Hiracium vulgaris*	Spreading Dogbane *Achillea rosaemifolium*
585 oil	90	–	5	–	5	–
MATACIL – D	34	–	–	1	58	7
MATACIL – F	85	7	–	–	8	–

Wild pollinators: Low overnight temperatures (3°C at time of treatments) caused numerous insects (mainly diptera spp.) to rest overnight completely inactive on blossoms and foliage, and these were immediately knocked down upon contact with the MATACIL formulated sprays. Insects resting overnight on the 585 oil plot were not knocked down and became active as air temperatures warmed. Insect activity in general commenced between 0600 and 0700, as temperatures increased into the low teens with clear skies and light winds. Temperatures climbed to the mid 20s by 14:30 (Table 5) and skies became partly cloudy with increasing winds. Diptera became active early in the day (Fig. 3A) and foraged mainly for nectar produced by the ox-eyed daisy, the most abundant flowering plant available. Hymenoptera on the other hand, became active later in the day (Fig. 3B) after air temperatures had climbed above the overnight lows and foraged mainly for pollens produced by heal-all and yellow hawkweed. No mortality or additional knockdown was observed beyond that recorded immediately following the two MATACIL treatments.

Diptera foraging activities on the MATACIL treated plots were substantially depressed for 5-7 hours after treatment compared to activity on the 585 oil treated and untreated control plots (Fig. 3A). Hymenoptera foraging activities were relatively similar on all plots on the day of treatment, with little activity occurring until close to mid-day (Fig. 3B). Hot calm weather conditions prevailed throughout the day after treatment (Table 6) and pollinator activity commenced early in the day on all except the MATACIL F plot, where diptera started foraging several hours later than on the other plots (Fig. 4). A large peak in hymenoptera foraging was recorded around mid-day on the MATACIL 1.8D plot when a few bumblebees (*Bombus* spp.) visited all the heal-all bloom on the plot. Hot, calm weather in the mid-morning of the second day after treatment (Table 7) resulted in high foraging activity on all plots, especially the control (Fig. 5). Complete overcast and rain showers moved into the area around noon and depressed insect activity on all plots.

Honeybees: No pollen was collected from the traps on the caged colonies. Adult bee mortality collected in the hive entrance dead bee trap and the plastic containers in the cage corners was quite low. Mortality is presented in Table 8 as totals for the period of hourly observations during the day and as the first reading taken the next morning, representing overnite mortality. Mortality patterns were fairly steady within each cage but varied considerably between cages. Mortality in the MATACIL 1.8D cage was consistently somewhat lighter than in the Insecticide Diluent 585 cage, but mortality in the MATACIL 1.8F cage was consistently much higher than in the other cages. A larger proportion of the mortality showed up in the cage corners than in the dead bee trap at the hive entrance in the MATACIL 1.8F cage, while almost equal numbers of dead bees were found in the two locations in the other cages.

Table 5. Weather data for 14 July 1981, MATACIL flowable formulations, experiment-1.

Time (E.S.T.)	Temperature °C		Wind (r.p.h)		Cloud cover 1/10's	bar. pressure (millibars of Hg)
	2m	10 m	speed	direction		
0400	5	7	0	-	Clear	968
0430	4	6	1	SE	Clear	968
0500	3	6	0	-	Clear	969
*0530	3	7	0	-	Clear	969
0600	5	8	1-2	ESE	Clear	969
0630	8	11	2-5	E	Clear	970
0700	11	14	3-5	NW	Clear	970
0730	15	17	7-8	N	Clear	970
0800	17	19	8-19	ENE	Clear	970
0830	11	19	7-12	NE	Clear	970
0900	24	20	5-10	NE	Clear	970
0930	26	21	3-4	NE	2	970
1000	26	20	6-18	NW	2	970
1030	25	22	6-23	N	3	970
1100	28	22	12-18	N	3	970
1130	23	22	10-19	N	4	970
1200	24	22	9-15	ENE	5	970
1230	23	23	10-17	N	5	970
1300	23	23	7-16	N	5	970
1330	24	25	5-10	B	6	970
1400	24	23	11-22	NW	6	970
1430	25	24	16-21	NE	7	970
1500	25	26	15-18	N	7	970
1530	25	24	16-23	NNE	8	970
1600	25	26	6-9	E	8	970
1630	27	26	8-10	ESE	8	970
1700	26	25	8-12	ENE	7	970
1730	26	24	6-14	ENE	7	970

* spray applications completed.

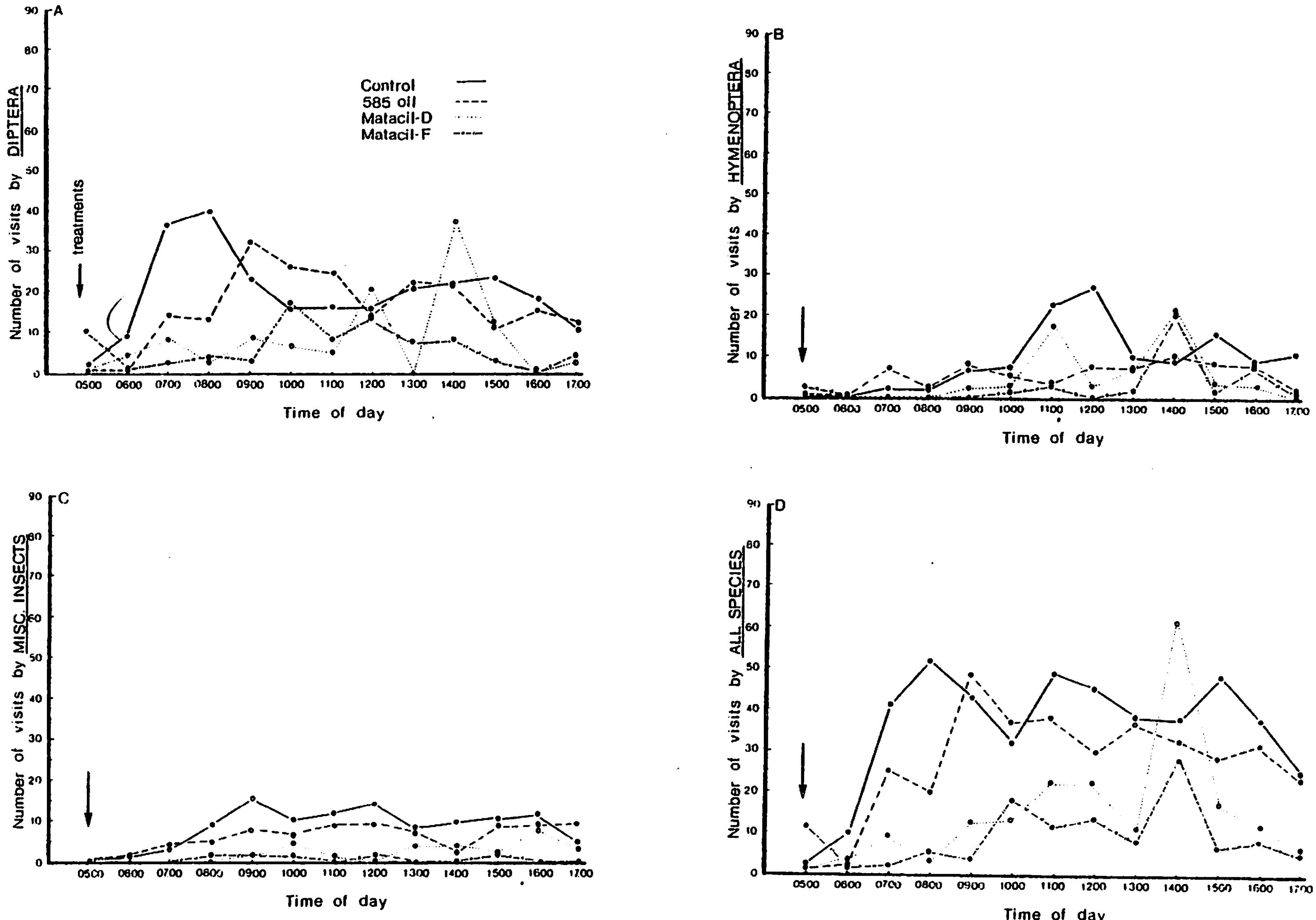

Fig. 3. Wild pollinator activity on treated and control plots on the day of treatment, Experiment 1, Searchmont, Ontario, 14 July 1981.

Table 6. Weather data for 15 July, 1981, MATACIL flowable formulations, experiment-1.

Time (E.S.T.)	Temperature °C 2m	Temperature °C 10 m	Wind (r.p.h) speed	Wind (r.p.h) direction	Cloud cover 1/10's	bar. pressure (millibars of Hg)
0645	10	8	0	-	Clear	971
0730	15	13	1-3	ESE	Clear	971
0830	20	18	1-4	EE	Clear	971
0930	29	24	0-2	ESE	Clear	971
1030	30	27	1-3	ESE	5	970
1145	25	24	0-1	E	5	970
1230	28	27	6-7	SSW	5	969
1330	28	6	8	NNW	5	969
1400	27	28	0	-	6	969
1515	27	25	3	NE	7	968
1630	26	25	3-9	NW	6	968
1645	28	27	15-18	NNW	6	968

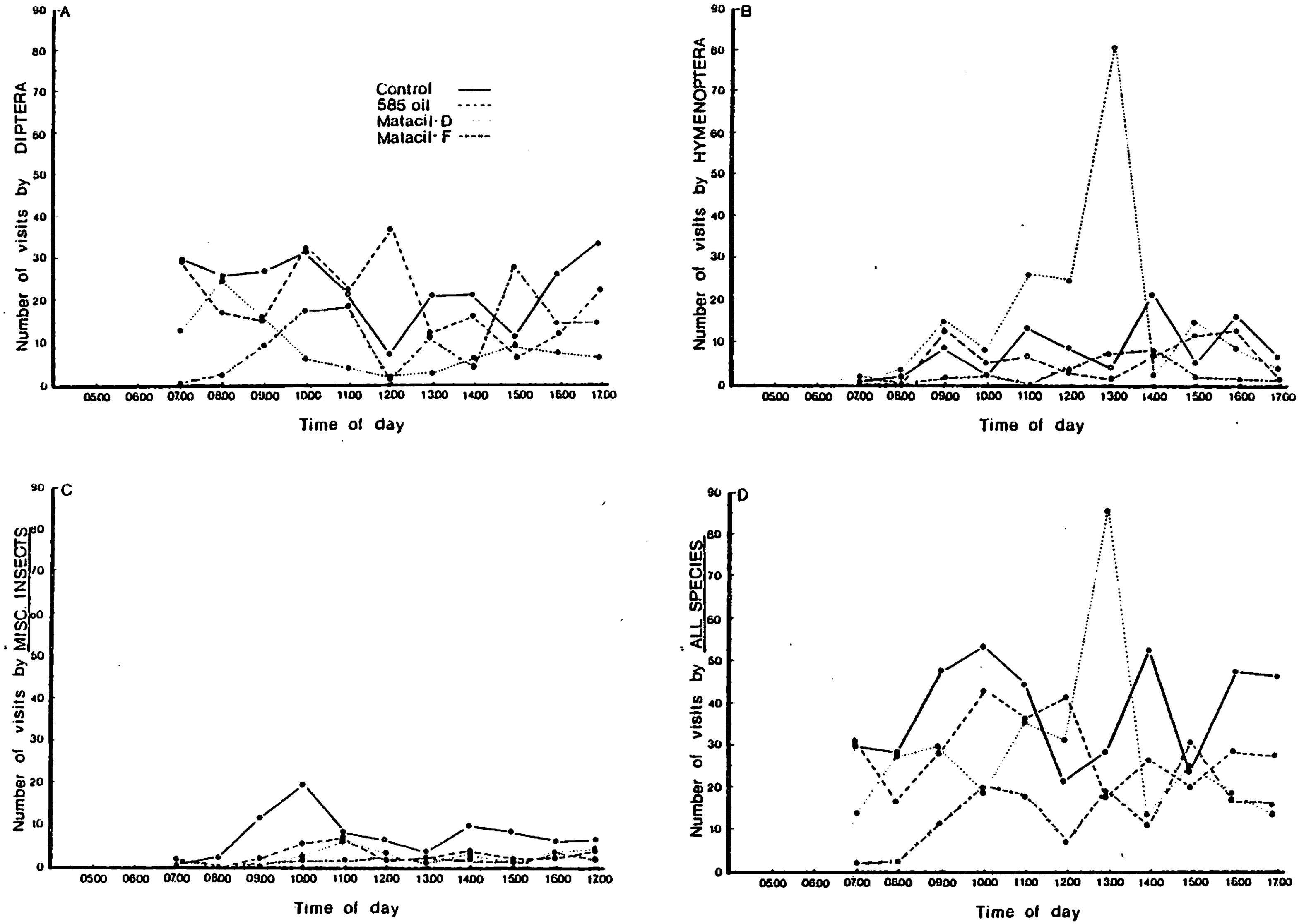

Fig. 4. Wild pollinator activity on treated and control plots on the day after treatment, Experiment 1. Searchmont, Ontario, 15 July 1981.

Table 7. Weather data for 16 July 1981, MATACIL flowable formulations, experiment-1.

Time (E.S.T.)	Temperature °C		Wind (r.p.h)		Cloud cover 1/10's	bar. pressure (millibars of Hg)
	2m	10 m	speed	direction		
0410	7	8	0	-	6	967
0720	15	15	1	S	6	967
0745	18	17	1	E	7	967
0830	19	20	0-3	E	8	967
0930	28	26	0	E	9	967
0945	28	25	0	E	7	967
1020	28	28	1	E	5	967
1045	28	25	5-7	SSE	5	967
1115	33	27	10-12	SSW	6	966
1145	26	25	5-7	NNW	6	966
*1215	18	17	0-1	E	10	966
**1245	18	17	4-5	S	10	967
1315	20	18	3-5	NNW	10	967
1345	22	21	2-3	S	8	967
1415	24	22	2-3	E	9	967
1445	23	21	5-7	S	10	966
***1515	23	22	0	SE	10	966
1545	23	21	1-3	S	10	966

* rain
** rain stopped
*** light drizzle

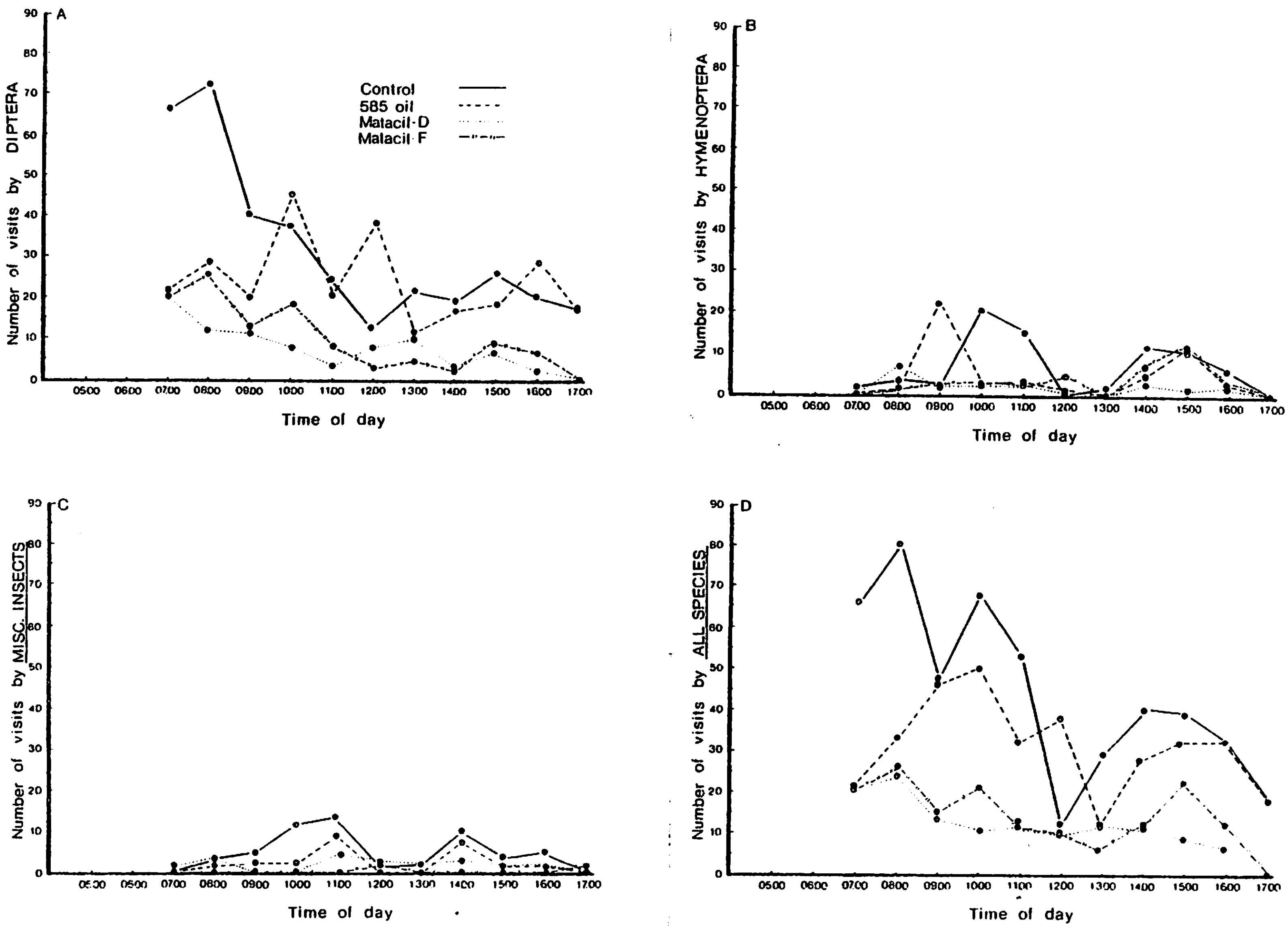

Fig. 5. Wild pollinator activity on treated and control plots on the second day after treatment, Experiment 1. Searchmont, Ontario, 16 July 1981.

Table 8. Honeybee mortality in caged experimental plots, Searchmont area, 14-16 July 1981.

	Number of dead bees											
	585 oil cage				MATACIL-D cage				MATACIL-F cage			
	trap		corners		trap		corners		trap		corners	
	day	night	day	night	day	night	day	night	day	night	day	night
14 July	1	11	2	1	3	3	1	4	31	16	38	42
15 July	7	6	8	8	3	2	1	3	47	6	37	53
16 July	7	-	9	-	0	-	2	-	13	-	13	-

Experiment-2

Methods

Weather: Weather data was collected in the same manner as for the first experiment. Sunrise during the second experimental period was 04.44 E.S.T.

Floral composition: Four experimental plots were established in the same fashion as the first experiment. Canada goldenrod, *Solidago canadensis* L. was the dominant flowering plant in the area and all other flowering species were removed from the experimental plots in order to eliminate any pollinator preferences as was experienced during the first experiment.

Wild pollinator activity: Activity counts of visiting pollinators were carried out in the same manner as was used during the first experiment, except a five day census period was employed which included one pre-spray census day and an approximately ½ day census on the final day.

RESULTS

Wild pollinators: A pre-treatment census was carried out between the hours of 11.00 and 18:00 on 27 July. Weather conditions were quite favorable early in the day but skies clouded over by 12:00 hours and temperatures ranged in the low 20's (Table 9). Insect activity was relatively high on the three plots monitored (the MATACIL-1.8D plot not being established until late in the day could not be censused). Diptera and hymenoptera were the two major groups of foraging insects active (Fig. 6).

Weather conditions on the treatment day were highlighted by temperatures ranging in the mid-teens, a dropping barometric pressure and light winds with rain, starting about 14:00 (Table 10). The MATACIL treatments were completed by 06:00 and as was recorded during experiment-1, insects resting overnight on foliage or blossoms were knocked down on contact. Insect activity patterns on all four plots were similar through the day (Fig. 7). Activity started quite late and peaked about 14:00, then dropped rapidly at the onset of rain. Insect activity appears to have been affected by both the treatment (activity on sprayed plots somewhat lighter than the untreated) and poor weather (overall reduction in activity when compared to other days). Rain forced the end to monitoring activities after 15:00.

Table 9. Weather data for 27 July 1981, MATACIL flowable formulations, experiment-2.

Time (E.S.T.)	Temperature °C		Wind (r.p.h)		Cloud cover 1/10's	bar. pressure (millibars of Hg)
	2m	10 m	speed	direction		
0853	18	16	4-5	ENE	Clear	977
1200	23	23	1-3	MNE	8	976
1230	22	22	3-4	NNE	9	976
1528	23	23	8-12	W	9	975
1615	22	21	4-10	W	9	975
1636	21	20	6-10	NW	9	975

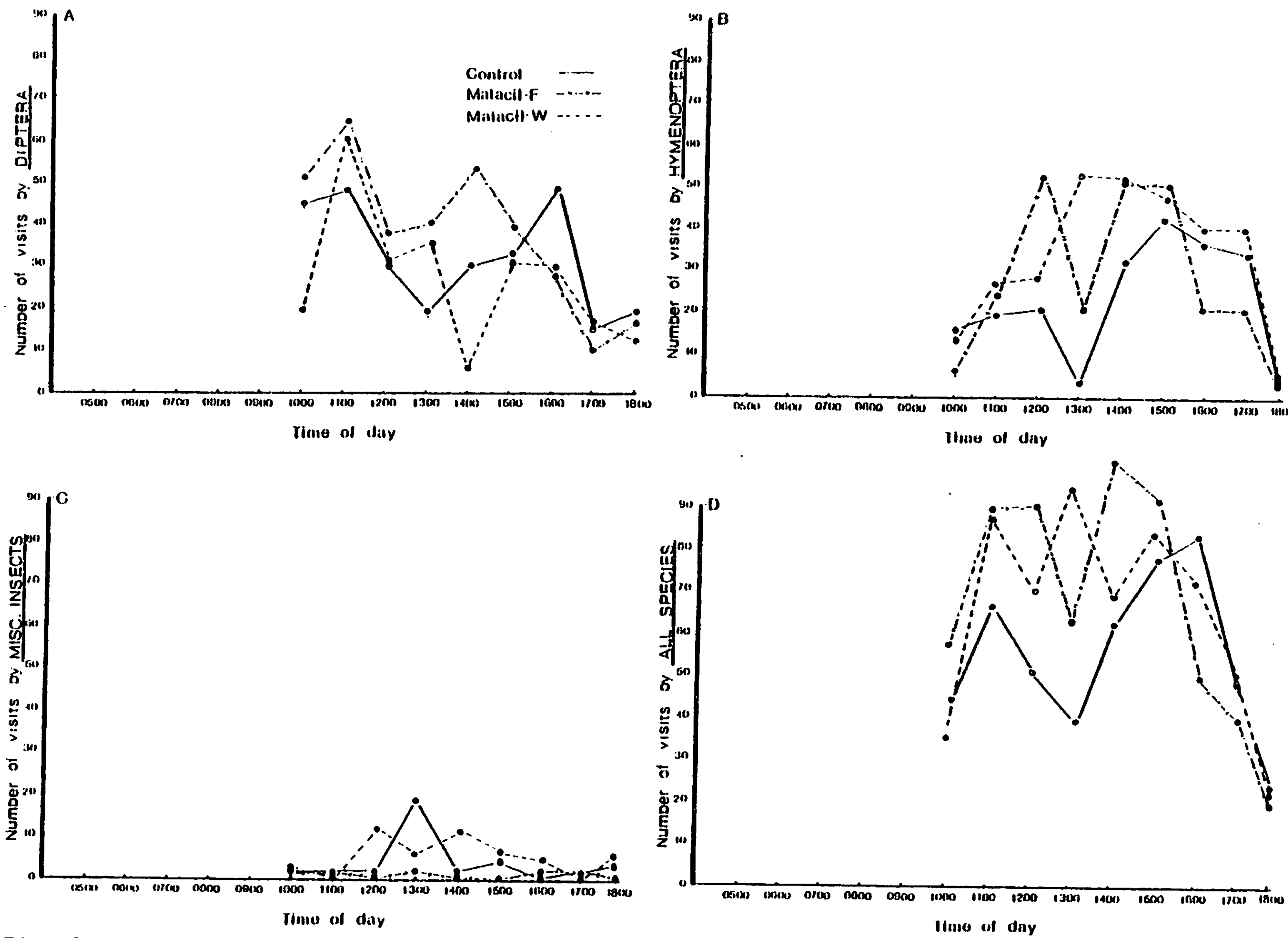

Fig. 6. Wild pollinator activity on treated and control plots on the day before treatment, Experiment 2. Searchmont, Ontario, 27 July 1981.

Table 10. Weather data for 28 July 1981, MATACIL flowable formulations, experiment-2.

Time (E.S.T.)	Temperature °C 2m	Temperature °C 10 m	Wind (r.p.h) speed	Wind (r.p.h) direction	Cloud cover 1/10's	bar. pressure (millibars of Hg)
0600	9	8	0	-	10	972
0730	11	10	0	-	10	972
0945	15	14	2-3	SE	10	972
1030	16	15	2-3	SE	10	971
1100	16	16	1-0	SE	10	971
1230	21	19	2	N	10	971
1518	16	15	3-4	WNW	10 (rain)	970
1645	15	14	3-7	WNW	10 (rain)	970

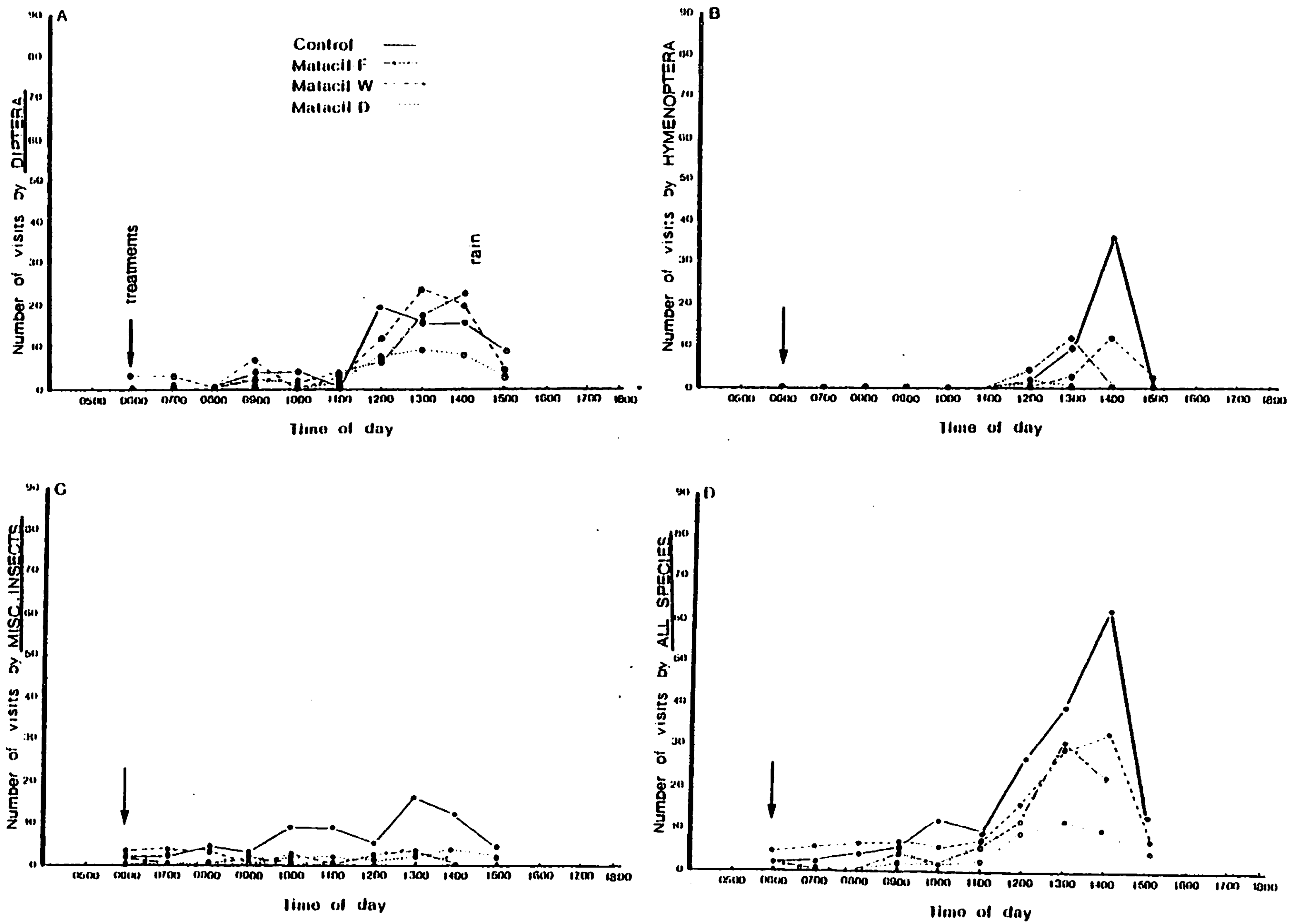

Fig. 7. Wild pollinator activity on treated and control plots on the day of treatment, Experiment 2. Searchmont, Ontario, 28 July 1981.

Table 11. Weather data for 29 July 1981, MATACIL flowable formulations, experiment-2.

Time (E.S.T.)	Temperature °C		Wind (r.p.h)		Cloud cover 1/10's	bar. pressure (millibars of Hg)
	2m	10 m	speed	direction		
0615	4	5	0	SE	5 (fog)	971
0715	7	8	1	SE	Clear	971
0730	9	10	5	SE	Clear	971
0815	11	12	3	E	Clear	971
0915	21	17	3	SE	Clear	971
1015	24	19	5-6	SW	Clear	971
1120	27	23	4-5	NW	Clear	971
1220	24	23	7-8	SW	Clear	971
1245	25	23	14-17	SW	Clear	971
1335	24	25	10-15	W	Clear	971
1430	24	25	6-13	W	1	971
1524	25	25	6-11	W	2	970
1735	24	24	4-6	MNW	Clear	970
1823	25	24	3-5	SW	Clear	971
1905	22	21	1-2	NE	Clear	971

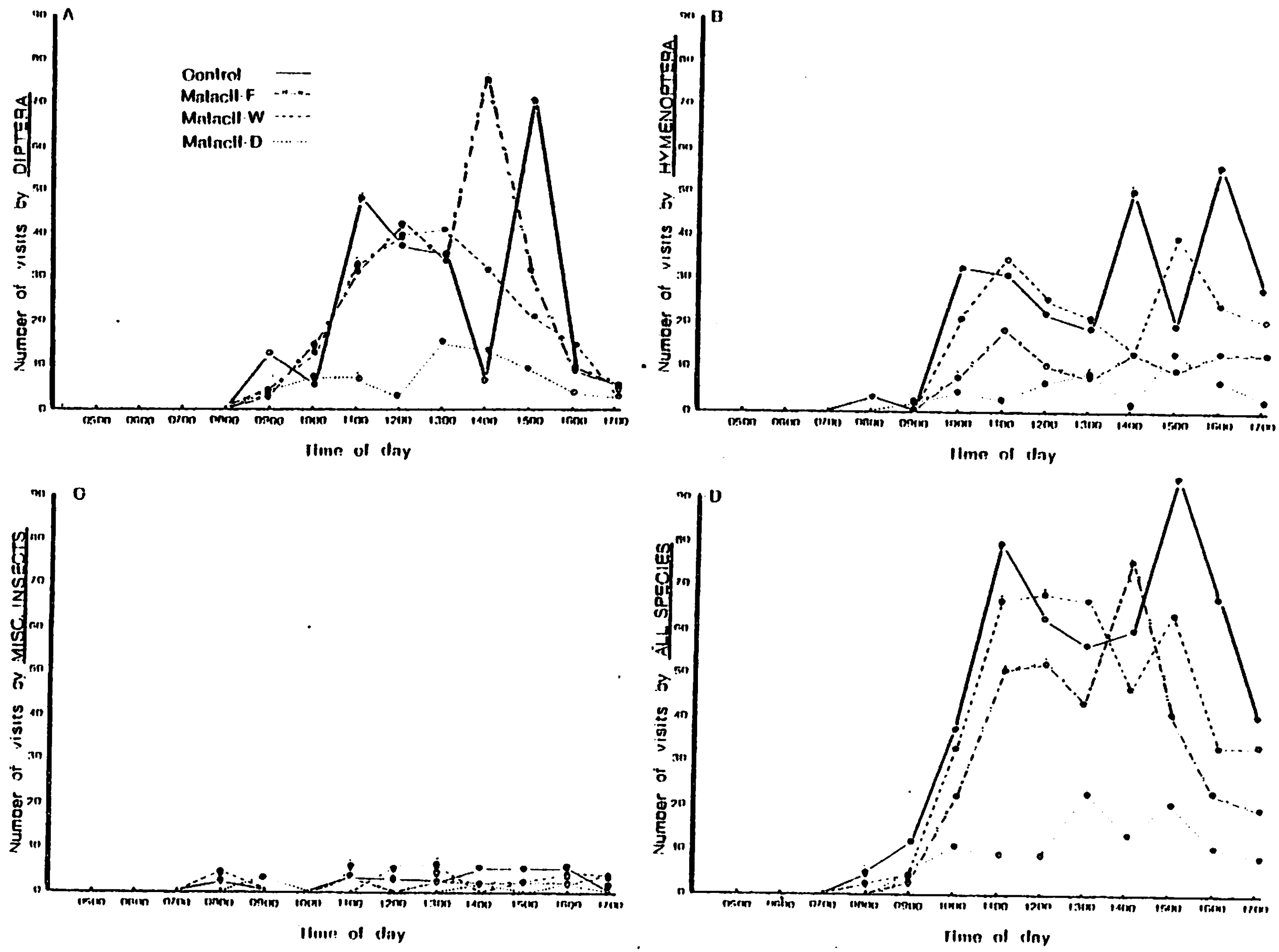

Fig. 8. Wild pollinator activity on treated and control plots on the day after treatment, Experiment 2. Searchmont, Ontario, 29 July 1981.

Table 12. Weather data for 30 July 1981, MATACIL flowable formulations, experiment-2.

Time (E.S.T.)	Temperature °C		Wind (r.p.h)		Cloud cover 1/10's	bar. pressure (millibars of Hg)
	2m	10 m	speed	direction		
0600	5	6	0	SE	Clear	973
0645	7	8	0	SE	Clear	973
0715	10	11	0	E	Clear	974
0745	12	13	1-2	SE	Clear	974
0815	13	15	0	SE	3	974
0845	16	17	4-5	SE	4	974
0915	25	20	3-6	SW	3	974
0945	28	21	10-11	W	4	974
1030	23	22	4-5	S	6	974
1130	32	26	8-10	SE	6	973
1230	28	26	12-14	NW	7	974
1315	26	26	4-12	W	7	974
1530	26	26	8-11	WNW	7	973
1745	26	25	8-12	WNW	1	973

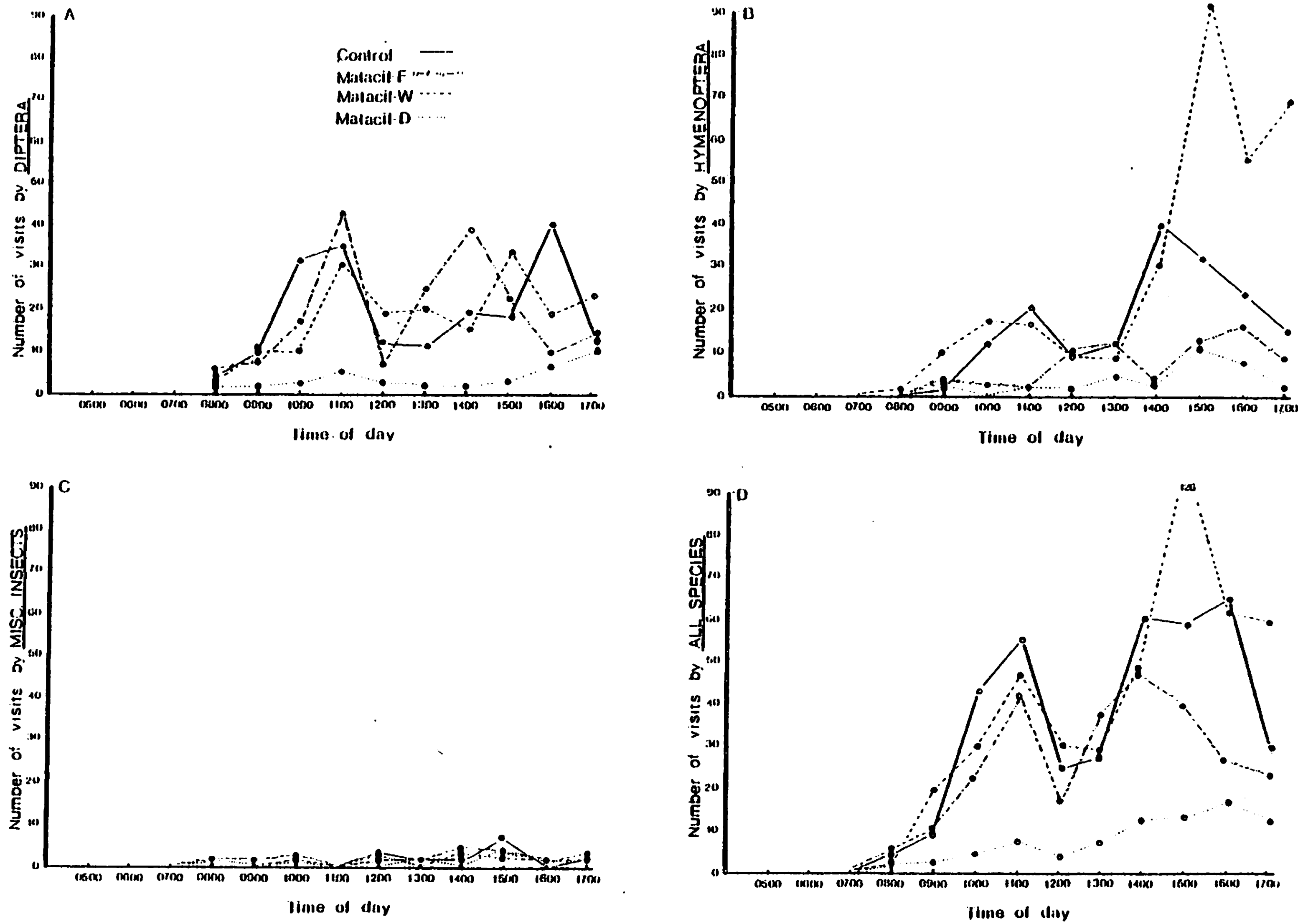

Fig. 9. Wild pollinator activity on treated and control plots on the second day after treatment, Experiment 2. Searchmont, Ontario, 30 July 1981.

Table 13. Weather data for 31 July 1981, MATACIL flowable formulations, experiment-2.

Time (E.S.T.)	Temperature °C 2m	Temperature °C 10 m	Wind (r.p.h) speed	Wind (r.p.h) direction	Cloud cover 1/10's	bar. pressure (millibars of Hg)
0600	8	8	0-2	SE	Clear	976
0720	12	12	0	SE	8	977
0745	13	13	0-7	NE	6	977
0827	20	18	0-3	E	4	976
0945	27	25	9-12	SSW	4	976
1021	27	23	5-13	SW	4	975

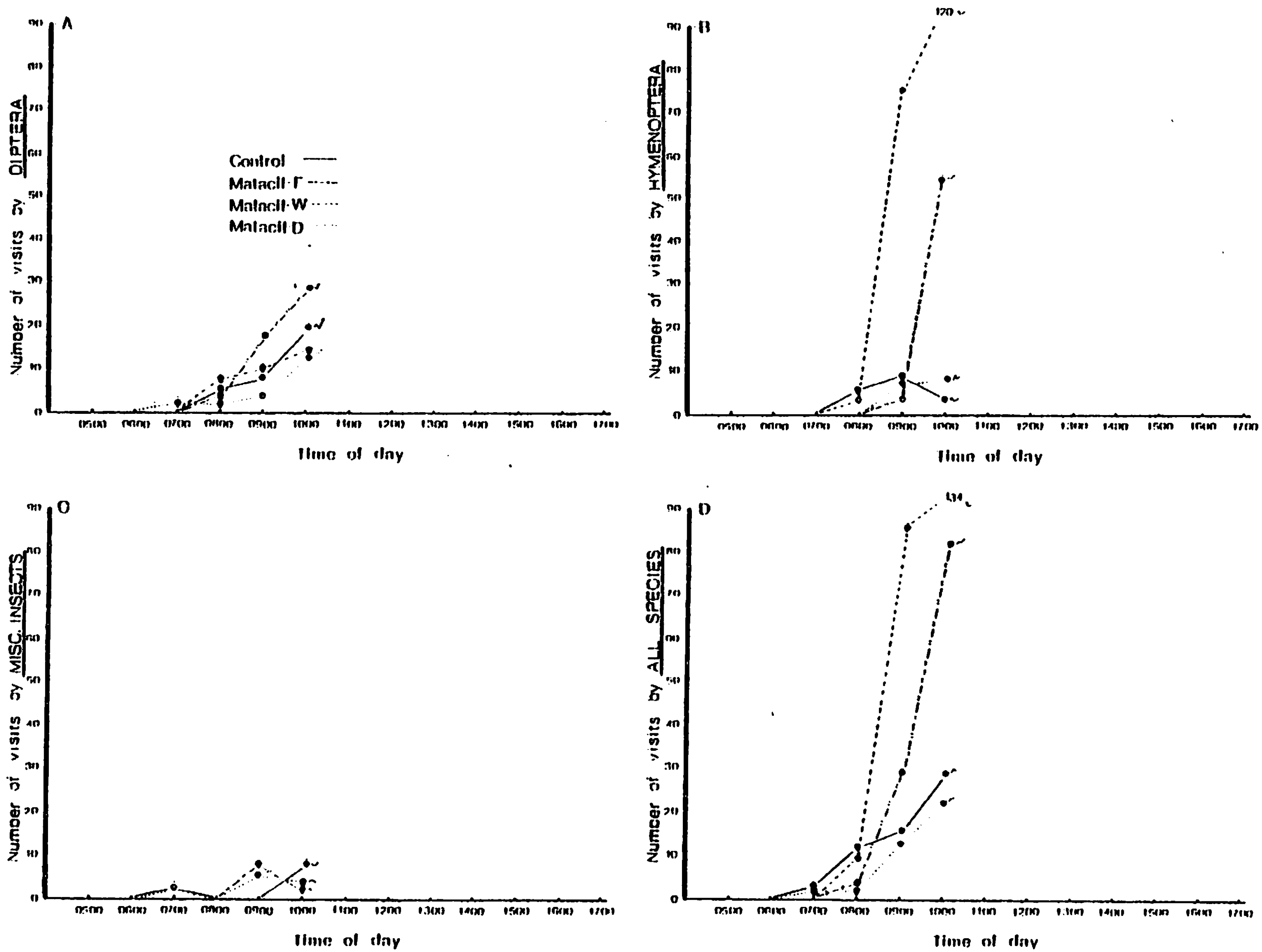

Fig. 10. Wild pollinator activity on treated and untreated plots on the third day after treatment, Experiment 2. Searchmont, Ontario, 31 July 1981.

Day 3 saw temperatures reach the mid 20's with clear skies (after early morning fog) and winds rising to 15 kph by mid-day (Table 11). Insect activity started slowly (Fig. 8) until the low overnight temperature (4°C at 06:15) started to rise and the low lying fog was burned off. Temperatures reached the low 20's by 10:00 resulting in an increase of insect (particularly diptera and hymenoptera) activity on all plots except MATACIL-1.8D.

Day 4 again experienced low overnight temperatures (5°C at 06:00) but increased to a high of 32°C by 11:30. Skies were clear early in the day with partial cloud by 08:30 with generally light winds and a rising barometer (Table 12). Insect activity peaked about 11:00 but dropped around noon (the temperature high for the day) and then peaked again around 15:00. Activity patterns were again similar for all plots but activity levels on the MATACIL-1.8D remained much lower than on other plots (Fig. 9).

Day 5 had a starting temperature of 8°C at 06:00 which quickly rose to the high 20's by 09:45 with partially cloudy skies and light winds (Table 13). Monitoring activities were carried out on this the day until activity trends were established. Activity started fairly early (08:00) and rose quickly on all plots. Activity counts were terminated at 10:00 (Fig. 10).

Honeybees: Theft of a honeybee cage and frame immediately before the second experiment precluded carrying out a comparison of honeybee colonies caged in untreated control and MATACIL 1.8D in 585, MATACIL 1.8F in 585 and MATACIL 1.8F in water treated plots of goldenrod blossom as was planned. Consequently, the two cages available were used to compare the effects of the MATACIL 1.8F formulation applied in Insecticide Diluent 585 and in water. An uncaged hive several hundred metres away from the caged hives was used to document control mortality at the hive entrance, but was not directly comparable to the treated hives as bees from this colony could forage in an unlimited area on whatever type of blossom they could find, not just goldenrod.

Honeybee mortality over the second experiment is presented in Table 14. Total mortality measured at the hive entrance over the study was quite similar for the three hives (48 for MATACIL 1.8F in water, 41 for MATACIL 1.8F in 585, 39 for the untreated control). Total mortality in the corners of the MATACIL 1.8F in water cage was, however, much higher than in the MATACIL 1.8F in 585 cage (187 versus 48).

Table 14. Honeybee mortality in caged experimental plots, Searchmont area, 28-30 July, 1981.

	number of dead bees									
	MATACIL-F in H_2O				MATACIL-F in 585				Control*	
	entrance		corners		entrance		corners		entrance	
Date	day	night	day	night	day	night	day	night	day	night
28 July	11	2	53	29	2	2	8	14	2	7
29 July	15	3	65	4	7	5	12	3	11	3
30 July	15	2	28	8	21	4	7	4	13	3

* uncaged colony some distance from treated plots.

Experiment-3

METHODS

The third experiment was carried out in a recently logged-over area where patches of fireweed, *Epilobium augustifoliae* L., had colonized the disturbed soils. Two areas of blossom were selected for pollinator monitoring. One, chosen as the treatment site, covered an area of approximately 120 m^2 while a somewhat smaller area about 4 km distant served as the untreated control site. Wild pollinators were monitored in much the same fashion as in experiments 1 and 2, with the addition of ten "knockdown containers" being placed under fireweed blossom on the ground throughout both plots to collect any mortality. Single colonies of honeybees were placed at each location just prior to treatment. The treatment colony was placed in the middle of the sprayed patch of fireweed bloom and was virtually isolated from any other nearby pollen source by surrounding thick growth of poplar saplings. The control hive had to be placed a short distance from the fireweed bloom where wild pollinator and knockdown studies were carried out, and had other patches of fireweed and fall asters, *Aster spp.*, in the immediate vicinity.

RESULTS

Wild pollinators: Prespray monitoring of both treated and untreated fireweed bloom indicated similar wild pollinator activity patterns (Fig. 11). Bumblebees (*Bombus spp.*) accounted for most of the wild pollinator visits on the treated plot and a large portion of the total pollinators visiting fireweed on the untreated plot. MATACIL 1.8F in water was applied between 7:10 and 7:30 EST 12 July, while a light ground fog covered the area. Warming temperatures burned the fog off by 10:00 and sunny skies prevailed until 13:00, when clouds moved into the area. *Bombus spp.* became active quite early in the day on both plots with peak activity recorded around 10:00 (Fig. 12). Species of hymenoptera other than *Bombus* did not reach peak activity on the untreated plot until after *Bombus* activity had declined. Diptera were most active early in the morning, then virtually disappeared while hymenoptera foraged. Honeybees did not locate the untreated fireweed bloom during the monitoring period.

Diptera activity on the treated plot paralleled that recorded on the untreated plot but did not increase towards the end of the monitoring period. Honeybees began to forage in the contaminated bloom about 10:30 (about the time that the rising temperature burned off the ground fog) but did not reach peak activity until after peak *Bombus* activity had declined (a situation similar to on the untreated plot where hymenoptera other than bumblebees peaked in activity once *Bombus* activity declined).

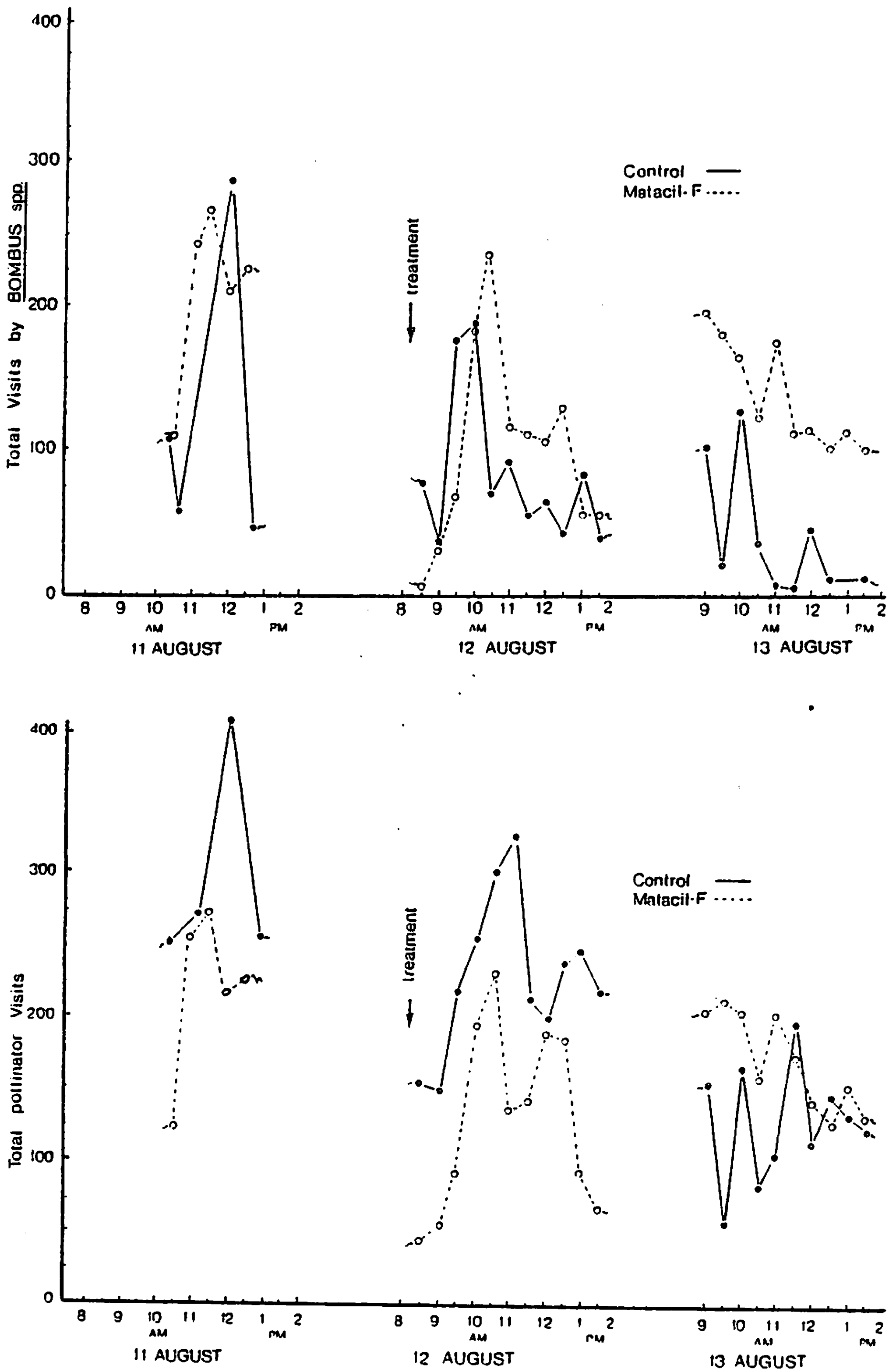

Fig. 11. Wild pollinator activity on MATACIL 1.8F and untreated control plots, Experiment 3. Searchmont, Ontario, 11-13 August 1981.

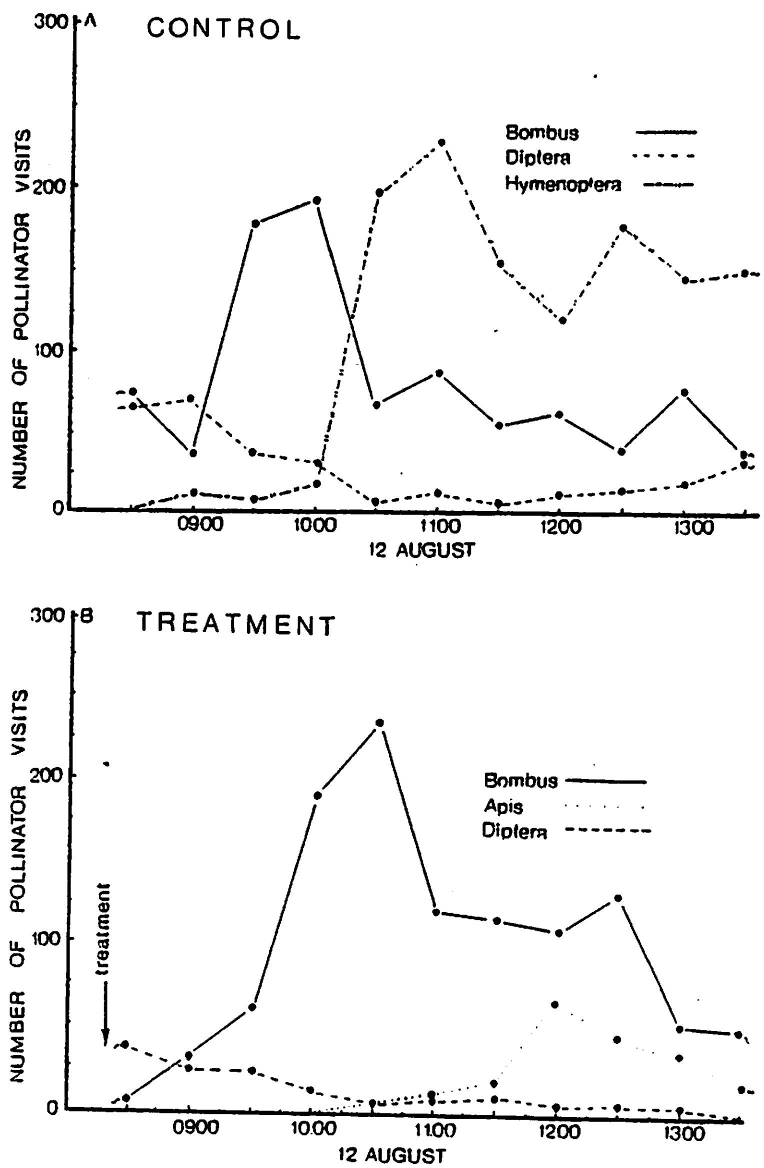

Fig. 12. Activity of various groups of pollinators on the untreated control and MATACIL 1.8F treated plots on the day of treatment, Experiment 3. Searchmont, Ontario, 12 August 1981.

A large number of insects were collected in knockdown buckets set out under fireweed blossom in the treated plot. Total knockdown collected was 81 insects, whereas only one insect, a honeybee, was collected from the ten buckets set out in the untreated area. Knockdown consisted mostly of Diptera (78%) along with much smaller numbers of Hemiptera (9%), Hymenoptera (6%) and Araneida (5%). Over half the Diptera collected were identified as *Fannia sp.* (Muscidae: Fanniinae). One bumble bee was collected in knockdown buckets, and two others were found in a distressed state in the treated area within several hours of treatment. Observations made over several hours of knocked down insects in the buckets suggested that some may have been capable of eventually recovering from their poisoning, as they continued to be active for many hours and showed some degree of recovery towards normal locomotory movements.

Pollinator activity on the study plots the day after treatment (13 August, Fig. 11) did not indicate any differences due to treatment. Considerable fluctuations in activity were apparent, especially on the control plot, but these were most likely due to breezy conditions keeping pollinators from foraging during peak gusts of wind.

Honeybees: A very slight impact to the foraging component of the hive located in the treated area is indicated when compared to the hive in the untreated control. Adult bee mortality was slightly higher at the treated hive and at the same time pollen collection was slightly lower (Table 15). No dead bees were collected from containers located throughout the treated plot, while a single honeybee was found in knockdown containers set out in the untreated plot.

Table 15. Honeybee mortality and pollen collection from MATACIL flowable formulation treated and untreated control plots, Searchmont area, 12-13 August 1981.

	Treated plot			Untreated plot		
	Mortality hive entrance	field	pollen collected (gms)	Mortality hive entrance	field	pollen collected (gms)
12 Aug.	7	0	3.91	3	1	5.62
13 Aug.	13	0	4.50	3	0	19.89

DISCUSSION AND CONCLUSIONS

Aminocarb's high contact toxicity was demonstrated by the immediate knockdown of insects, mostly dipterans, present on experimental plots at the time they were treated with MATACIL 1.8D or 1.8F sprays. The speed and magnitude of knockdown observed reflects the high treatment rate (350 g AI/ha), and are likely to be considerably greater than knockdown effects which would occur at operational application rates (52 to 87 g AI/ha). A direct relationship between knockdown effects and applied dosage has been shown for aerial applications of MATACIL 1.8D (Kingsbury et al. 1981). When a fairly large area was treated with MATACIL 1.8F in the third experiment, knockdown effects were observed on three bumblebees, but the vast majority of bumblebees present in the area when sprayed or foraging in it shortly after treatment appeared unaffected. This suggests that bumblebee mortality due to operational applications of MATACIL 1.8F at conventional dosage rates would be very light, as has been found with MATACIL 1.8D (Plowright and Rodd, 1980).

The effects of MATACIL treatments on overall wild pollinator activity in these experiments were slight. Some short term reductions in activity are suggested after both MATACIL 1.8D and 1.8F treatments, especially among dipterans, but there is little evidence of effects lasting beyond the day of treatment. Effects of MATACIL 1.8F did not appear to be any greater than MATACIL 1.8D. In the final experiment where a fairly large area was treated with MATACIL 1.8F applied in water, there is virtually no suggestion that wild pollinator activity was affected despite the observed knockdown of insects and high level of pollinator activity prior to treatment.

The results of wild pollinator activity studies do demonstrate the important influences of weather patterns, pollen and nectar sources available and competing pollinators present on the activity of particular groups of pollinators. Cold air temperatures, brisk winds and rain all suppressed pollinator activity at various times during these experiments. In the first experiment, differences in effects of aminocarb sprays on diptera and hymenoptera seemed to be related to differences in their choice of blossom foraged on. Diptera mostly utilized ox-eyed daisies for collecting nectar or resting on (Fig. 13). These blossoms present a large, flat, horizontal surface held upright above the surrounding vegetation, and may present highly contaminated surfaces to pollinators utilizing them after an insecticide spray. Hymenoptera foraging activities were directed mainly towards the pollen producing hawkweed and heal-all. Yellow hawkweed bloom closes during the night and the inner surface is well protected from early morning spraying. Upon opening, the bloom presents a largely pesticide-free surface upon which to land or forage. Heal-all, being a rather short plant is very often protected by the foliage of surrounding plants and grasses and the small florets

Fig. 13. Syrphid fly (Diptera:Syrphidae) foraging on an ox-eyed daisy blossom. Searchmont,Ontario. 1981.

may consequently remain relatively pesticide free. The influences of competing groups of pollinators upon one another can be expressed directly through scaring or chasing of individuals away from blossoms, or indirectly through depleting pollen and nectar sources so they are no longer attractive to other pollinators. Although the study of these interactions is beyond the scope of the present study, their influences are apparent in some of the results obtained. Dipteran activity often appeared to decrease as hymenoptera activity increased. The activity of different hymenoptera (bumblebees, honeybees and others) peaked at different times when present together, suggesting they were exerting some influences on the activity of each other.

Honeybee colonies caged within MATACIL 1.8F treated plots suffered higher mortality than control colonies, particularly mortality away from the hive measured in buckets placed in the cage corners. Several factors suggest, however, that these results may not be totally due to the insecticide. The mortality observed was gradual over several days, rather than a sharp peak on the day of application as has normally been found with insecticide induced mortality in honeybee colonies in forest situations (Buckner et al. 1974 and 1975, Buckner and McLeod 1975). When a honeybee colony was placed in the middle of a relatively large MATACIL 1.8F treated area and exposed to the insecticide through normal foraging activities, mortality within the hive was only 10 bees/day, slightly above the control mortality of 3 bees/day. This suggests that much of the mortality of caged hives may be due to caging effects and stresses. Mortality for different caged hives might vary with colony strength, composition (in terms of age class structure of bees) and food reserves as well as being dependent on insecticide treatment.

In conclusion, the experiments carried out do not suggest that MATACIL 1.8F sprays will present any greater hazard to pollinators than MATACIL formulations previously used in Canadian forest insect control programs.

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