REPORT ON AN ECOLOGICAL SURVEY OF TERRESTRIAL INSECT COMMUNITIES IN THE AOSERP STUDY AREA

by

J.K. RYAN

G.J. HILCHIE

McCourt Management Ltd.

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ABSTRACT

Insect communities were sampled in 12 sites representative of major vegetation types in the study area of the Alberta Oil Sands Environmental Research Program (AOSERP).

Insect biomass in 1978 averaged 8.2 $kg \cdot ha^{-2}$ (oven dry weight), ranging from 2.8 kg (jack pine site) to 31.1 kg (fen site). In 1979, average biomass per site was 5.9 $kg \cdot ha^{-2}$, ranging from 0.9 kg (disturbed site) to 20.9 kg (fen). Most insects were soil dwellers as only 1.6 to 8% of biomass was collected on foliage. Diptera larvae dominated soil collections. Ants (Hymenoptera, Formicidae) at most sites contributed heavily to the biomass total. Coleoptera and Lepidoptera were the third and fourth ranked contributors to biomass totals.

Members of 261 insect families were found in the study area, of which 220 were collected in this survey. A collection of butterflies yielded 51 species, making a total 55 species known from the area. Representatives of 80 species of carabid beetles were collected, and the total carabid fauna of the AOSERP vicinity was found to be 139 species.

Insect damage surveys showed great variation in the rates of insect attack on dominant plant species. Dogwood leaves bore the greatest frequency of insect scars (84 to 100%), while aspen leaves had the most leaf area removed (14.7%). Few deciduous tree stems bore damage, but gall and bud damage were common on spruce. Insects caused little crown mortality.

Trophic structure analysis showed that herbivores comprised the largest insect group. Carnivores, which were mostly entomophagous, were over-represented in quantitative samples due to their activity. The saprovore food chain allows protein concentration by microbes which are then consumed by saprovore animals.

ACKNOWLEGEMENTS

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Hugh Philip of the Plant Industry Laboratory, Alberta Agriculture, provided the New Jersey light traps used in the light trap program. Alberta Forestry Service personnel assisted in this study, notably Bob Thomas of Bitumount Tower and Carrie Jessie of Muskeg Tower. Several systematists made determinations of insect genera and species collected in this study, including V.R. Vickery, G.E. Ball, Bruce Heming, C.D. Bird, Steve Ashe, Jim O'Hara, Gary Gibson, and John Spence. We extend our thanks to each of these people.

1. INTRODUCTION

In 1978, the Alberta Oil Sands Environmental Research Program (AOSERP) commissioned this study of the terrestrial insect communities of the AOSERP study area (Figure 1). The purpose was to produce documentation of insect energy resources available to biotic communities in the region, and to evaluate the roles of insects in the food web. Data on insect populations and biomass were required as baseline ecosystem information for future reference.

The biomass of insects in the AOSERP study area was reported to range from 0.28 to 3.11 g oven dry weight at sites of 12 representative habitats (Ryan and Hilchie 1979). These insects comprise the food base for members of 153 species of vertebrates and over 100 families of arthropods, which occur in the study area (Ealey et al. 1979). From a study on Syncrude lease land, Porter and Louiser (1975) concluded that environmental disturbances could lead to population explosions of destructive insects, such as bark beetles, which could seriously affect forests in the study area. While this appears to be unlikely, development of the oil sands may lead to numerous changes in insect populations which should be monitored (Hilchie and Ryan 1980). An outbreak of aspen leaf moth was reported recently in the AOSERP study area (Wong and Melvin 1976).

General studies of the insects of Alberta contain information on species represented in the AOSERP area (Belicek 1976; Bowman 1951; Brooks and Kelton 1967; Carr 1920; Larson 1975; Strickland 1938a, 1938b, 1939, 1946a, 1946b, 1947, 1952, 1953; Whitehouse 1918). Personnel at the Northern Forest Research Centre, Environment Canada, in Edmonton regularly investigate forest insect pests in the study area, and this centre presently houses a collection of aquatic insects from an AOSERP aquatic environment study.

This study is a continuation of a preliminary investigation started in autumn 1978 (Ryan and Hilchie 1979). Sites representative of the dominant habitat types found in the study area were monitored regularly to document activities of their insect inhabitants. All study sites were accessible by road. None was on an area presently under development for oil sands recovery.

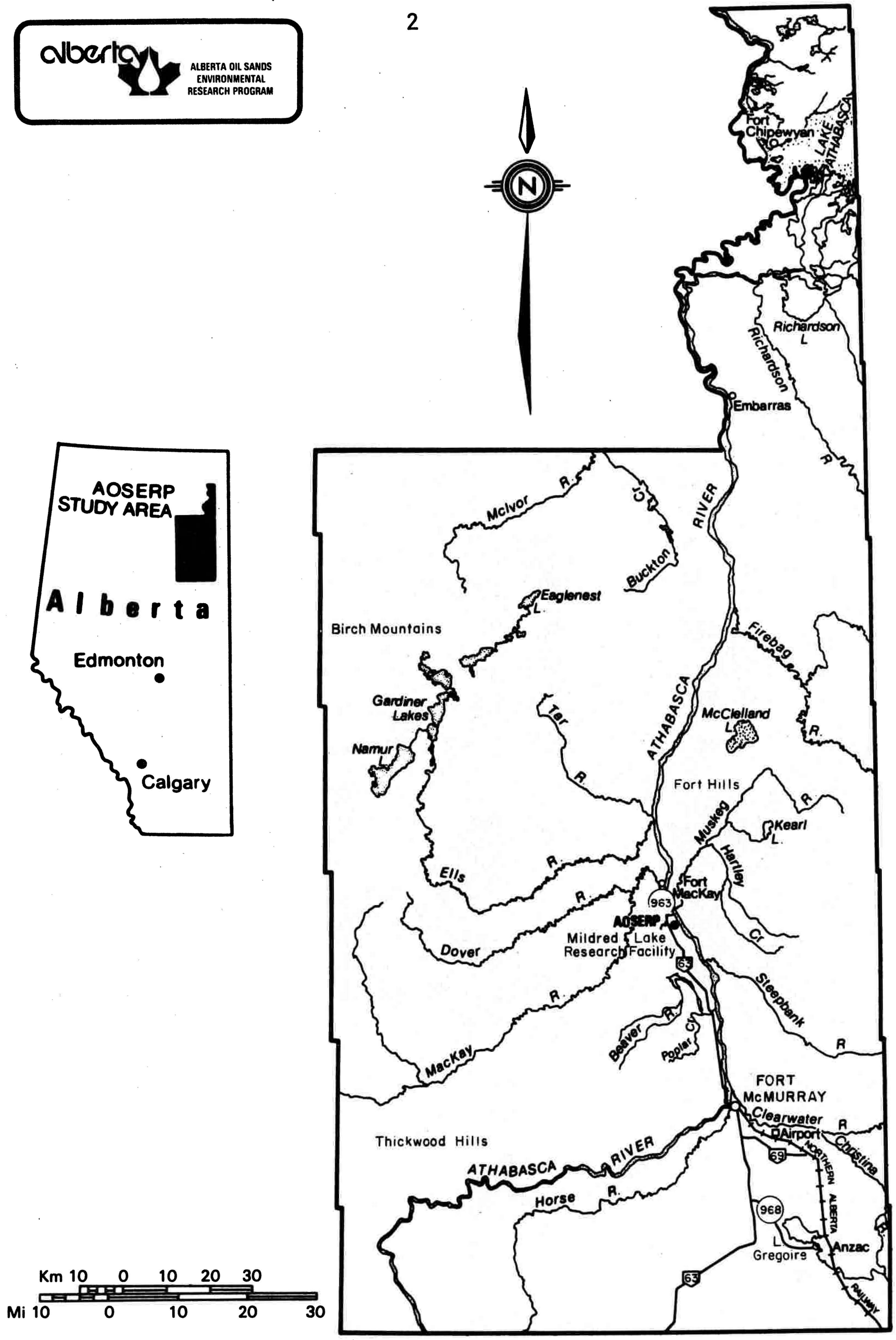

Figure 1. Location of the AOSERP study area.

1.1 OVERALL OBJECTIVES

The general objective of this study was to document the relative abundance of insect families that are present within the biotic communities of the AOSERP study area and to allow an evaluation of the roles of insects in the food web. This knowledge will be useful in the construction of a general ecological model of the AOSERP study area and in predicting the ultimate impact of the loss of any specific habitat type and/or insect group due to industrial activities.

The basic questions to be answered by this study were: what insects occur in each of the biotic communities, where they are located within the community, and what is their role within the community.

1.2 SPECIFIC OBJECTIVES

In order to meet the overall objectives, the following specific objectives were set:

1. To describe the taxonomic composition, seasonal occurrence, and relative productivity of insect fauna in plant and soil-litter communities of the AOSERP study area;
2. To describe the relative proportions of taxonomic groups with herbivorous, entomophagous, and other food habits;
3. To describe how insect communities (different trophic groups) express such characteristics as community organization and association; and
4. To determine if there are any unique areas (habitats) or insect groups with special biological characteristics that are detrimental or beneficial to the terrestrial ecosystem.

2. MATERIALS AND METHODS

2.1 SAMPLE SITES

Fourteen main habitat types occur in the AOSERP study area (Thompson et al. 1978). Representatives of 12 of these habitat types were located along the Fort MacKay Road (Hwy 963) and the Thickwood Hills Alberta Forestry Service (AFS) fire lookout road, and selected for study. Both areas were within the AOSERP study area boundaries, but beyond construction activities of Suncor (formerly Great Canadian Oil Sands) and Syncrude Canada Ltd. (Syncrude).

The locations of these study sites are shown by site number in Figures 2 and 3. These sites, in Thompson et al. (1978) terminology, are: (1) Riparian Forest, (2) White Spruce-Aspen Forest, Coniferous, (3) Aspen Forest, (4) Black Spruce Bog, (5) Mixed Coniferous Forest, (6) Mixed Forest, (7) Non-vegetated (here a roadfill scrape area), (8) Jack Pine Forest, (9) Semi-open Tamarack Bog, (10) Fen, (11) Lightly Forested Tamarack, and (12) Deciduous-shrub Wetland. The White Spruce-Aspen Forest, Coniferous (2) site along MacKay Road in 1978 was replaced by a larger site along Thickwood Hills Road in 1979. The Non-vegetated site was progressively invaded by plants and is more accurately described as a disturbed area. The vegetation of these sites is described briefly in Section 3.5 of this report. Two habitat types which were not accessible by road, and hence not included in this study, include a recent burn site and an upland open community.

2.2 INSECT SAMPLING

Insects occupy a diverse array of microhabitats and, consequently, their populations must be sampled by different methods. Numerous techniques have been used to sample insects (cf. Southwood 1971). The methods described below were chosen for their suitability to the objectives of this study, and for their comparatively high collection efficiency for a broad range of insect taxa. In 1978, samples were collected from 18 August to 30 September. In 1979, the sample sites were first inspected on 8 May, when the ground was still

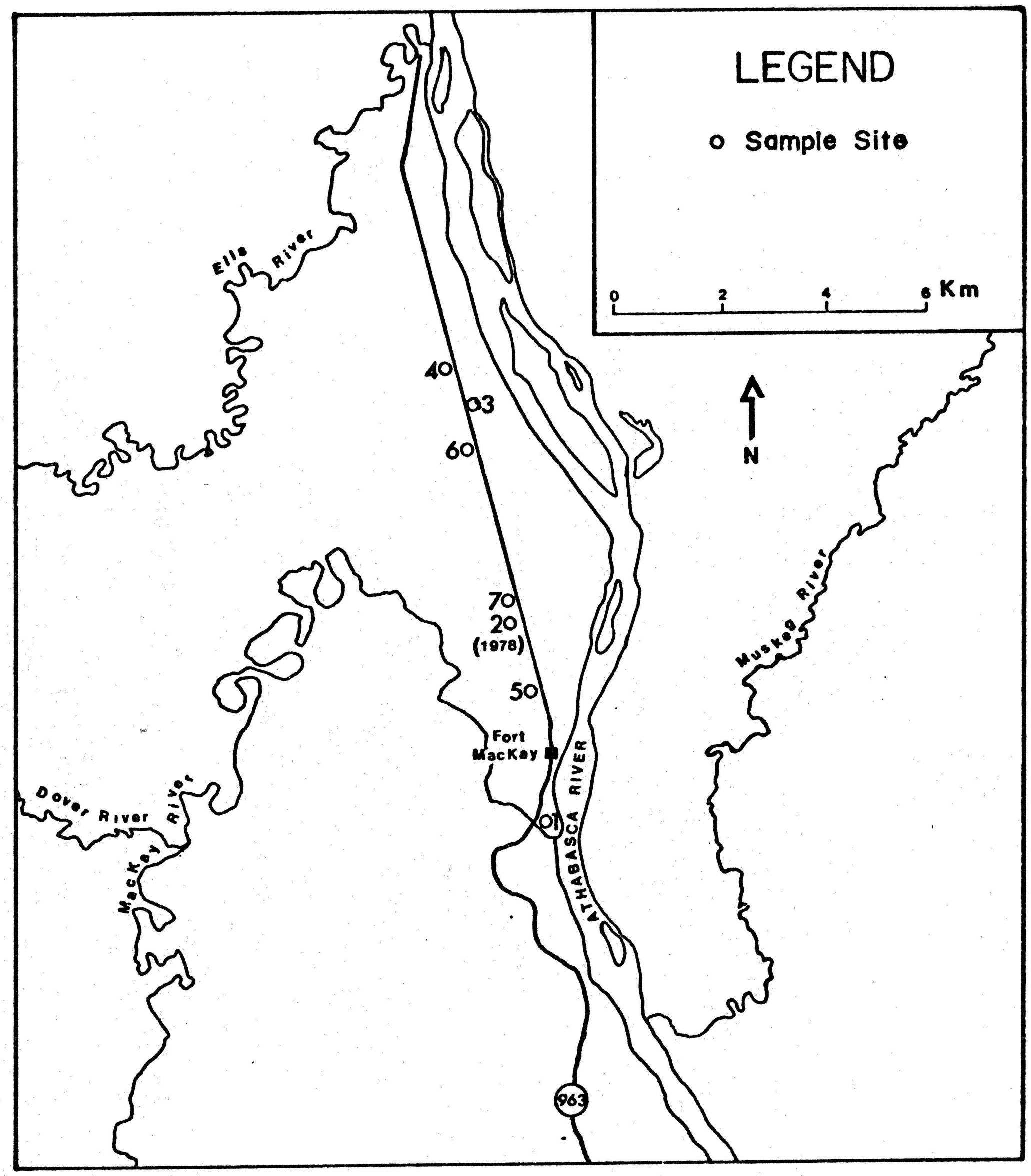

Figure 2. Location of study Sites 1 to 7, including old Site 2 (1978).

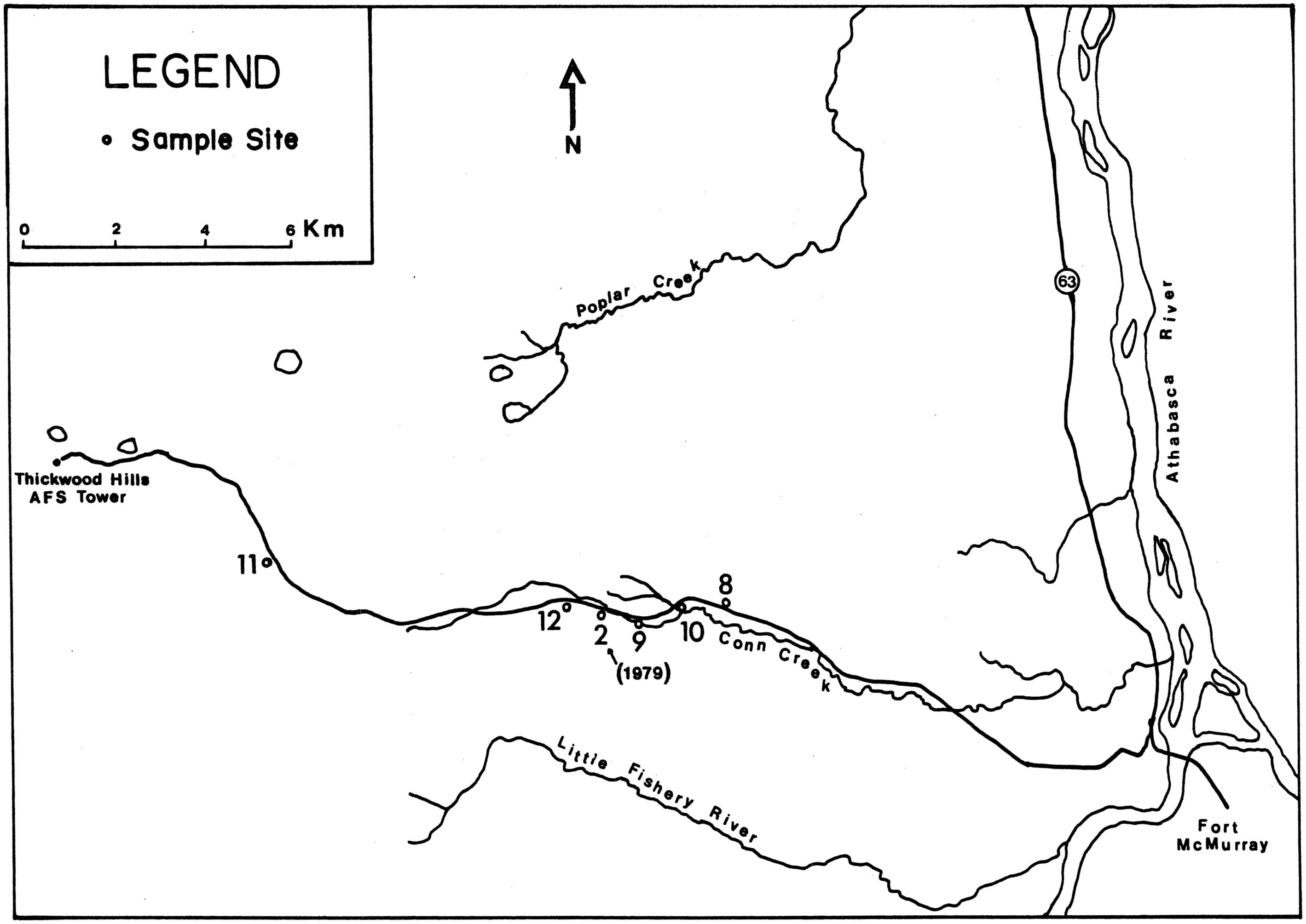

Figure 3. Location of Study Sites 8 to 12 and new Site 2 (1979).

partially snow-covered and the riparian site was flooded, and the last insects were collected on 28 September.

2.2.1 Tullgren Funnels

A bank of Tullgren funnels, shown in Figure 4, was built for this study. Each funnel was a sheet metal cone, with a top diameter of 30.5 cm and exit diameter less than 1 cm. Soil cores to be extracted were put inverted or horizontal on a piece of paper the size of the sample, then placed on the uppermost of two 1/8 in. mesh circular wire screens. An unvented shield with a 25 W light bulb tightly covered the funnel. A sample vial placed below collected the extracted invertebrates. Soil cores were extracted with heat for 72 h, or until completely dry.

Six soil cores were collected for each Tullgren and O'Connor funnel sample. A 15 m knotted cord was stretched in each habitat and a core was taken at each knot using a tapered bulb planting tool. Each core (5.1 cm x 6.3 cm diameter) was placed in a plastic bag and, with few exceptions, was in an extraction funnel within 6 h. Cores were taken of the top 5 cm of soil and comparative depth cores were taken to 10 and 15 cm. The 1978 sample dates for each habitat are given in Table 26 (see Appendix 7). Samples were collected at biweekly intervals in 1979 throughout the summer.

Adult flies, moths, and beetles belonging to the families Lathridiidae, Cryptophagidae, and Leptodiridae were not counted and sorted from the 1979 samples.

2.2.2 O'Connor Funnels

Two stands, containing 45 total O'Connor funnels, were built for this study. These are illustrated in Figure 5. The funnels were constructed and cores extracted in 2.5 cm units, as described by O'Connor (1962). Extraction times were doubled for all 12 Variac settings, so that a complete extraction required 6 h. This modification was made to allow insect larvae longer time to escape the soil core than O'Connor allowed for enchytraeid worms.

Figure 4. Set of 45 Tullgren funnels used at Mildred Lake Research Facility to extract soil insects.

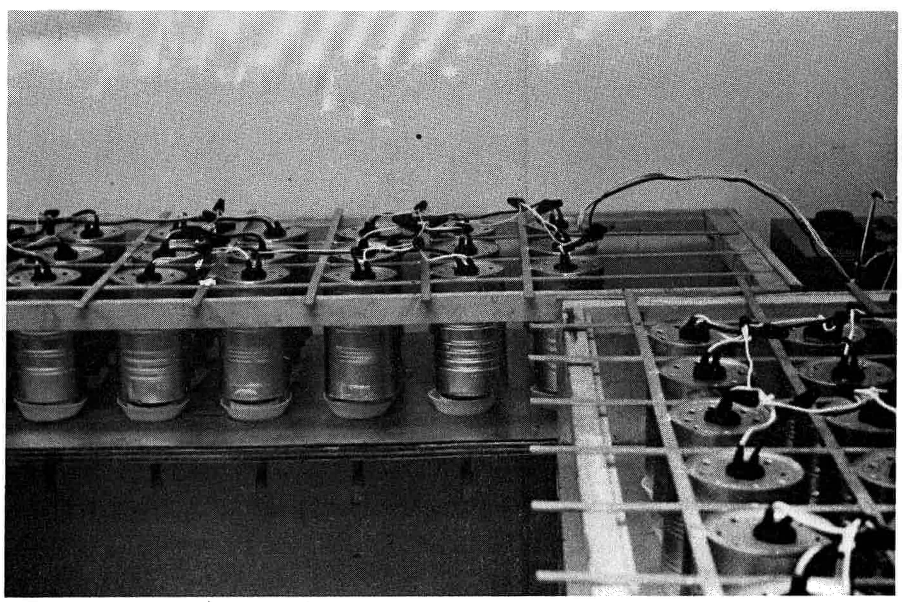

Figure 5. O'Connor funnel system used at Mildred Lake to extract soil insects in water with stepped heating from 60 W light bulbs.

2.2.3 Pyrethrum Spray

Foliage inhabiting arthropods can be collected with a pyrethrum spray system (Martin 1966). Using this method, the authors sampled with an oil-based 0.332% pyrethrum plus 1.66% piperonyl butoxide solution. The last series of 1978 samples utilized a water-based product diluted to the same strength. These knock-down chemicals were applied with a hand pump sprayer on randomly chosen trees and bushes at each sample site, except the disturbed and fen sites which could not be sampled by this technique. The foliage was shaken, and stunned insects and spiders fell onto 0.5, 0.75, and 1 m^2 sheets spread beneath the sprayed area. This procedure is illustrated in Figure 6. Collected arthropods were preserved in alcohol in 1978 and stored frozen in 1979. Foliage was sampled twice in 1978 and four times at monthly intervals in 1979.

2.2.4 Sweep Net Sampling

Sweep net samples were collected at head height and ground vegetation levels from each site, except at the fen and disturbed sites where only low vegetation samples could be taken. A single sample consisted of twenty-five 180^o net sweeps, with a 30.5 cm diameter net, while walking through undisturbed vegetation. Arthropods thus collected were stunned with ethyl acetate, then transferred to alcohol preservative in 1978. In 1979 specimens were stored frozen.

The biomass of insects netted in 1979 was separated into trophic groups. These categories include members of the following taxa: Herbivores--Homoptera, Plecoptera, Ephemeroptera, Lepidoptera, Miridae, male Culicidae, Chloropidae, Dixidae, Elateridae, Curculiondae, and Cynipidae; Saprovores--Collembola, Helodidae, Lathridiidae, Anthomyiidae, Chironomidae, Heleomyzidae, Lonchaeidae, Muscidae, Phoridae, Sciaridae, and Tipulidae; Carnivores--Neuroptera, Anthocoridae, Nabidae, Ceratopogonidae, female Culicidae, Empididae, Coccinellidae, and most aculeate Hymenoptera; Omnivores--Thysanoptera, Psocoptera, and Formicidae.

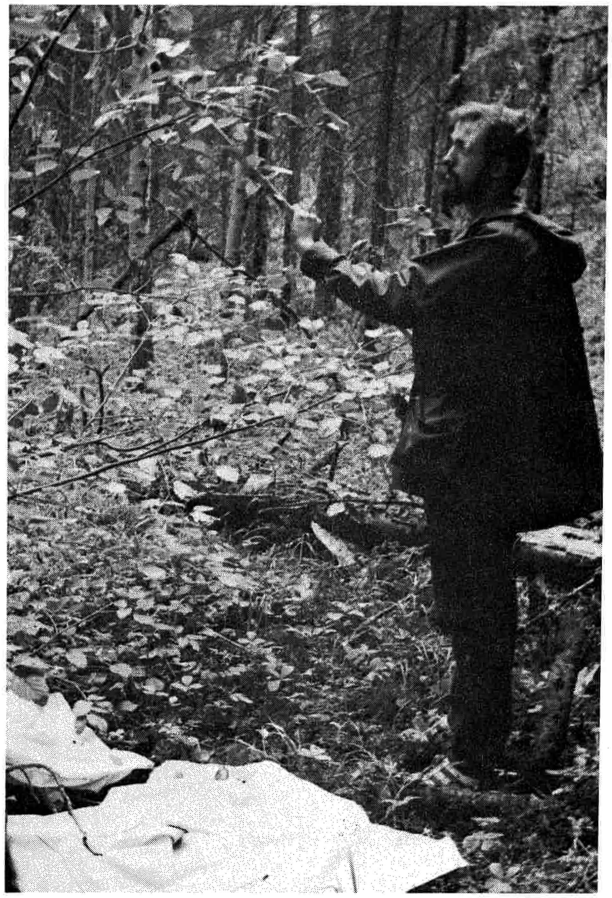

Figure 6. Pyrethrum spray technique showing insects being shaken by Gerry Hilchie from sprayed alder onto a 1 m^2 sheet funnel.

2.2.5 Pitfall Traps

Pitfall traps were made from 20 cm x 20 cm x 5 cm plastic freezer boxes. Tops were cut and moulded to make eight sloped entries. Caulking was used to taper the edges of the tops for easier insect access. Four traps were buried with tops flush to ground surface at each site. These were filled with a 2% formalin solution plus several drops of liquid detergent. One such trap is shown in Figure 7. Collected arthropods were removed at approximately 10 d intervals.

2.2.6 Malaise Trap

A white gauze Malaise trap was operated at the AOSERP Mildred Lake Research Facility. Insects collected in the trap were removed daily, while authors were at the site, and mounted or preserved for later identification. In 1979, the daily catch of biting flies was recorded.

2.2.7 Light Traps

In 1978, two modified New Jersey AC light traps (Figure 8) and one specially designed, modified Robinson DC light trap (Figure 9) were used to collect night flying insects. All traps contained a 15 W fluorescent ultraviolet light source. The trap at Mildred Lake operated nightly from 19 August to 30 September, while the other two traps were operated sporadically.

In 1979, seven additional modified Robinson traps were added to the sampling program. The trap at Mildred Lake operated nightly from 9 May to 28 September. The remaining nine traps were set up at the following Alberta Forestry Service towers: Thickwood Hills, Stoney Mountain, Algar, Bitumount, Birch Mountain, Legend, Ells, Muskeg, and Richardson. A letter of introduction was sent to each tower operator prior to contact and, on contact, the traps were wired and hung and vials, preservative, labels, and a letter of instruction were given to each operator.

Figure 7. One of 48 modified plastic pitfall traps used to collect ground dwelling insects. This one, at the spruce bog site, was flooded under 5 cm of water following early September rains, 1978.

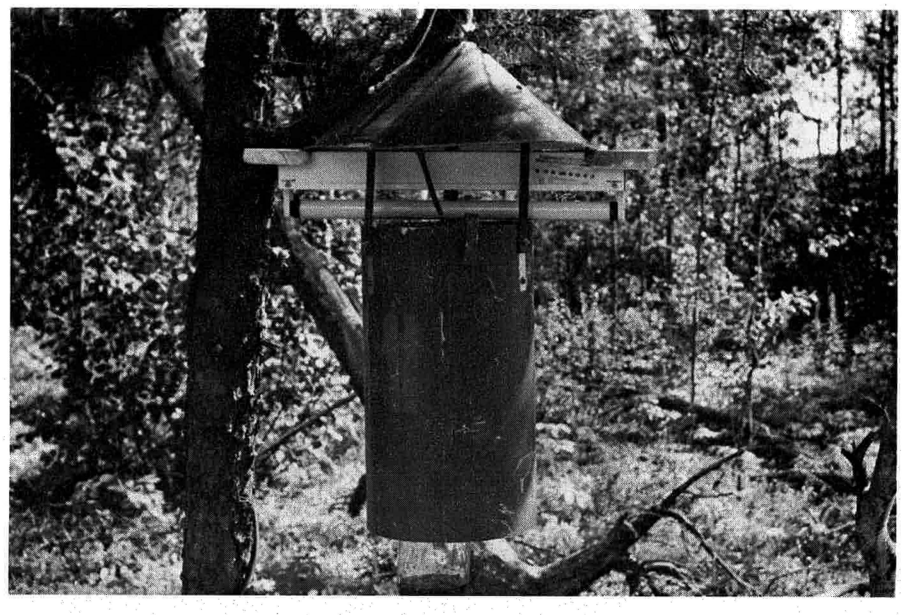

Figure 8. New Jersey light trap for crepuscular and nocturnal insects.

Figure 9. Modified Robinson battery-powered light trap designed and built for AOSERP insect sampling.

2.2.8 Leaf Damage Survey

Leaves of 10 dominant shrub and tree species were inspected for insect damage and attached insects. Each sample in 1978 consisted of 250 leaves collected randomly, with not more than five leaves from any one stem nor more than 10 from a single plant. In 1979, 150 leaves were similarly collected from plants of the same species at the same sites. For black spruce, 500 needles were examined. All samples were collected in early September by which time leaf growth had ceased. These were inspected in the laboratory for insect galls, mines, feeding scars, and attached insects such as scales. Causative agents of galls and damage were determined through keys and information in Wong et al. (1977) and Johnson and Lyon (1976).

2.2.9 Stem Damage Survey

The terminal 25 cm of branches of 10 dominant shrub and tree species were examined for insect inhabitants and damage from 25 to 30 September 1978. Two twigs of branches were chosen randomly on each plant, the terminal 25 cm measured with a piece of wire, and then inspected for insects and insect damage. Each sample consisted of 100 stem examinations.

In 1979, terminal 25 cm of branches of black spruce (*Picea mariana*), white spruce (*Picea glauca*), and jack pine (*Pinus banksiana*) were clipped and brought to the laboratory. Sets of 100 stems were inspected for arthropod damage and inhabitants. All signs of insect damage, as well as ages of needles on each stem, were recorded.

2.2.10 Crown Damage Survey

Crowns of black and white spruce, jack pine, and poplar trees were inspected with 7.5X binoculars, or by direct sight, to assess bark beetle attack and infestation rates. Sets of 100 trees were examined and categorized as to tree height, crown condition, insect damage symptoms, and crown mortality.

2.2.11 Emergence Traps

Six pyramid shaped traps were used to collect winged insects emerging from 1 m^2 plots of ground. These traps had nylon screen sides, a polyethelene skirt buried in the ground, a tubular conduit frame, and a funnel collecting mechanism at the top. Trapped insects were removed at approximately weekly intervals, at which time spiders and uncollected insects were collected with a battery-powered vacuum cleaner. Two traps were placed in aspen forest, mixed conifer forest, and black spruce forest sites within 2 km of the Mildred Lake camp. This project was undertaken at McCourt Management initiative and expense.

2.2.12 Subsequent Laboratory Procedures

Samples brought to the laboratory were sorted to insect family and counted. They were oven dried at 60°C for 72 h, or until dry, and then weighed on a Sartorius or Metler balance accurate to 0.1 mg.

Weight loss from leaching of insect body fluids into alcohol was estimated. Alcohol, in which the 1978 light trap samples were stored, was saved, filtered to remove debris, oven dried, and weighed. This residue weight was then compared to the total mass of insects originally preserved in that alcohol.

3. RESULTS

The data collected in this study are organized into five sections: (1) insect populations and biomass; (2) insect damage surveys; (3) biomonitoring data; (4) insect taxa found; and (5) a description of the insect fauna of the study sites.

3.1 INSECT POPULATIONS AND BIOMASS

3.1.1 Funnel Extractions

Results of the Tullgren and O'Connor funnel extractions are given, in Tables 27 to 62 of Appendix 7, as the average standing crop and biomass per square metre for all insect families extracted and, additionally, as population numbers for spiders, mites, ticks, pseudoscorpions, millipedes, snails, and enchytraeid worms. Where members of a family were extracted by both techniques, the greater population is reported (i.e., some Collembola were recovered in O'Connor funnels and some fly larvae in Tullgren funnels, but greater numbers were obtained from the other funnels for each group). The life stage--immature or adult-- is noted for endopterygote insects. Fly larvae listed as belonging to the family Anthomyiidae in 1978 results were later determined to be largely members of the family Cecidomyiidae (G.C.D. Griffiths, discussion September 1980, Dept. Entomology, Univ. Alberta). Peterson's (1960) text does not adequately distinguish between larvae of these two families. Consequently, determinations of members of the family Anthomyiidae are designated to be uncertain in the 1978 data.

Vertical distributions of invertebrates in the top 7.5 cm of soil are given in Table 1. This 1978 information was obtained from O'Connor funnels only. It is given for seven abundant taxa which are shown to be heavily concentrated in the top 2.5 cm of soil.

Variation in the distribution of larvae of four Dipteran families from Sites 1, 6, and 12 is shown by data in Table 2. In 26 of 84 extractions, no larvae were found, and in 28 extractions, the population mean exceeded twice the standard error of the mean. Thus, these insects have clumped, not random, distributions. Standard errors calculated for populations from the other 1978 sites showed

Table 1. Vertical distribution of invertebrates in the top 7.5 cm of soil, from O'Connor funnel data in 1978.

	SITE	Enchytraeidae	DIPTERA:					ACARINA
			Ceratopogonidae	Chironomidae	Fungivoridae	Empididae	Anthomyiidae	
% of top 5.0 cm population found in top 2.5 cm	1	64	100	50	92	83	77	72
% of top 7.5 cm population found in top 5.0 cm		84	50	67	100	100	79	100
% top 5.0 cm in top 2.5 cm	2	89	100	71	97		73	74
% top 7.5 cm in top 5.0 cm		100	100	92	100		94	100
% top 5.0 cm in top 2.5 cm	3							
% top 7.5 cm in top 5.0 cm		88		100	100	100	100	100
% top 7.5 cm in top 5.0 cm	4	73		84	56		100	57
% top 7.5 cm in top 5.0 cm		83		100	90		100	55
% top 5.0 cm in top 2.5 cm	5	89		a	58		69	81
% top 7.5 cm in top 5.0 cm		60		58	100		83	88
% top 5.0 cm in top 2.5 cm	6	90		100	100		100	
% top 5.0 cm in top 2.5 cm	7	33		75				
% top 7.5 cm in top 5.0 cm		78						
% top 5.0 cm in top 2.5 cm	8	91		100	100		71	95
% top 7.5 cm in top 5.0 cm		85		100	100		81	98
% top 5.0 cm in top 2.5 cm	9	90	33	82	100	100	50	96
% top 5.0 cm in top 2.5 cm	10	88	66	92	94		100	85
% top 5.0 cm in top 2.5 cm	11	36	38	57	33	100	-[a]	90
% top 7.5 cm in top 5.0 cm		72		55	100		-	53
% top 5.0 cm in top 2.5 cm	12	87	71	79	58			56
% top 7.5 cm in top 5.0 cm		85	70	84	92		-	81
mean % of top 5.0 cm populations found in top 2.5 cm		70	77	72	73	92	73	78
mean % of top 7.5 cm populations found in top 5.0 cm		83	64	83	95	100	87	86

[a]Upper subsample contained no specimens and lower sample did.

Table 2. Variation in the distribution of larvae of four Diptera families in O'Connor funnel samples from three sites in 1978. Results are expressed as sample means (of 6 cores) ± 2 standard errors of the mean.

Site	Date	Depth cm	Ceratopogonidae	Chironomidae	Fungivoridae	Anthomyiidae[a]
1	19 Aug.	0 - 2.5	0.17 ± 0.14	0.67 ± 0.67	1.67 ± 1.0	0.5 ± 1.0
	24 Aug.	0 - 2.5	0.17 ± 0.14	1.0 ± 0.73	1.17 ± 1.5	2.5 ± 1.5
		2.5 - 5.0	0.17 ± 0.14	0.5 ± 0.45	0	0.67 ± 0.67
	5 Sept.	- 1.25	1.83 ± 2.9	0.67 ± 0.99	0.83 ± 0.61	4.17 ± 2.7
		1.25- 2.5	0	0.5 ± 0.45	0.17 ± 0.14	0.33 ± 0.42
	25 Sept.	- 1.25	0	0	0	1.83 ± 1.1
		1.25- 2.5	0	0.17 ± 0.14		1.5 ± 2.2
6	19 Aug.	0 - 2.5	0	0	1.33 ± 1.9	0.33 ± 0.42
	31 Aug.	0 - 2.5	0	0.67 ± 0.99	1.17 ± 0.96	0.5 ± 0.45
		2.5 - 5.0	0	0	0	0
	23 Sept.	0 - 2.5	0	1.17 ± 1.6	0.33 ± 0.42	0.17 ± 0.14
12	23 Aug.	0 - 2.5	2.33 ± 2.5	4.33 ± 2.0	1.5 ± 1.2	0
	4 Sept.	0 - 1.25	1.17 ± 0.96	1.83 ± 2.1	0.17 ± 0.14	0
		1.25- 2.5	0.33 ± 0.42	1.0 ± 0.5	0.5 ± 0.45	0
		2.5 - 3.75	0.67 ± 0.99	0.67 ± 0.67	0	0.17 ± 0.14
		3.75- 5.0	0.5 ± 0.69	0.5 ± 0.69	0	0.17 ± 0.14
	24 Sept.		1.0 ± 2.0	4.83 ± 2.75	0	1.17 ± 0.96
	28 Sept.	0 - 1.25	2.17 ± 2.1	6.83 ± 6.4	1.0 ± 1.6	0
		1.25- 2.5	1.0 ± 1.0	1.0 ± 1.0	0.33 ± 0.42	0
		2.5 - 3.75	0.67 ± 0.67	0.67 ± 0.67	0	0
		3.75- 5.0	0.17 ± 0.14	0.17 ± 0.14	0.17 ± 0.14	0

[a]Uncertainty

similar trends. Clumped distributions cannot be analyzed by parametric statistical methods. They require that large numbers of samples must be taken to stabilize the population means.

3.1.2 Foliage Insects

The pyrethrum sample results are given in Tables 63 to 82 of Appendix 7. These data provide estimates for the above-ground standing crops of insects (by family) and spiders. Population biomass is given by order and in brackets for dominant families within the order. Less abundant taxa biomass is shown under miscellaneous insects. One functional distinction should be recognized in the taxa collected. Some insects, like members of the Hemiptera and Homoptera, are foliage inhabitants throughout their lives. Others, like most of the Diptera, are transitory adults whose immature stages did not inhabit foliage.

3.1.3 Standing Crops

Insect and spider standing crops at the 12 sample sites in 1978 are summarized as seasonal averages in Tables 3 and 5, and for 1979 in Tables 4 and 6. These data are combined from Tables 27 to 82 of Appendix 7 and increased by a factor of 1.16 (see Section 3.1.7). In 1978, the fen (Site 10) had the greatest number of insects per square metre (31 627) with a biomass of 3.11 g (oven dry weight), even though these figures were determined solely from soil extractions as the sedge vegetation was too low and dense for pyrethrum spray sampling. The non-vegetated/disturbed area (Site 7) had the smallest insect population, 463 individuals$\cdot m^{-2}$, but had the second largest biomass due to the extraction of a large moth in the Tullgren funnels. The average insect population per site was 5104 individuals weighing 0.84 $g\cdot m^{-2}$. Standing crop numbers were overwhelmingly (92% of total) dominated by the soil inhabitants, but individuals found above ground were heavier and totaled 4 to 33% of the soil insect biomass. Spider populations from the soil cores are surface and immediately above-surface vegetation dwellers. Their populations tended to be greater than the foliage spider populations, but the foliage spider biomass frequently

Table 3. Summary of standing crop populations per square metre of insects and spiders at AOSERP study sites in 1978.

	Individuals·m⁻²											
	1	2	3	4	5	6	7	8	9	10	11	12
INSECTA	3 134	3 556	3 990	2 213	2 891	1 549	463	1 157	4 212	31 637	2 337	4 103
soil	3 111	3 540	3 986	2 208	2 865	1 542	463	1 146	4 201	31 637	2 311	4 074
foliage	23	16	4	5	26	7		11	11		26	29
COLLEMBOLA	761	184	658	297	318	351	0	229	106	211	264	509
soil	761	184	658	297	317	351	0	228	106	211	264	508
foliage	+[b]	+	0	+	1	+		1	+		+	1
PSOCOPTERA	8	32	26	2	14	19	0	0	1	0	1	2
soil	0	26	26	0	0	18	0	0	0	0	0	0
foliage	8	6	+	2	14	1		+	1		1	2
HEMIPTERA	22	31	67	70	39	37	13	267	92	53	71	19
soil	13	26	66	70	35	35	13	264	88	53	53	0
foliage	9	5	1	+	4	2		3	4		18	19
(Aphididae)	5	4	1	0	2	1		1	2		15	12
COLEOPTERA	73	92	395	105	105	175	93	108	288	105	459	265
soil	72	92	395	105	105	174	93	105	286	105	457	263
foliage	1	+	+	+	+	1		3	2		2	2
LEPIDOPTERA	1	66	93	176	1	35	40	0	35	18	37	53
soil	0	66	93	176	0	35	40	0	35	18	35	53
foliage	1	+	+	+	1	+		+	+		2	+
DIPTERA	2 217	3 055	2 502	1 392	2 184	878	251	500	3 653	29 583	1 416	3 060
soil	2 213	3 053	2 500	1 390	2 179	879	251	496	3 650	29 583	1 414	3 057
foliage	4	2	2	2	5	2		4	3		2	3
HYMENOPTERA	27	81	248	153	161	35	53	36	18	1 667	72	150
soil	26	80	248	159	35	53	35	35	18	1 667	70	158
(Formicidae)	0	40	105	117	88	18	0	18	0	1 649	53	140
foliage	1	1	+	1	2	+		1	+		2	1
(Formicidae)	0	0	0	0	0	+		0	0		+	+
(Tenthredinidae)	+	+		0	0	+		0	+		1	+
miscellaneous insects												
soil	26	13	0	13	70	18	13	18	18	0	18	35
foliage	+	+	+	0	+	+		+	+		+	+
ARANEDIA												
soil	53	158	105	176	105	70	79	88	184	70	298	281
foliage	9	7	2	4	13	6		4	5		7	4

[a] rounding off to nearest integers may cause slight discrepancies with data in Tables 22 to 82.

[b] less than 0.5

Table 4. Average standing crop populations per square metre of insects and spiders at AOSERP study sites in 1979.

	Individuals·m^{-2}											
	1	2	3	4	5	6	7	8	9	10	11	12
INSECTA												
soil	3 201.6	6 884.0	3 290.2	2 799.4	3 664.3	1 984.7	379.7	1 505.6	3 237.9	26 542.0	4 179.8	5 506.8
foliage	13.75	8.48	7.83	2.13	5.73	10.20	-	9.90	11.43	-	6.30	25.45
COLLEMBOLA												
soil	2 000.2	4 847.5	1 805.6	1 502.2	1 316.2	1 052.9	131.6	911.6	1 005.4	3 383.2	847.0	1 854.8
foliage	0.13							0.05			0.03	
PSOCOPTERA												
soil		21.1	42.2	5.3	5.3	37.0	5.3	10.6		10.05	10.5	
foliage	0.90	0.40	0.93	0.13	1.20	0.28	-	0.15	0.13	-	0.10	0.15
HEMIPTERA (*sensu latu*)												
soil	47.6	342.2	189.6	137.0	131.7	121.3	26.4	100.2	142.3	69.8	563.4	319.1
foliage	5.18	2.73	1.58	0.80	1.20	4.75	-	2.30	5.45	-	2.13	22.28
COLEOPTERA												
soil	95.0	279.5	210.8	72.8	163.3	79.3	58.2	100.4	126.6	134.7	194.1	215.1
foliage	0.60	0.53	0.75		0.58	0.83	-	0.50	2.15	-	0.85	0.60
NEUROPTERA												
soil												
foliage	0.05	0.23	0.08	0.15		-	0.10	0.03	-	0.10		
LEPIDOPTERA												
soil	10.5	5.3	5.3	11.6	15.8		10.6	15.9	10.6		10.5	15.9
foliage	5.08	0.28	0.33	0.03	0.10	0.25	-	0.15	0.15	-	0.10	0.13
DIPTERA												
soil	985.1	1 114.3	637.5	759.3	1 489.6	508.6	31.6	271.9	1 642.5	14 339.0	2 095.2	2 953.1
foliage	5.70	2.40	2.75	1.00	1.83	2.98	-	5.25	2.48	-	1.83	1.38
HYMENOPTERA												
soil	58.0	63.5	399.9	316.4	442.3	147.6	79.1	42.2	310.5	8 553.5	442.3	68.8
foliage	6.25	1.90	1.90	0.20	0.78	1.03	-	1.35	1.03	-	1.15	0.73
Formicidae												
soil		21.1	289.5	279.0	405.3	39.7	57.9	15.9	294.6	8 548.2	421.1	15.8
foliage		0.05	0.05		0.10	0.33	-	0.30	0.15	-	0.23	0.18
Tenthredinidae												
soil					21.1							
foliage	0.25	0.18	0.03		0.08	0.05	-		0.35	-	0.05	0.10
ARANEIDA												
soil	52.7	516.0	305.2	203.2	225.3	284.3		274.3	342.2	163.3	284.1	401.1
foliage	2.88	4.88	2.70	1.53	3.87	3.85	-	5.65	4.03	-	4.63	1.25
ACARINA												
soil	7 000	13 500	7 700	10 400	12 100	5 900	158	19 700	7 000	3 400	11 600	8 800
PSEUDO-SCORPIONIDA												
soil	68.4			26.4	2.6				10.5		36.9	11.6
DIPLOPODA												
soil	5.3	10.6	5.3					10.6				

[a] All values are summarized from Tables 27 to 82, including totals. Inconsistencies created in summarizing may make the apparent total insect population differ slightly from the actual total.

Table 5. Summary of standing crop biomass per square metre of insects and spiders at AOSERP study sites in 1978.

	Biomass·m^2											
	1	2	3	4	5	6	7	8	9	10	11	12
INSECTA	391[a]	689	777	498	408	405	1 166	281	460	3 113	1 012	668
soil	324	576	751	479	325	330	1 166	231	416	3 113	862	505
foliage	67	113	26	19	83	75		50	44		150	163
COLLEMBOLA												
soil	17	5	20	6	6	14	0	22	6	14	4	2
PSOCOPTERA												
foliage	4	2	0	2	17	3		1	1		2	5
HEMIPTERA					31				29			76
soil	+				22				16			0
foliage	24	79	12	2	9	13		6	13		53	76
(Aphididae)	5	3				2		2	3		35	15
COLEOPTERA	60	58	358	56	59	103	200	56	124	37	262	149
soil	51	56	356	49	55	98	200	45	103	37	254	100
foliage	9	2	2	7	4	5		11	21		8	49
LEPIDOPTERA	17	236	94	114	7	63	891	7	15		54	29
soil	0	226	92	112	0	57	891	0	14		8	22
foliage	17	10	2	2	7	6		7	1		46	7
DIPTERA	253	225	170	148	159	140	72	113	248	588	139	204
soil	247	217	163	143	122	118	72	95	246	588	134	194
foliage	6	8	7	5	37	22		18	2		5	10
HYMENOPTERA		69	105	131	116							207
soil		58	104	130	112							193
(Formicidae)	0	35	82	119	85		0		0	2 445	450	171
foliage	6	11	1	1	4	23		2	3		36	14
(Formicidae)	0	0	0	0	0	3		0	0		2	7
(Tenthredinidae)	2	10	0	0	0	10		0	2		3	4
miscellaneous insects												
soil	9	14	17	39	8	43	3	69	31	29	12	4
foliage	1	1	2	0	5	3		5	3		0	2
ARANEIDA	176	87	32	30	96	199	47	55	243	35	99	201
soil	122	44	5	9	33	126	47	26	213	35	55	177
foliage	54	43	27	21	63	73		29	30		44	24

[a] Biomass totals may differ slightly from data in Table 12 to 32 (times 1.16) due to rounding off subtotals here to nearest integer

[b] Entry signifies presence, with biomass included under miscellaneous insects.

Table 6. Average standing crop biomass per squate metre of insects and spiders at AOSERP study sites in 1979.

	Biomass·m^{-2}											
	1	2	3	4	5	6	7	8	9	10	11	12
INSECTA												
soil	165.9	378.2	465.2	467.5	944.2	185.6	85.8	378.2	491.8	2 085.7	595.1	743.6
foliage	13.25	8.03	8.67	0.69	4.18	13.01	-[c]	9.17	11.97	-	6.69	18.10
COLLEMBOLA												
soil	15.0	10.4	18.6	9.3	13.9	12.8	1.2	4.6	9.3	41.8	9.3	9.3
foliage							-			-		
PSOCOPTERA												
soil												
foliage	0.39	(0.08)[b]	0.18	0.01	0.046	0.08	-	0.04	0.09	-	0.05	0.06
HEMIPTERA (*sensu latu*)												
soil												
foliage	2.13	2.52	1.89	0.39	0.48	4.65	-	(0.50)	3.07	-	0.93	11.72
COLEOPTERA												
soil	58.0	243.6	128.8	61.5	161.2	30.0	22.0	60.3	117.2	52.2	106.7	361.9
foliage	1.43	1.94	1.57		0.93	1.92	-	1.32	3.98	-	2.69	2.53
NEUROPTERA												
soil												
foliage	0.11	0.19	0.15		0.14		-	0.16	0.02	-	0.09	
LEPIDOPTERA												
soil	4.6	4.6	8.1	3.5	7.0		2.3	2.3	4.6		4.6	3.5
foliage	5.51	0.89	2.72	+[d]	0.42	2.39	-	2.41	0.22	-	0.59	0.19
DIPTERA												
soil	88.2	63.8	40.6	81.2	358.4	20.9	16.2	242.4	257.5	358.4	63.8	334.1
foliage	3.19	1.09	1.72	0.22	0.79	2.24	-	3.25	1.28	-	1.65	2.28
HYMENOPTERA												
soil		25.5	259.8	293.5	390.9	56.8	19.7	46.4	90.5	1 613.6	390.9	22.0
foliage	0.43	0.80	0.55	0.04	0.96	0.88	-	0.82	3.20	-	0.61	0.99
Formicidae												
soil		24.4	257.5	290.0	372.4	54.5	18.6	+	89.3	1 608.9	387.4	18.6
foliage		(0.05)	+		(0.40)	(0.27)	-	(1.09)	0.19	-	0.39	(0.06)
Tenthredinidae												
soil												
foliage	0.17	(0.41)	0.04		0.73	0.20	-		2.19	-	0.15	(0.15)
Miscellaneous Insecta												
soil	5.8	30.2	9.3	18.6	12.8	15.1	24.4	22.0	12.8	19.7	19.7	12.8
foliage	0.07	0.53	0.16	0.03	0.06	0.67	-	0.70	0.13	-	0.03	0.33
ARANEIDA												
soil	4.6	84.7	141.5	40.6	23.2	77.7		56.8	37.1	134.6	24.4	84.7
foliage	2.18	7.12	3.02	1.51	7.94	3.98	-	6.42	4.49	-	2.54	1.51
PSEUDO-SCORPIONIDA												
soil	17.4			8.1	3.5			3.5		11.6		3.5

[a]All values are means from Tables 27 to 82, with soil totals being multiplied by 1.16 to correct for fat leaching into alcohol. Inconsistencies created in summarizing may make the total insect biomass differ from the totals obtained by adding all component categories.

[b]Parentheses indicate that the figure shown is the mean of some, but not all, of the animals counted in this category (the balance being included as miscellaneous Insecta).

[c]-Entry means habitat zone not sampleable.

[d]+Entry signifies presence, with biomass included under miscellaneous insects.

exceeded that of the soil dwellers. In the semi-open tamarack bog (Site 9), the total spider biomass was 52% of the total insect biomass, the highest percentage that spiders represented of the insect biomass at any site.

Early in 1979, it was discovered that adult flies, moths, and beetles were attracted to light bulbs used to drive insects from soil cores. Consequently, these insects were excluded from soil population totals unless they were believed to be inhabiting extracted soil cores. While this means that data between the two years are not absolutely comparable, the practical difference is that 1978 figures are slightly inflated.

The 1979 data parallel those of 1978. The fen again supported the largest insect populations, averaging 26 542 individuals and weighing 2.09 $g \cdot m^{-2}$. The non-vegetated/disturbed site (7) again supported the lowest insect population, 380 m^{-2}, and also the lowest biomass of 0.09 $g \cdot m^{-2}$. The average insect population per site was 5275 individuals weighing 0.59 $g \cdot m^{-2}$ which is 3% more individuals and 42% lower average biomass than was found in 1978. The standing crop populations were 99.8% from the soil, and the biomass of foliage inhabitants contributed an average of 1.6% to the total estimated biomass. Spider populations were greater at all but two sites in 1979, but the biomass of spiders collected was 65% less than that found in 1978. There is a gradient of lowest populations and biomasses at the driest sites, and greatest populations and biomasses at the wettest sites, an exception being the black spruce bog (Site 4).

Fall 1978 was rather wet with uncommonly frequent rain; 1979 was a rather dry season. Greater populations of Psocoptera and aphids were collected on foliage in 1978 versus 1979. The average biomass of all insects on foliage was less in 1979 (9.3 mg) than 1978 (79.0 mg). Spider biomass on foliage was also lower in 1979. These differences were due to the effect of rain on the foliage habitat, modifying the habitat to allow it to support more insects than in dry 1979.

3.1.4 Net Sweeps

The 1978 net sweep sample results are given in Tables 83 and 84 of Appendix 7. These data show a seasonal trend in the reduction of insect numbers and biomass with a slight increase in the spider biomass over the same period. At the 10 sites where head height and ground vegetation sweeps were taken, the ground sweeps picked up 1.64 times more insect biomass than the higher foliage sweeps.

The 1979 net sweep sample results are plotted, in Figures 26 to 37 of Appendix 7, as the number of families of insects represented at each of the nine sample times. Family diversity was greater in mid-season than in early and late season, except for a few sites where the diversity of flies remained high in late season. Sites 3 (aspen forest) and 4 (black spruce bog) had the lowest diversities while Site 10 (fen) had the greatest. The head height sweeps showed low diversity at Sites 3, 11 (Tamarack forest), and 12 (Deciduous wetland). Diptera were more diverse than other groups of insects.

Table 7 data show some distinct differences in the trophic structures of insect populations netted at the study sites. Herbivores were proportionally most important where there was extensive herbaceous vegetation. The non-vegetated/disturbed site (7) was herbivore dominated and was the site with the least amount of woody vegetation. Other herbaceous vegetation areas include Sites 1, 10, and 12. These sites showed low ratios of carnivores to potential prey. Where the vegetation was woody and the foliage perennial, the ratio of carnivores to potential prey was greater and the saprovore proportion was also greater. The mixed forest site (6) contained a large biomass of herbivores, reflecting its diverse understory vegetation. Sites dominated by conifer trees [black spruce bog (4), mixed coniferous forest (5), and the jack pine forest (8)] contained relatively low numbers of individuals and low insect biomasses.

Table 7. Trophic level analysis of insect net sweep results, 1979.

Site	Herbivores	Saprovores	Carnivores	Omnivores	Carn./Pot. prey	Sapro./Total
Number of individuals						
1 Riparian	134	703	302	28	0.35	0.60
2 White spruce	131	440	395	34	0.73	0.49
3 Aspen	121	213	234	18	0.68	0.37
4 Black spruce	37	192	160	6	0.68	0.49
5 Mixed Coniferous	85	234	191	9	0.58	0.45
6 Mixed Forest	135	195	242	26	0.68	0.33
7 Disturbed	983	94	100	27	0.09	0.08
8 Jackpine	50	375	242	4	0.56	0.56
9 Tamarack Bog	80	333	191	8	0.45	0.55
10 Fen	216	598	177	8	0.22	0.60
11 Tamarack Forest	172	158	159	48	0.42	0.29
12 Deciduous Wetland	317	238	129	161	0.18	0.28
Biomass (mg oven dry)						
1 Riparian	155	139	180	0	0.56	0.29
2 White spruce	137	181	236	13	0.71	0.32
3 Aspen	248	78	206	6	0.62	0.15
4 Black spruce	35	37	46	6	0.60	0.30
5 Mixed Coniferous	51	50	110	2	1.06	0.24
6 Mixed Forest	435	75	146	15	0.28	0.11
7 Disturbed	787	65	128	22	0.15	0.07
8 Jack pine	87	78	93	1	0.56	0.30
9 Tamarack Bog	52	56	76	8	0.66	0.29
10 Fen	302	195	196	2	0.39	0.28
11 Tamarack Forest	133	78	98	16	0.43	0.24
12 Deciduous Wetland	207	72	70	109	0.18	0.16

3.1.5 Light Traps

Light trap results for 1978 are shown in Figure 10. Peak moth collections were made between 25 August and 10 September. During this 17 night period, there were only four nights without rain. On 1 September, the peak moth catch night, there was a minimum night temperature of 12°C, the warmest night during the light trap period [Atmospheric Environment Service (AES) meteorological records, Mildred Lake Research Facility]. The 9.6 mm of rain on this day did not dampen the flying spirits of these moths, but caused warm conditions which in turn caused the greatest moth flight activity.

The remaining 1978 light trapped insects at Mildred Lake were 99% Diptera, primarily members of the Chironomidae, Sciaridae, and Mycetophilidae. Other taxa collected include Trichoptera, Hymenoptera, Psocoptera, Coleoptera, Neuroptera, and Ephemeroptera. Larvae belonging to the dipteran families Sciardae and Mycetophilidae [collectively called Fungivoridae by Peterson (1960)], Chironomidae, and Ceratopogonidae dominated soil insect populations. Adults of these were collected by sweep netting, but not in notable quantities. The light traps, however, attracted large number of sciarids, mycetophilids, and chironomids. The light trap results show that members of these families were active at night. Their abundance in soil is confirmed by their dominance in light trap results. Ceratopogonids were found infrequently, which meant either they appeared earlier in the season or they had behaviour patterns which caused them to be missed in our samples. In 1979, ceratopogonids were collected in the Mildred Lake light trap throughout the season, with peak numbers of 6600 to 10 500 being collected nightly from early July to mid-August. During June and September, it was uncommon to collect more than 200 individuals in one night. Thus, these insects were also active at night and, again, the light trap data independently confirm observations of their abundance.

In 1978, the Fort MacKay light trap yielded higher collections and more diverse taxa during its short period of operation than did the Mildred Lake trap. Poor results from the Thickwood Hills trap

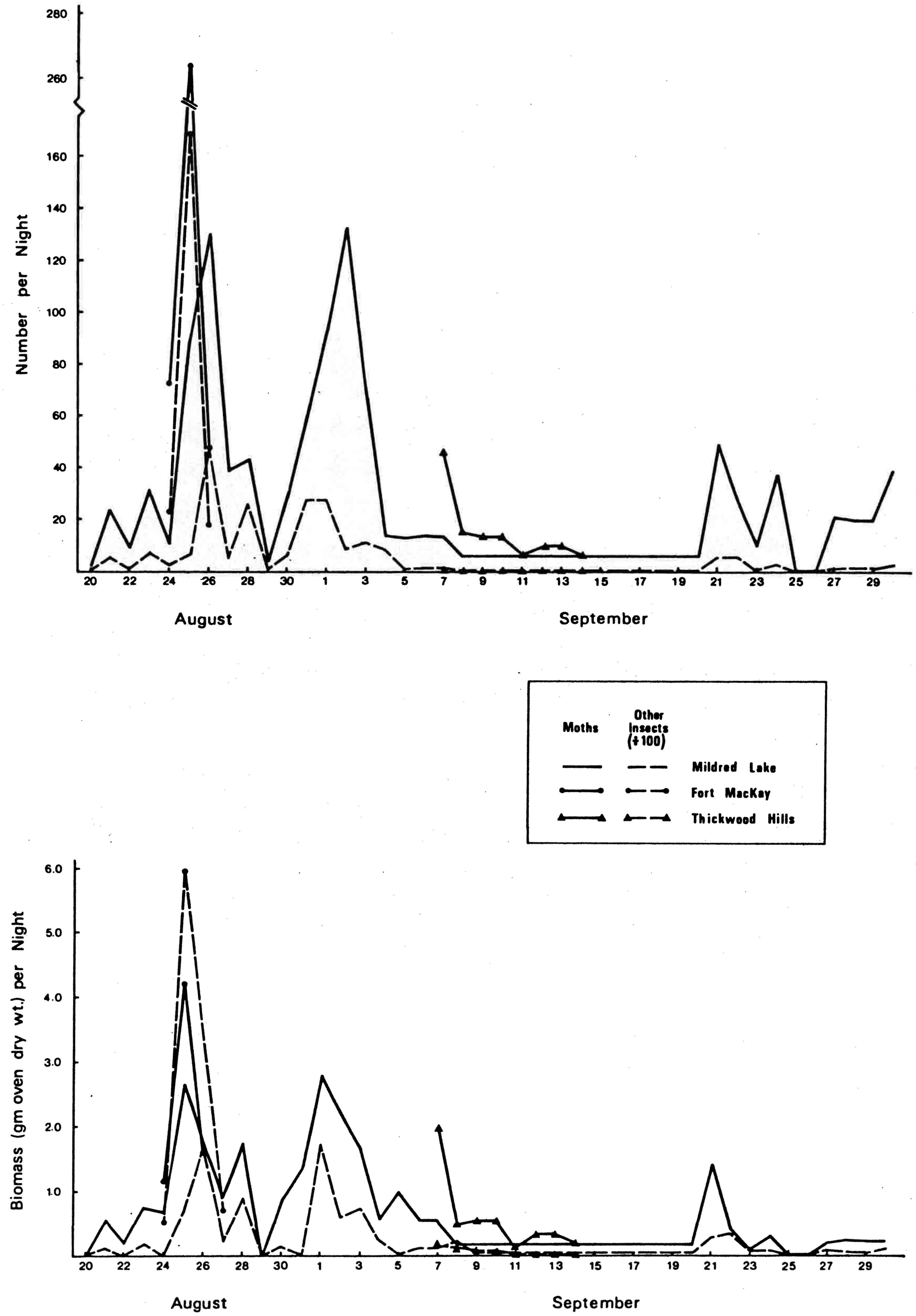

Figure 10. Light trap results from Mildred Lake, Fort MacKay Ranger's House, and Thickwood Hills Lookout Tower, 1978.

may be due to the placement of this trap beside a shed (thus halving its attractant area) and a dim light due to weak batteries.

The 1979 Mildred Lake light trap results are shown for numbers of noctuid moths (including Arctiidae, Noctuidae, and Bombycoidea of the family Lasiocampidae) and all other insects collected (see Figure 11). The early season peak of noctuid moths, between 9 to 25 May, represents trapped moths which overwintered as adults. Moth activity increased in early July and tapered off in late August. It can be seen that the greatest numbers of other insects were trapped from 1 July to 15 August. The numbers collected appear to be directly related to nightly temperatures. Noctuid moths generate body heat in order to fly at night (Hanegan and Heath 1979); therefore, their activity periods can extend into colder weather than flies can tolerate. The peaks of "other insects" reflect seasonal activity patterns of different species (e.g., cryptophagid beetles were quite abundant in July, with 54 000 individuals trapped 20 July and few trapped later). Chironomid flies dominated the numbers collected in 1979.

The biomass of insects collected at the Mildred Lake trap is shown in Figure 12. Large peaks of "other insect" biomass captured between 5 July and 16 August outweigh the moth peaks. Altogether, less than 0.5 kg of insects were collected throughout the season at this trap.

Problems developed with light traps at the AFS lookout towers. Tower operators had no incentive to tend the traps and quickly neglected them, except at Bitumount, Muskeg, and Thickwood Hills (where they were gradually neglected). Since the modified traps did not have suction fans like the New Jersey traps, fewer small insects were collected. Heavy bodied insects which struck the trap vanes were most likely to be captured in the modified Robinson traps. These insects included larger moths, beetles, corixids, and Trichoptera.

The Thickwood Hills trap results were similar to those from Mildred Lake. Many muscids were collected, which are active diurnally, and also Trichoptera were abundant. The trap at Bitumount tower picked up thousands of forest tent caterpillar moths (*Malacosoma*

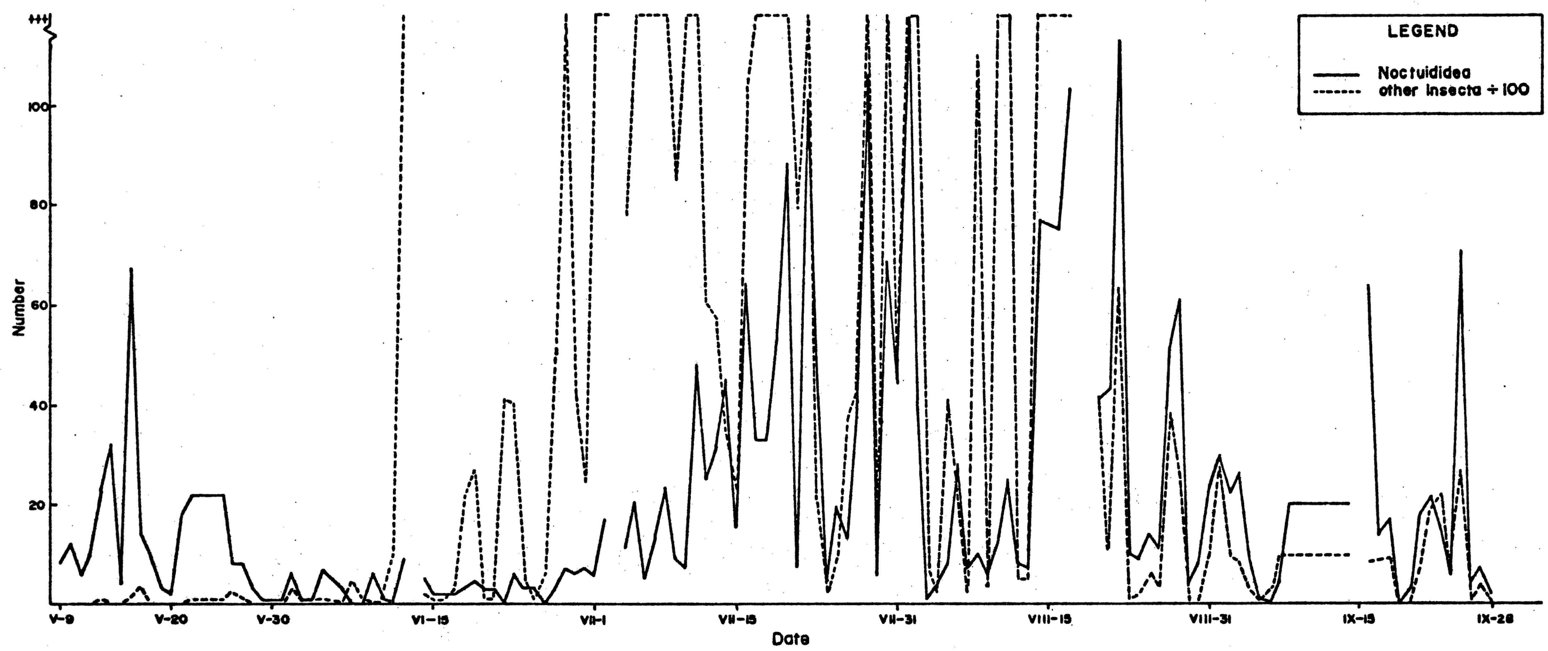

Figure 11. Light trap at Mildred Lake: numbers of noctuid moths and all other insects recorded daily, 1979.

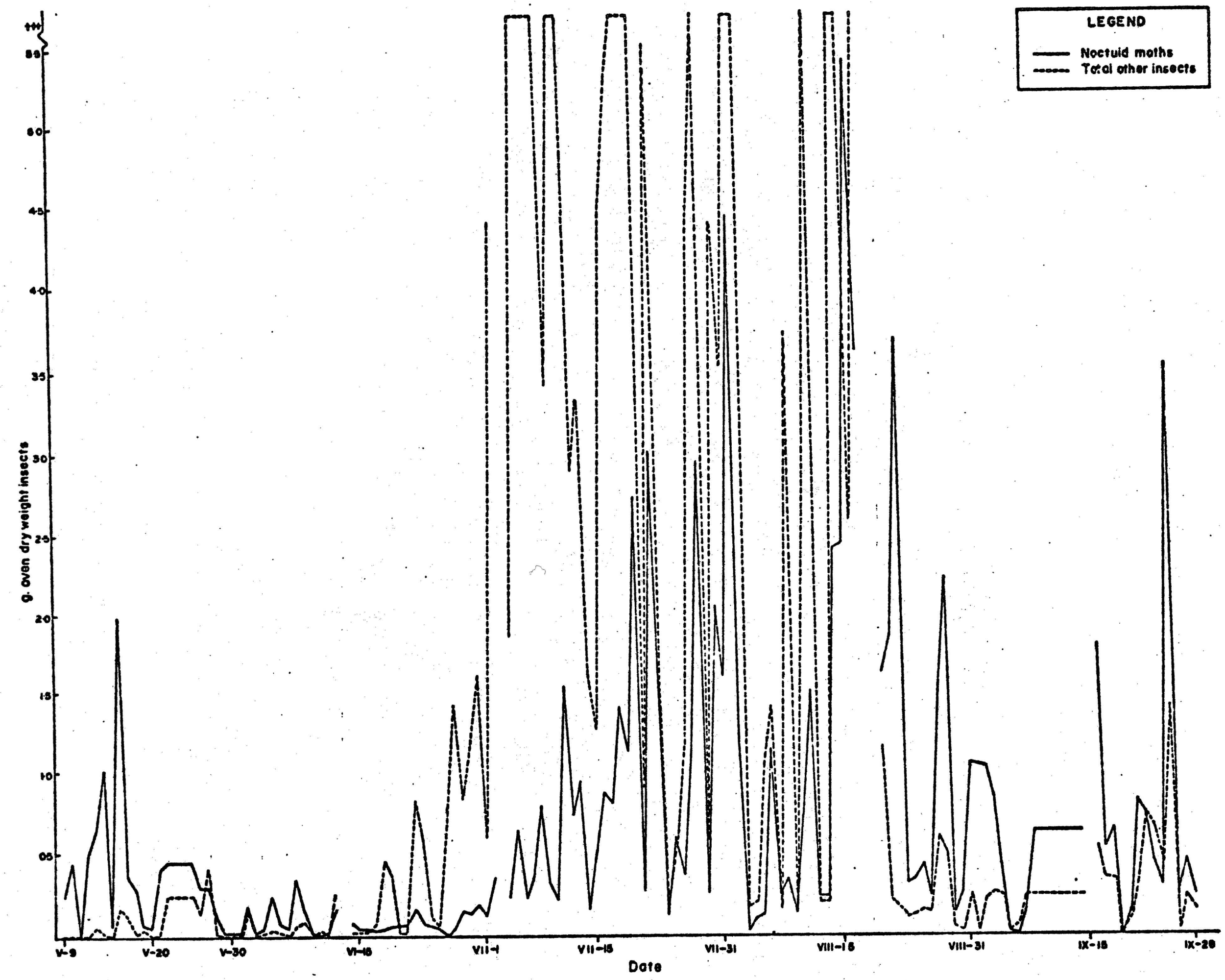

Figure 12. Light trap at Mildred Lake: biomass of noctuid moths and all other insects recorded daily, 1979.

disstria Huebner) in the latter half of August. Aquatic insects, such as corixids and Trichoptera, were abundant in contrast to the Mildred Lake results, and muscids were occasionally abundant in the collection jar. At Muskeg tower, strikingly few chironomid and other Nematocera flies were collected compared to the other sites. Aquatic insects were more abundant than at Mildred Lake. About 100 specimens of the dung beetle *Aphodius* sp. were collected here but were not noted at the other sites.

3.1.6. Malaise Trap

A Malaise trap is primarily a device to collect insects for taxonomic study. However, biting flies trapped in 1979 were counted daily and the results are shown in Figure 13. Few black flies and ceratopogonid flies were collected in the trap despite their observed abundance. Mosquitos and tabanids were commonly collected; their seasonal activity periods are evident from these Malaise trap records. Tabanids were most abundant in early summer while mosquitos were active throughout the summer, particularly mid-June to mid-July. The peak numbers collected 7 and 8 August followed light rain and wind. The riparian forest site, normally plagued with mosquitos, had very few at this time. Apparently, a large movement of mosquito populations occurred at this time which brought enormous numbers to the Mildred Lake camp from outlying areas.

3.1.7. Leached Lipid Correction

The alcohol preservative from the 36 containers of 1978 light trap specimens was saved in an enamel tray. This yielded 1.45 L of urine-colored fluid (plus an unknown loss from evaporation) which was dried in a foil boat. The tacky darkened residue, after 3 d of being oven dried at 60^{o}C, weighed 8.664 g. The total oven-dried biomass of insects preserved in this fluid for 3 mo was 55.04 g. Therefore, the alcohol-leached fat represents a 13.6% loss from the total 63.71 g, and the oven-dried insect biomass must be corrected by a factor of 1.16 to obtain oven dry biomass at time of capture.

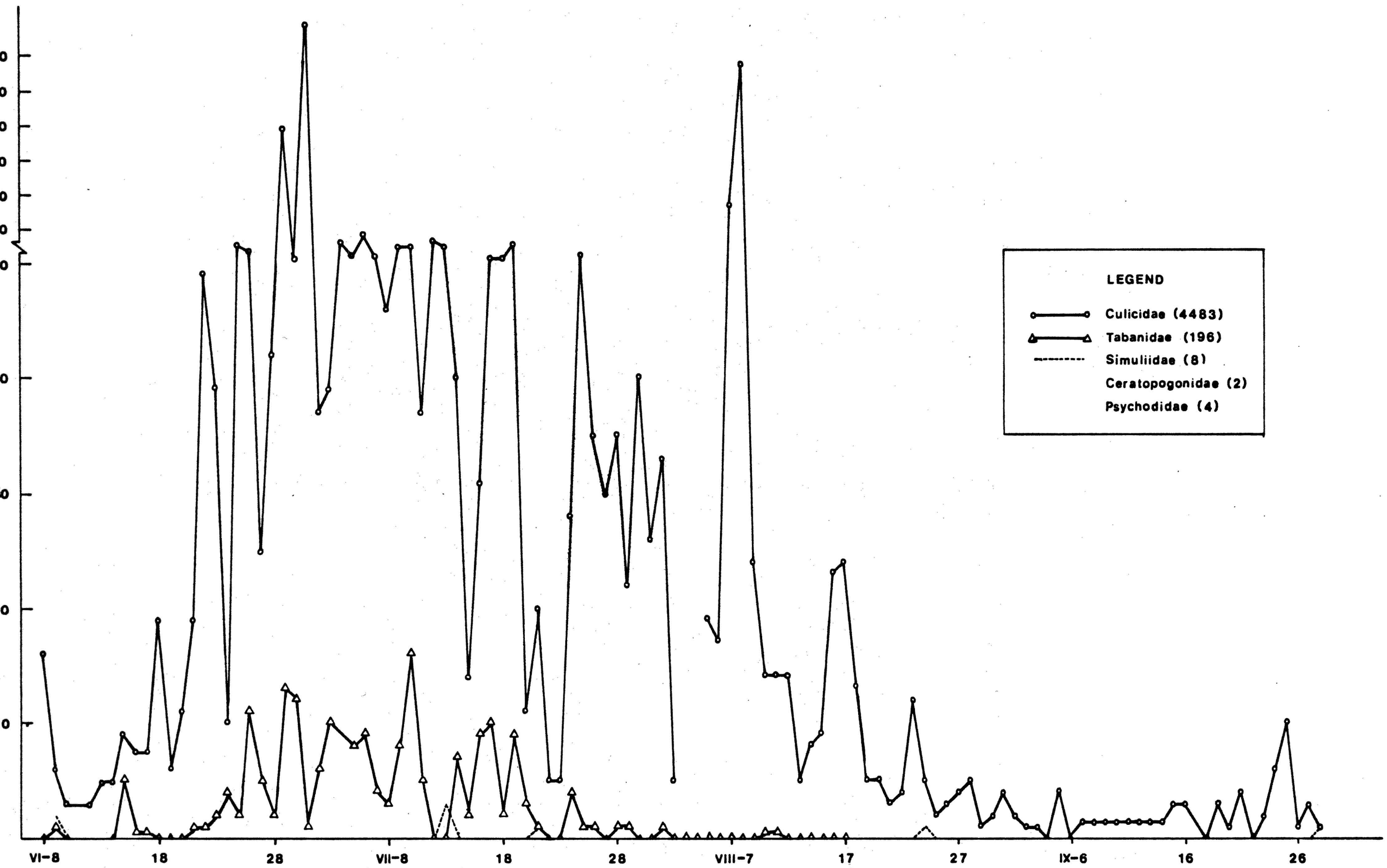

Figure 13. Daily collections of biting flies in Malaise trap at Mildred Lake, 1979.

3.2 INSECT DAMAGE SURVEYS

The leaf damage survey of 1978, reported in Table 8, showed great variation in the rates of insect attack on the leaves of different plants. Virtually all dogwood (*Cornus stolonifera*) (note: all plant species names are taken from Moss 1959) leaves bore insect scars, while only 20% of blueberry (*Vaccinium myrtilloides*) leaves were attacked, and 1% of black spruce (*Picea mariana*) needles bore attack scars. The estimated area missing for attacked leaves was highest for aspen (*Populus tremuloides*) leaves at 14.7%, and second highest with blueberry leaves, at 13.2%. Altogether, the estimated area missing for attacked deciduous leaves was 7.8% and for the single conifer was 0. It was often difficult to separate insect damage from mite damage or other causes, particularly when deciding the cause of small holes. Also, mite and insect galls were not separated for willow (*Salix* sp.) and birch (*Betula papyrifera*) leaves. Aphids and psocids were abundant on the deciduous leaves. Some probably wandered from their parent leaf during storage before being counted, but most appeared to remain clumped on this original leaf. The heaviest overall infestation occurred in dogwood leaves, 172 of which bore an average 6.7 aphids (also including some psocids). Scars left by these insects were not recognizable (with any certainty), except where a gall was made, but they did cause some net loss to the vitality of the leaf. Examples of these types of leaf damage are shown in Figures 14 to 17.

Insect damage to leaves in 1979 is shown in Table 9. The damage patterns of this year were similar to 1978. Eighty-four percent of the dogwood leaves examined in 1979 bore insect damage as opposed to nearly 100% in 1978. Alder leaves suffered the largest leaf area removed in 1979, 10%, as opposed to 4.3% area missing in 1978. These leaves bore mines in 37 to 250 leaves in 1978 and only one of 150 leaves in 1979. There was an overall decrease in the average number of insect galls, mines, leaves rolled, and phytophagous insect larvae found in 1979. Also, fewer aphids and psocids were found. These data are interpreted to mean that insect attacks on leaves were heavier in spring of 1979, causing the observed damage,

Table 8. Insect damage and insects evident on mature leaves of dominant plants collected in the AOSERP study area in 1978.

	No. Leaves	Insect Damaged	Ribbed or Holed....	$\bar{x}$/ Leaf	Edges Chewed	Leaf Area Missing % Average	No. Insect Galls[a]	No. Insect mines	Leaves Rolled	Phytophagous Insect Larvae	Aphids or No. Leaves...	Psocids per Leaf
Alnus crispa	250	92	27	3.0	30	4.3	0	37	2	0	61	1.7
Betula papyrifera	250	131	70	1.3	17	3.4	44[a]	3	0	1	26	1.4
Cornus stolonifera	250	249	220	12.6	25	4.9	0	0	2	8	172	6.7
Populus balsamifera	250	179	142	3.2	50	5.1	10	2	5	5	178	4.6
Populus tremuloides	250	174	100	2.1	111	14.7	17	9	6	8	64	2.0
Salix sp.	250	182	86	1.9	89	10.6	55[a]	3	0	16	22	7.9
Shepherdia canadensis	250	184	17	1.4	68	6.4	0	0	0	0	1	1
Viburnum trilobum	250	99	62	4.6	50	8.0	0	1	0	1	172	1.5
Vaccinium myrtilloides	250	51	11	2.9	33	13.2	0	2	0	0	0	0
Picea mariana	500[b]	6	0	0	0	0	0	5	0	0	0	0

[a] Gall totals on *Betula papyrifera* and *Salix* sp. are mite and insect caused; these are primarily mite galls.

[b] Needles.

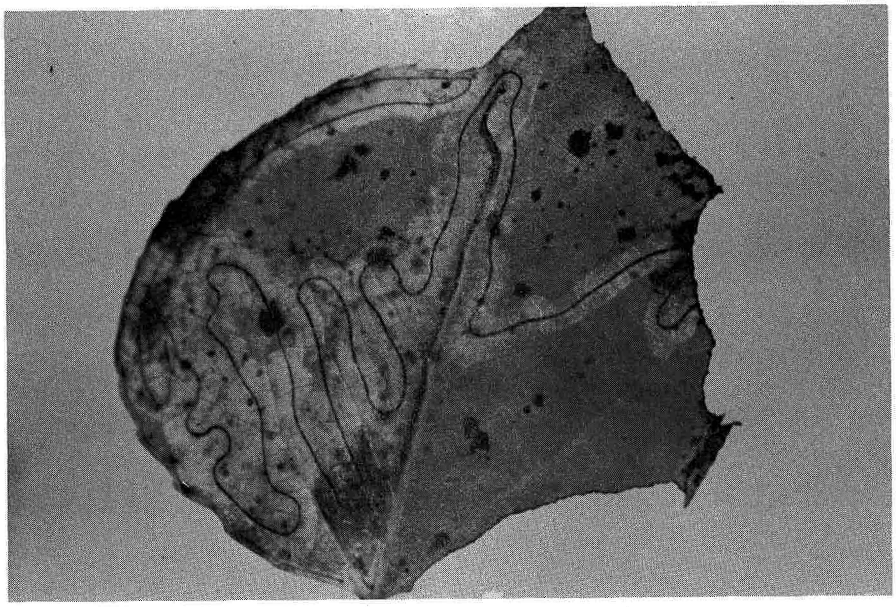

Figure 14. Leaf mine by larva of *Phyllocnistis populiella* (Chambers) (Lepidoptera), and leaf border removed, on aspen poplar.

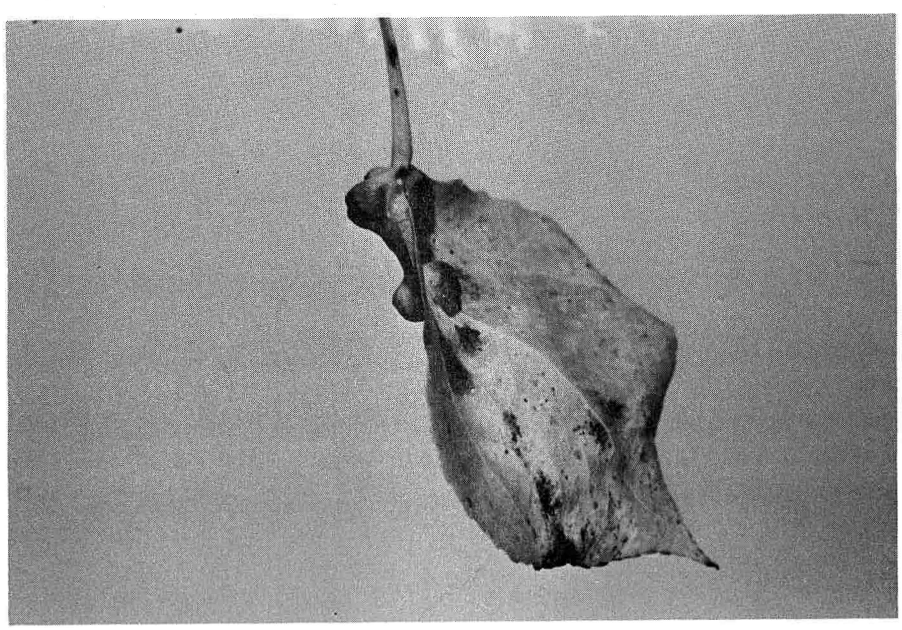

Figure 15. Galls of cecidomyiid fly larvae on aspen poplar leaf.

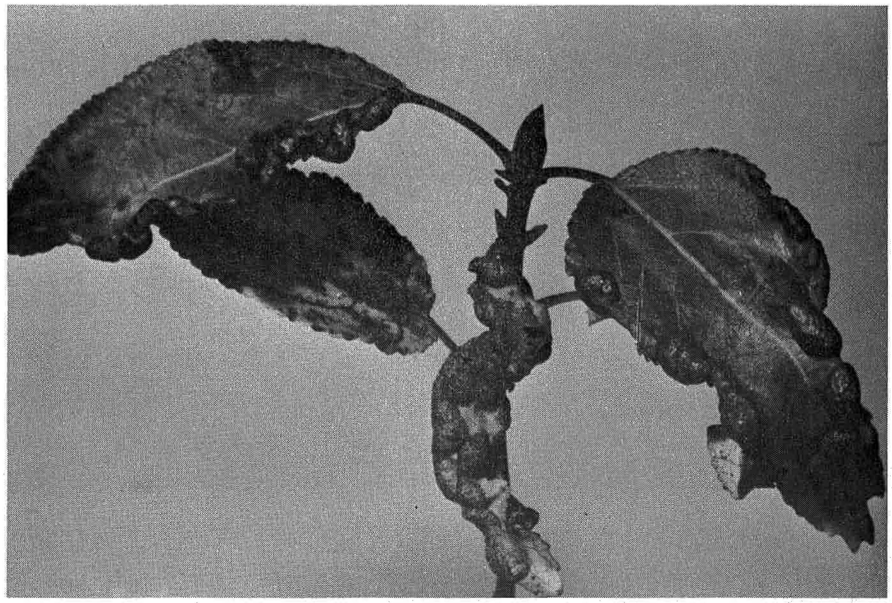

Figure 16. Galls of the aphid *Parathecabius populimonilis* (Riley) on balsam poplar leaves.

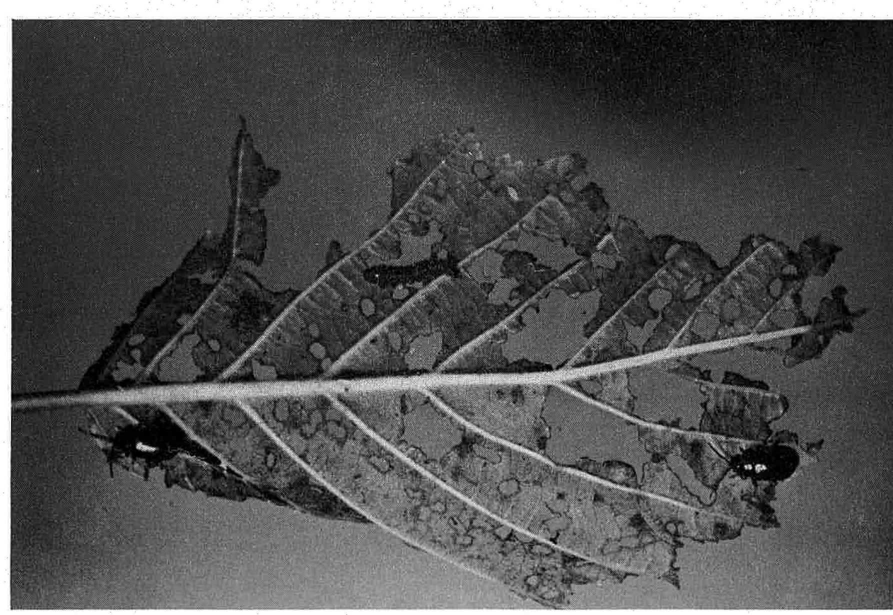

Figure 17. Damage to alder (*Alnus crispa*) leaf caused by larvae and adults of the beetle *Altica ambiens* (Le Conte) (Chrysomelidae).

Table 9. Insect damage and insects evident on mature leaves of dominant plants collected in the AOSERP study area in 1979.

	No. Leaves	Insect Damaged	Ribbed or Holed	$\bar{x}$/ Leaf	Edges Chewed	Leaf Area Missing % Average	Insect Galls[a]	Insect Mines	Leaves Rolled	Phytophagous Insect Larvae	Aphids or No. Leaves.....	Psocids /Leaf
Alnus crispa	150	76	35	2.1	36	10.0	0	1	0	0	37	1.2
Betula papyrifera	150	72	57	3.1	15	3.0	0	14	0	3 pupae	3	1.0
Cornus stolonifera	150	126	107		26	6.5	0	2	0		34	1.3
Populus balsamifera	150	71	43		15	3.6	13	3	1	0	0	0
Populus tremuloides	150	110	81	2.4	63	6.7	45	1	0	0	2	1
Salix sp.	150	57	22		34	8.1	6	1[b]	0	0	0	0
Shepherdia canadensis	150	48	17	1.4	38	8.5	0	0	0	0	2	1
Viburnum trilobum	150	86	40		25	8.6	0	2	0	0	124	5.8
Vaccinium myrtilloides	150	22	11	1.4	13	5.3	0	0	0	0	0	0
Picea mariana	500	11	0		2	10.0	0	0	0	0	9	1.7

[a] 99 mite galls
[b] 4 mite galls

but that these insects left the leaves earlier than they did in 1978. The wet 1978 fall (favourable to plants and insects) versus the dry 1979 summer (unfavourable to plants and insects) were responsible for these differences.

The stem damage survey of 1978, in Table 10, shows that few stems of deciduous plants bore insect damage. *Salix* sp. was the one exception, with eight galls on seven stems. Conifer tree stems were much more heavily attacked, with 34% bearing insect caused scars. For both spruce species, the bulk of these scars were galls (79) followed by bud damage (57). Bud death caused a difficulty in definition of the terminal 25 cm of a stem, since live leaders continue to grow while others have been killed and cease growth. Thus, for spruce, the terminal 25 cm means a total length of 25 cm of stem, including several terminals, at the end of a single branch. Jack pine (*Pinus banksiana*) bore scars at old staminate cone portions which were at first thought to be insect chewing scars. No scale insects were found on alder (*Alnus crispa*) and rose (*Rosa acicularis*) stems, while 1 to 66 were found on stems of the remaining deciduous tree species. Insect and spider predators found during this survey are also listed in Table 10. Examples of stem damage are shown in Figures 18 to 21.

The 1979 stem damage survey of conifer trees, reported in Table 11, was done with cut stems in the laboratory rather than while standing beside trees, and consequently is more thorough. Eighty-two percent of black spruce stems bore signs of insect damage, being mostly insect killed buds and tips. Blister galls, caused by cecidomyiid fly larvae, were found on 72% of the white spruce stems examined (versus 5% of the black spruce). Jack pine stems bore insect damage on 66% of examined stems. Most of this observed damage involved needles being stripped, mined, or punctured, and only 3% of the stems examined bore insect-killed buds and tips. No *Phenocaspis pinifoliae* (Fitch), or other species, scales were found on any stems in 1979.

Tree damage is evaluated in Table 12. No tree crowns were found killed by beetle attack. Close inspection of small trees revealed that leader terminal buds were often killed by small insect larvae, apparently cecidomyiid flies. However, laterals rapidly

Table 10. Insect predators and damage evident on the terminal 25 cm of branches of dominant plants in the AOSERP study area.

	Stems	Undamaged by Insects	Insect Galls	Bud Damage	With Needles Mined or Cut	Scale Insects	Predators: Crypsopid Larva	Coccinellid	Syrphid Larva	Araneida
Alnus crispa	100	100								
Cornus Stolonifera	100	100				1				5
Ledum groenlandicum	100	99	1			5				
Rosa acicularis	100	100								1
Salix sp.	100	93	8			11			2	
Shepherdia canadensis	100	100				66		1		
Viburnum trilobum	100	100				3				3
Picea glauca	100	66	33	18	2		1			2
P. glauca	100	61	29	18	7					
P. mariana	100	55	17	21	16					2
Pinus banksiana	100	85		8	a					6
P. banksiana	80	63		1	a	3				4

[a]Needle loss by staminate cone bearing and insect feeding were not distinguishable.

Figure 18. Gall of the pine leaf chermid *Pinus pinifoliae* (Fitch) on white spruce needles.

Figure 19. Gall of the cecidomyiid midge *Mayetiola* sp. on *Salix* sp.

Figure 20. Gall on stem of *Ledum groenlandicum* (Oeder) caused by unidentified insect.

Figure 21. Willow cone gall made by larvae of the cecidomyiid midge *Rhabdophaga strobiloides* (Osten Sacken), also occupied (insert) by Lepidoptera and Hymenoptera larvae.

Table 11. Insect damage and insects evident on terminal 25 cm of coniferous tree stems collected in the AOSERP study area during 1979.

	Location	Stems Without Insect damage	Insect Killed buds and tips	Cone Galls	Needles stripped	Blister Galls	Spiders	Needle mines and punctures	Maximum Age Needles (Years)
Picea mariana	200 m. N. Ft. MacKay	20	78 stems with $\bar{x}$ = 1.8	13 stems with $\bar{x}$ = 1.8	9 stems with $\bar{x}$ = 2.8 cm	8 stems with $\bar{x}$ = 3.2 cm	27	0	10.0 (4-13)
Picea mariana	Site 4	17	77 stems with $\bar{x}$ = 2.39	12 stems with $\bar{x}$ - 2.3	36 stems with $\bar{x}$ = 2.0	2 stems with $\bar{x}$ = 0.6	10	0	9.8 (4-13)
Picea glauca	1.5 km E. AOSERP	7	78 stems with $\bar{x}$ = 5.73	14 stems with $\bar{x}$ = 2.0	34 stems with $\bar{x}$ = 3.7 cm	76 stems with $\bar{x}$ = 13.3 cm	33	0	
Picea glauca	7 km S. Suncor	3	70 stems with $\bar{x}$ = 4.44	14 stems with $\bar{x}$ = 1.6	38 stems with $\bar{x}$ = 4.2 cm	68 stems with $\bar{x}$ = 8.5 cm	18	0	
Pinus banksiana	2 km S. Suncor	40	3 stems with $\bar{x}$ = 1.0[a]	0	36 needles on 18 stems	(50+ Chermids on 34 stems)[b]	11	45 stems with $\bar{x}$ = 2.7	5.0 (2-7)
Pinus banksiana	2 km W. McM. Airport	44	7 stems with $\bar{x}$ = 1.0[a]	0	64 needles on 19 stems	(24 Chermids on 16 stems)[b]	13	29 stems with $\bar{x}$ = 2.5	4.4 (1-7)
Pinus banksiana	2 km E. AOSERP	29	2 stems with $\bar{x}$ = 1.0[a]	1 spittlebug mass	67 needles on 26 stems	(39 Chermids on 14 stems)[b]	24	46 stems with $\bar{x}$ = 2.7	4.7 (2-6)
Pinus banksiana	AOSERP camp	39	0[a]	0	83 needles on 22 stems	(116 Chermids on 24 stems)[b]	16	50 stems with $\bar{x}$ = 2.5	5.0 (3-7)

[a]Stem bored to produce sap encrustation. Total No. sap encrustations (descending order); 5, 19, 20, 12 on 5, 17, 19, 11 stems.
[b]Chermids did not produce galls on these jack pines.

Table 12. Tree damage survey in the AOSERP study area, with particular attention to insect damage.

Tree Species	Location	Height	Crowns Healthy	Damaged or deformed	Survey by[a]
Picea mariana	Site 4	$\leq$15 m	86 87	area below crown often denuded, cause unknown	JR
P. mariana	Site 8	$\leq$10 m	88	Terminal buds killed by insects, but trees recovered.	JR
P. mariana	Ells River	$\leq$10 m	99	1 mistletoe	GH
P. glauca + *P. mariana*	Site 3	$\leq$15 m	93	4 clumped crowns, 3 long spindly leaders	JR
P. g. + *P. m.*	Site 2	10 - 20 m	97	2 shade killed; 1 crown with yellowed needles, possibly beetle-damaged	GH
P. g. + *P. m.*	Site 6	$\leq$10 m	98	1 mistletoe; 1 broken top	JR
P. g. + *P. m.*	Ells River	$\leq$15 m	100		GH
P. g. + *P. m.*	Site 5	$\leq$10 m	100		GH
Pinus banksiana	Site 5	10 - 20 m	95	5 wind damaged crowns	GH
Pinus banksiana	Site 8	$\leq$10 m	99	1 leader broken	JR
Pinus banksiana	Ells River	10 - 25 m	100		GH
Populus tremuloides	Ells River	15 - 20 m	98	1 dead tree; 1 dying, leaves with insect damage	GH
Populus temuloides	Site 5	2 - 15 m	92	trees killed through competition	GH

[a] JR = James Ryan

[b] GH = Gerald Hilchie

became leaders and trees continued to grow, albeit with a slight deflection from the vertical. Some terminals of spruce trees were denuded, bore cancerous clumps, or were abnormally spindly, the causes of which remain unknown to the authors.

3.3 INSECT BASELINE DATA FOR BIOMONITORING STUDIES

Population parameters given throughout this report are relevant to biomonitoring of insect populations in the AOSERP study area. Two categories of the data, emergence trap and pitfall trap results, are considered to be specifically relevant to biomonitoring efforts (Hilchie and Ryan 1980).

3.3.1 Emergence Traps

The numbers of insects collected$\cdot m^{-2}$ in emergence traps at aspen, mixed conifer, and black spruce forest sites are given by family and date collected in Tables 85 to 90 in Appendix 7. These insects were also oven dried and weighed, but several samples were lost so these data were not tabulated.

The aspen forest traps collected 476 and 441 total insects for the season. Diptera constituted 68% of the total number of insects collected at this site. Half of these were members of the family Bibionidae, which were also abundant in traps at the mixed forest site in fall. The 28 spiders collected had to have consumed some of the adult insects in the traps and therefore represent unmeasured insect production. All predatory and parasitic insects have this net effect. One trap at this site was damaged twice by a bear.

The mixed coniferous forest traps collected an average 548 insects and 21 spiders, making this the most productive of the three sites. Large numbers of winged ants were collected in one trap between 13 to 20 August, accounting for much of this higher productivity.

The black spruce site produced less than half the number of insects that were collected at the mixed conifer site, with an average 266 and 36 spiders$\cdot m^{-2}$. The peak production of insects at this site occurred from June to July, and no large burst of bibionid flies was collected at the end of the season.

3.3.2. Pitfall Traps

Pitfall traps provided continuous records of the presence and activity of carabid beetles and spiders at the study sites. Altogether, 76 species of carabid beetles were collected using pitfall traps. Four rare species were collected in the light and Malaise traps for a total of 80 species. An additional 59 species were reported for this region by Lindroth (1961, 1963, 1966, 1968, 1969a) for a total of 139 species of carabid beetles known from the region. Thus, the carabid fauna in the AOSERP study area is quite diverse. The two disturbed sites, the riparian forest (which is regularly flooded) and the nonvegetated/disturbed site, contained large numbers of carabid species, many of which were common to both sites. The herbaceous vegetation of these sites apparently supported large numbers of herbivores which created opportunities for the invasion of predatory carabid beetles. Some species of carabids were abundant and cosmopolitan at the study sites and would be suitable for use in a biomonitoring program. *Calathus ingratus* and *Pterostichus pensylvanicus* appear to be good choices for such a biomonitoring program.

Spiders could also be used in a pitfall trap biomonitoring program. Members of the families Lycosidae and Thomiscidae would be most suitable for such a study. The species collected at pitfall traps in the 12 study sites are listed in Table 23.

3.4 INSECT TAXA FOUND IN THE AOSERP STUDY AREA

3.4.1 Taxa Collected

A list of insect families found represented in the AOSERP study area, particularly at the 12 study sites and Mildred Lake facility, is presented in Table 13. This list of 261 families compiled from specimens collected during the 1978 and 1979 field season represents a comprehensive but not an exhaustive catalogue of families. Rare or patchily distributed taxa could be easily missed. When

Table 13. Families of insects represented in terrestrial habitats within the AOSERP study area.

	Barton and Wallace[a] (1980)	1979	1978	Porter and Lousier (1975)
COLLEMBOLA				
Entomobryidae		+	+	
Isotomidae		+	+	+
Onychiuridae		+	+	+
Poduridae		+	+	+
Sminthuridae		+	+	+
EPHEMEROPTERA	+			
Ametropodiadae	+			
Baetidae				
Baetiscidae	+			
Caenidae	+	+		
Ephemerellidae	+		+	+
Ephemeridae	+			
Heptageniidae	+	+		
Leptophlebiidae	+			
Metretopodidae	+			
Siphlonuridae	+			
Tricorythidae	+	+		
ODONATA				
Aeshnidae	+	+		+
Coenagrionidae (Agrionidae)	+	+	+	+
Corduliidae	+			
Gomphidae	+			
Libellulidae	+	+	+	+
ORTHOPTERA				
Acrididae		+	+	+
Tetrigidae		+	+	+
PLECOPTERA				
Capniidae	+			
Chloroperlidae	+			
Isoperlidae	+	+		
Leuctridae	+			
Nemouridae	+	+	+	+
Perlidae	+			
Perlodidae	+			
Pteronarcidae	+	+		
Taeniopterygidae	+	+	+	
PSOCOPTERA				
Pseudocaeciliidae		+	+	+
Psocidae		+	+	+
THYSANOPTERA				
Aeolothripidae		+		
Phlaeothripidae		+	+	
Thripidae		+	+	
HEMIPTERA				
Anthocoridae		+		
Aradidae		+	+	+
Alydidae		+		
Corixidae	+	+		
Dipsocoridae		+		
Gerridae		+	+	
Lygaeidae		+	+	
Miridae		+	+	+
Nabidae		+	+	
Notonectidae	+	+		
Pentatomidae		+	+	+
Saldidae		+	+	
Tingidae		+	+	+
HOMOPTERA				
Aleyrodidae				
Aphididae		+	+	+
Cercopidae		+	+	+
Chermidae		+	+	+
Cicadellidae		+	+	+
Cixiidae		+		+
Coccidae		+	+	

continued . . .

Table 13. Continued.

	Barton and Wallace[a] (1980)	1979	1978	Porter and Lousier (1975)
Delphacidae		+	+	
Derbidae		+		
Diaspididae		+		
Eriosomatidae		+	+	
Fulgoridae		+	+	
Membracidae	+			
Phylloxeridae		+		
Pseudococcidae		+	+	
COLEOPTERA				
Anobiidae		+	+	
Anthicidae		+	+	+
Anthribidae			+	
Buprestidae		+	+	+
Byrrhidae		+	+	+
Cantharidae		+	+	+
Carabidae		+	+	+
Cerambycidae		+	+	+
Cephaloidae		+		
Chrysomelidae		+	+	+
Cicindelidae		+	+	
Cisidae		+		
Cleridae		+		+
Coccinellidae		+	+	+
Colydiidae			+	+
Cryptophagidae		+	+	
Cucujidae		+	+	+
Curculionidae		+	+	+
Dermestidae		+		
Dytiscidae		+	+	+
Elateridae	+	+	+	
Elmidae	+			
Erotylidae		+		
Eucinetidae		+		
Eucnemidae				+
Gyrinidae	+	+		
Haliplidae	+	+		
Helodidae		+	+	+
Heteroceridae		+		
Histeridae			+	+
Hydrophilidae	+	+	+	
Lampyridae		+	+	+
Lathridiidae		+	+	
Leiodidae		+		
Leptodiridae		+	+	
Lucanidae		+		
Lycidae		+		+
Malachiidae (=Melyridae in part)		+		
Melandryidae		+	+	
Meloidae		+		
Mordellidae		+	+	+
Mycetophagidae			+	
Nitidulidae		+	+	+
Orthoperidae		+	+	
Ostomidae		+		
Pedilidae		+		
Phalacridae		+	+	
Pselaphidae		+	+	
Ptiliidae		+		
Pyrochroidae		+		
Salpingidae		+		
Scaphidiidae		+	+	
Scarabaeidae		+	+	+
Scolytidae		+	+	
Silphidae		+	+	
Staphylinidae		+	+	+

continued. . .

Table 13. Continued.

	Barton and Wallace[a] (1980)	1979	1978	Porter and Lousier (1975)
Tenebrionidae		+	+	+
NEUROPTERA				
Chrysopidae		+	+	
Coniopterygidae		+		
Hemerobiidae		+	+	+
Myrmeliontidae		+		
Sialidae	+			
TRICOPTERA				
Brachycentridae	+			
Glossosomatidae	+			
Helicopsychidae	+			
Hydropsychidae	+			
Lepidostomatidae	+			
Leptoceridae	+			
Limnephilidae	+	+	+	+
Molannidae	+			
Philopotamidae	+			
Phryganeidae	+	+		
Polycentropodidae	+			
Rhyacophilidae	+			
LEPIDOPTERA				
Aegeriidae		+		
Agaristidae		+		
Arctiidae		+	+	
Blastobasidae		+		
Coleophoridae		+		
Cosmopterygidae		+	+	
Drepanidae		+		
(Gelechioidae GCOS)		+		
Geometridae		+	+	+
Gracilariidae		+	+	+
Hepialidae		+		+
Hesperidae		+		
Heliodinidae		+		
Lasiocampidae		+		
Liparidae (=Lymantriidae)		+		
Lycaenidae		+		+
Nepticulidae				+
Noctuidae		+	+	+
Notodontidae		+	+	
Nymphalidae		+	+	
Oecophoridae				+
Olethreutidae				+
Papilionidae		+		
Pieridae		+	+	+
Pterophoridae		+	+	+
Pyralidae	+	+	+	
Saturniidae		+		
Satyridae		+		
Sphingidae		+		
Tineidae		+	+	
Tortricidae		+	+	
DIPTERA				
Agromyzidae		+	+	
Anisopodidae				+
Anthomyiidae		+	+	+
Anthomyzidae		+	+	
Asilidae		+	+	+
Bibionidae		+	+	+
Bombyliidae		+	+	+
Calliphoridae		+	+	
Cecidomyiidae		+	+	+
Ceratopogonidae		+	+	+
Chamaemyiidae		+	+	
Chaoboridae		+	+	+
Chironomidae		+	+	+
Chloropidae		+	+	+
Clusiidae		+	+	
Conopidae		+		+

Continued . . .

Table 13. Continued.

	Barton and Wallace[a] (1980)		Porter and Lousier (1975)
	1979	1978	
Culicidae	+	+	+
Cuterebridae	+	+	
Dixidae	+	+	+
Dolichopodidae	+	+	+
Drosophilidae	+	+	
Empididae	+	+	+
Ephydridae		+	
Heleomyzidae	+	+	
Lonchopteridae	+	+	
Milichiidae	+	+	
Muscidae	+	+	+
Mycetophilidae	+	+	+
Otitidae	+	+	
Phoridae	+	+	+
Piophilidae	+	+	
Pipunculidae	+	+	+
Psilidae	+		
Psychodidae	+	+	+
Ptychopteridae	+	?	
Rhagionidae	+	+	
Sarcophagidae	+	+	
Scatopsidae	+	+	
Sciaridae	+	+	+
Sciomyzidae	+	+	+
Sepsidae		+	+
Simuliidae	+	+	+
Stratiomyidae	+	+	+
Syrphidae	+	+	+
Tabanidae	+	+	+
Tachinidae	+	+	+
Tephritidae	+		
Therevidae	+	+	+
Tipulidae	+	+	+
Trichoceridae	+	+	
Trixoscelididae		?	
SIPHONAPTERA			
Leptosyllidae	+	+	
Ceratophyllidae	+	+	
HYMENOPTERA			
Apidae	+	+	+
Argidae	+		+
Braconidae	+	+	+
Ceraphronidae	+	+	
Chalcididae	+		+
Chrysididae	+	+	+
Cimbicidae	+		
Colletidae	+		+
Cynipidae	+	+	
Diapriidae	+	+	+
Diprionidae	+	+	+
Dryinidae	+	+	
Encyrtidae	+	+	
Eucharitidae	+		+
Eucoilidae	+		
Eulophidae	+	+	+
Eupelmidae	+	+	
Eurytomidae	+	+	
Formicidae	+	+	+
Gasteruptiidae	+		
Halictidae	+	+	+
Ichneumonidae	+	+	+
Megachilidae	+	+	+
Megaspilidae	+		
Mymaridae	+	+	
Perilampidae			+
Platygasteridae	+	+	
Pompilidae	+	+	+
Proctotrupidae	+	+	+

continued. . .

Table 13. Concluded.

	Barton and Wallace[a] (1980)	1979	1978	Porter and Lousier (1975)
Pteromalidae		+	+	+
Scelionidae		+		+
Sphecidae		+	+	+
Tenthredinidae		+	+	+
Torymidae		+	+	+
Trichogrammatidae		+	+	
Vespidae		+	+	
Xyelidae		+		
Orders	16	16	16	14
Families	261	220	161	111

[a]aquatic insects only

comparing the families of insects collected in 1978 and 1979, many groups which emerge early in the season (June and July) were missed in 1978 but captured in the 1979 sampling program. If another summer of collecting were approved, the authors predict that at least 20 additional insect families could be found in the AOSERP study area.

Certain insect groups could be identified to the genus or species level with relative ease compared to other groups. Experts were consulted who kindly made and confirmed insect indentifications. Insect families in which these identifications were made are presented in Tables 14 to 22. Some specimens sent to experts were retained by them.

Specimens of the collembolan *Proisotoma muskegensis* were determined by Ken Christianson (letter 22 October 1979, Biology Dept., Grinnel College, Iowa) from 40 g (fresh weight) of Collembola collected in one pitfall trap at the jack pine forest site (8) in June 1979.

Thysanoptera, collected in O'Connor funnels and emergence traps, were identified (Table 14) by B.S. Heming (Department of Entomology, University of Alberta). Most of the thrips species identified were widespread in North America. Many occur on grasses, flowers, and conifers. Members of *Aeolothrips* prob. *intermedius* are facultatively predatory on other small arthropods.

V.R. Vickery (Lyman Entomological Museum, Ottawa) identified five grasshopper species from specimens collected on the Suncor dike. These and some Hemiptera genera are presented in Table 15.

Members of the Endopterygota form the largest group of insects. Of these, the order Coleoptera contains the largest number of species. In spite of the size of the group, beetles are well-known in North America (Arnett 1971; Hatch 1953, 1957, 1961, 1965, 1971). Coleoptera form a large constituent of the insect fauna in the AOSERP study area. Carabids were identifed with keys (Lindroth 1961, 1963, 1966, 1968, 1969a) and these determinations were checked and corrected by G.E. Ball (Department of Entomology, University of Alberta). The 80 species identified are listed in Table 16. S. Ashe (Department of Entomology, Univeristy of Alberta) identified members of the Staphylindae. These

Table 14. Thysanoptera[a] of the AOSERP study area.

Family	Species
Aeolothripidae	*Aeolothrips* prob. *intermedius* Baynall
Phlaeothripidae	*Cephalothrips monilicornis* (Reuter)
	Haplothrips nr. *aculeatus* (F.)
	Lispothrips nr. *brevicrualis* (Shull)
Thripidae	*Apterothrips secticornis* (Trybom)
	Chilothrips pini Hood
	Oxythrips nr. *ajugae* Uzel
	Taeniothrips sp.
	Thrips pini (Uzel)
	T. vulgatissimus Haliday

[a]Determinations by B.S. Heming.

Table 15. Some Expoterygote insects of the AOSERP study area.

Order and Family	Species
Opthoptera	
Tetrigidae	*Tetrix* sp.
Acrididae	*Camnula pellucida* Scudder *Chothippus curtipennis curtipennis* Harris *Melanoplus bruneri* Scudder *M. sanguinipes sanguinipes* Fabr. *Trimerotropis verruculatus verruculatus* Kirby
Hemiptera	
Corixidae[a]	*Artocorixa* sp. *Callicorixa* spp. *Cenocorixa* sp. *Hesperocorixa* spp. *Sigara* spp. *Trichocorixa* spp.
Notonectidae	*Notonecta* spp.
Gerridae[b]	*Gerris remyis* Say *Limnoporis dissortis* Drake and Hams
Saldidae	*Salda* sp. *Saldula* sp.
Tingidae	*Corythucha* sp. *Physatocheila* sp.
Aradidae	*Aradus* sp.
Alydidae	*Alydus* sp.
Homoptera	
Psyllidae	*Psylla floccosa* Patch
Chermidae	*Adelges* sp.
Aphididae	*Parathecabius populimonilis* Riley
Chermidae	*Pineus pinifoliae* Fitch

[a]For a list of species of aquatic Hemiptera, see Barton and Wallace (1980) or Table 33 of Smith (1979).

[b]Determinations by J. Spence.

Table 16. Carabidae of the AOSERP study area.

Species	Site[a,b] 1	2	3	4	5	6	7	8	9	10	11	12	Mildred Lake	Reported in Lindroth (1961 - 1969)
1 *Carabus chamissonis* Fischer	6[c]	4	4	3										*
2 *C. maeander* Fischer										3				*
3 *C. taedatus* Fabricius	1													*
4 *C. serratus* Say		1				2								*
5 *Calosoma frigidum* Kirby		8				1								*
6 *Nebria obtusa* Leconte														*
7 *N. gyllenhali* Schönherr	9	2												*
Opisthius richardsoni Kirby														P
8 *Notiophilus semistriatus* Say								5						
9 *N. borealis* Harris	1													
10 *Diachelia arctica* Gyllenhal										2				
11 *Blethisa quadricollis* Haldeman														*
12 *B. multipunctata* Linne													UV	*
13 *B. julii* Leconte										1				
14 *Elaphrus clairvillei* Kirby										5		2		*
15 *E. olivaceus* Leconte										3				
16 *E. lecontei* Crotch														*
17 *E. americanus* Dejean			1							3				*
18 *E. californicus* Mannerheim														*
19 *E. pallipes* Horn														*
20 *Loricera pilicornis* Fabricius										3				
21 *Dyschirius politus* Dejean														*
22 *D. truncatus* Leconte														*
23 *D. integer* Leconte														*
24 *D. frigidus* Mannerheim							5							*
25 *P. nigricornis* Motschulsky				3					2		2	1		*
26 *D. globulosus* Say														*
27 *D. setosus* Leconte														*
28 *Miscodera arctica* Paykull	1			1	5	2	3	6				1		
29 *Patrobus lecontei* Chaudoir		2		1	1			1		1		1		
30 *P. stygicus* Chaudoir				1										*
P. longicornis Say														P
P. septentrionis Dejean														P
P. foveocollis Eschscholtz														P
31 *Diplous aterrimus* Dejean														*
32 *Trechus apicalus* Motscholsky	4						1							P
33 *Bembidion levettei* Casey														*
34 *B. inaequale* Say														*
35 *B. punctatostriatum* Say														*
36 *B. carinula* Chaudoir														*
37 *B. lapponicum* Zetterstedt														*
38 *B. coxendix* Say														
39 *B. nitidum* Kirby							7							P
40 *B. interventor* Lindroth							4							*
41 *B. kuprianovi* Mannerheim	3													*
42 *B. planatum* Leconte														*
43 *B. grapei* Gyllenhal	3													*
44 *B. bimaculatum* Kirby	3						2							*
45 *B. sordidum* Kirby	3						1							*
B. petrosum Gebler														P
46 *B. rupicola* Kirby	1						3							*
47 *B. obscurellum* Motscholsky	1						3							*
B. sejunctum Casey														P
48 *B. transversale* Dejean														*
49 *B. incrematum* Leconte														*
50 *B. dorsale* Say														*
51 *B. intermedium* Kirby														*
52 *B. semipunctatum* Donovan	3									1				*
53 *B. graphicum* Casey														*
54 *B. nigripes* Kirby														*
55 *B. versicolor* Leconte										1				
56 *B. quadrimaculatum* Linne	2						5							*
57 *B. dubitans* Leconte														*
58 *B. mutatum* Gemminger & Harold				1			1							
59 *B. morulum* Leconte						1		1		2		1		
60 *B. transparens* Gebler										2				*
61 *B. concretum* Casey														*
62 *B. fortestriatum* Motscholsky												1		
63 *Tachys nanus* Gyllenhal														*
64 *Pterostichus lucublandus* Say	5				4		6							*
65 *P. adstrictus* Eschscholtz	7	4	1		4	1	2	4			3			*
66 *P. pensylvanicus* Leconte	3	4	8	2	3	6	5	6			1			*
67 *P. caudicalis* Say														*
68 *P. luctuosus* Dejean														*
69 *P. patruelis* Dejean										3	1			
70 *P. chipewyan* Ball														*
71 *P. barryorum* Ball														*
72 *P. riparius* Dejean	10	2		1		3	1	1		5				*
73 *P. punctatissimus* Randall	3	3		5	6			4	4		5	3		*
74 *P. haematopus* Dejean		7		3	3	2								*
75 *Calathus ingratus* Dejean	6	7	6	3	8	7	4	7						*
76 *Synuchus impunctatus* Say	1				1		4	1						*
77 *Agonum obsoletum* Say													ML	P
78 *A. quadripunctatum* DeGeer					1									*
79 *A. consimile* Gyllenhal										1				*
80 *A. sordens* Kirby	2													*

Continued

Table 16. Concluded.

Species	Size 1	2	3	4	5	6	7	8	9	10	11	12	Mildred Lake	Reported in Lindroth (1961-1969)
81 *A. retractum* Leconte	9		5			4				4		6		
82 *A. gratiosum* Mannerheim				1							2	2		
83 *A. thoreyi* Dejean														*
84 *A. nigriceps* Leconte										1				*
85 *A. bicolor* Dejean														*
86 *A. piceolum* Leconte	9			2							4	1		*
87 *A. ferruginosum* Dejean	3						1							
88 *A. anchomenoides* Randall														*
89 *A. cupripenne* Say							1							P
90 *A. quinquepunctatum* Motscholsky								1	1		2			
91 *A. cupreum* Dejean													1	P
92 *A. affine* Kirby										4				*
93 *A. metallescens* Leconte														*
94 *A. placidum* Say							1							
95 *A. mannerheimi* Dejean		1		1	2			1	1		2	1		P
96 *A. decentis* Say	10	3	6			1		1		1	5	3		*
97 *Amara lacustris* Leconte														*
98 *A. torrida* Panzer														*
99 *A. latior* Kirby														*
100 *A. schwarzi* Hayward			1	1		1	4							
101 *A. obesa* Say														*
102 *A. quenseli* Schönherr							4							*
103 *A. discors* Kirby						1	1							
104 *A. sinuosa* Casey														*
A. pseudobrunnea Lindroth														P
105 *A. patruelis* Dejean							1			3				*
106 *A. erratica* Duftschmid							2							
A. laevipennis Kirby							3							
107 *A. lunicollis* Schiødte														P
108 *A. aenopolita* Casey			1				4	2						*
109 *A. coelebs* Hayward														*
110 *A. littoralis* Mannerheim														*
111 *A. cupreolata* Putzeys														*
112 *A. convexa* Leconte														*
113 *Harpalus amputatus* Say														*
114 *H. lewisi* Leconte							5							*
115 *H. laticops* Leconte														*
116 *H. egregius* Casey														*
117 *H. fulvilabris* Mannerheim			3			2								*
H. carbonatus Leconte														P
118 *H. pleuriticus* Kirby														*
119 *H. fuliginosus* Duftschmid							4					1		*
120 *H. opacipennis* Haldeman							1							*
121 *Harpalellus basilaris* Kirby														*
122 *Trichocellus cognatus* Gyllenhal				1			1							*
123 *Bradycellus lecontei* Csiki														*
124 *B. semipubescens* Lindroth														*
125 *B. georgei* Lindroth														*
126 *Stenolophus conjunctus* Say							3							
127 *S. comma* Fabricius													UV	
128 *Diplocheila striatopunctata* Leconte														*
129 *Badister neopulchellus* Lindroth														*
130 *Chlaenius lithophilus* Say	1											1		*
131 *C. niger* Randall														*
132 *C. alternatus* Horn								1		3				*
133 *Lebia atriventris* Say													UV	
134 *L. viridis* Say														*
135 *L. moesta* Leconte														*
136 *Microlestes linearis* Leconte				1			3							
137 *Metabletus americanus* Dejean														*
138 *Cymindis cribicollis* Dejean	2		1		2	1								P
C. planipennis Leconte														P
139 *C. pilosa* Say					1									
C. unicolor Kirby														P

[a]Site numbers refer to those used in text.

[b] * = recorded from McMurray
P = possible occurrence,
UV = collected in ultraviolet light trap
ML = collected in malaise trap.

[c]Numbers refer to the following abundance size classes
(Class No: specimens collected)

1 : 1	6 : 32 - 63
2 : 2 - 3	7 : 64 - 127
3 : 4 - 7	8 : 128 - 255
4 : 8 - 15	9 : 256 - 511
5 : 16 - 31	10 : 512 - 1023

identifications are presented in Table 17. Other beetle taxa are presented in Table 18.

Most species of butterflies are found early in the summer and, consequently, were missed in the late 1978 field season. Fifty-one species of butterflies were collected in 1979 (see Table 19) and four additional species are known to occur in the area. Approximately 167+ species and subspecies of butterflies are known to occur in Alberta (N. Kondla 1979 unpublished list) Many moths were caught but few were left in identifiable condition after being mutilated by the New Jersey light trap fan blades. Identifications for some of these are presented in Table 20.

Hymenoptera were well-represented by parasitic forms in the AOSERP study area. G. Gibson (Department of Entomology, University of Alberta) identified some Chalcidoidea which are listed in Table 21. Larvae of a rare parasite, *Gonotopus bicolor* Ashmead (Dryinidae), were found protruding through the bodies of leafhoppers (Cicadellidae). Other genera of Hymenoptera identified are also included in this table.

Diptera were perhaps the most abundant and diverse group in the AOSERP study area, and the most difficult to identify. A few genera and species are presented in Table 22.

Arachnids are not insects but are arthropods. Ground dwelling spiders collected in pitfall traps were identified by R.E. Leech (personal communication, 22 October 1979). These determinations are presented in Table 23. Spiders represent a major group of insect predators and should not be overlooked when examining the trophic organization of an insect community.

3.4.2 Insect Fauna Origins

In most parts of Canada, insects have colonized rather than evolved in a region. Insect colonization first took place in the AOSERP study area shortly after the retreat of the Wisconsin ice sheet and first colonization by pioneer vegetation, about 10 000 to 11 000 B.P.

Table 17. Staphylinidae of the AOSERP study area.[a]

Subfamily	Species
Staphylininae	*Philonthus* sp.
	Quedius spp.
	Heterothops sp.
	Staphylinus sp.
	Ontholestes cingulatus undet.
Olisthaerinae	*Olisthaerus* sp.
Oxytelinae undet.	
Tachyporinae	*Lordithon* spp.
	Mycetoporus spp.
	Tachyporus spp.
	Tachinus spp.
	Cilea silphoides
Paederinae	*Paedrus* sp.
	Lathrobium spp.
	Lobrathium sp.
Habrocerinae	*Habrocerus* sp.
Steninae	*Stenus* sp.
Oxyporinae	*Oxyporus occidentalis*
Xanthopyginae	*Creophilus maxillosus*
Omaliinae	*Boreophilus hennigianus* undet.
Aleocharinae	
Oxypodini	
Aleocharini	
Bolitocharini	
Athetini	

[a]Determinations by S. Ashe

Table 18. Beetles (Coleoptera) of the AOSERP study area.

Family	Species
Cicindelidae	*Cicindela longilabris* Say
	C. limbata hyperborea Le Conte
	C. repanda Dejean
	C. tranquebarica Herbst
	C. duodecimguttata Dejean
	C. limbalis Klug
Carabidae (see Table 16)	
Dytiscidae	*Acilius* sp.
	Agabus spp.
	Bidessus sp.
	Carrhydrus crasspies Fall
	Colymbetes sp.
	Deronectes sp.
	Dytiscus spp.
	Graphoderus sp.
	Hydaticus sp.
	Hydroporus sp.
	Ilybius sp.
	Neoscuptopterus sp.
	Rantus sp.
Haliplidae	*Haliplus* sp.
Gyrinidae	*Gyrinus* sp.
Hydrophylidae	*Enochrus* sp.
	Helophorus sp.
	Hydrobius sp.
Staphylinidae (see Table 17)	
Silphidae	*Nicrophorus guttulus* Mots.
	Nicrophorus sp.
	Silpha sagax Mannerheim
	S. lapponica Herbst
Scarabaeidae	*Aegialia* sp.
	Aphodius leopardus Horn
	A. fossar Lin.
	Dichelonyx sp.
	Trox sp.

continued. . .

Table 18. Continued.

Family	Species
Helodidae	*Cyphon variablus* Thumb
Byrrhidae	*Byrrhus* sp.
Buprestidae	*Agrilus* spp. *Anthaxia* sp. *Buprestis langi* Mannerheim *B. maculiventris* Say *B. nuttalli* Kirby *Chrysobothris* spp. *Dicerea tenebrica* Kirby *D. tenebrosa* Kirby *Melanophila drummondi* Kirby *M. acuminata* Dejean *Peocilonota cyanipes* Say
Elateridae	*Ctenicera cruciata* Linn. *Ctenicera* spp. *Lacon* sp.
Lampyridae	*Ellychnia corrusa* complex
Dermestidae	*Dermestus* sp.
Ostomidae	*Ostoma* sp.
Cleridae	*Enoclerus* sp. *Trichodes ornatus* Say
Lucanidae	*Platycerus* sp.
Tenebrionidae	*Upis ceramboides* Linn.
Cephaloidae	*Cephaloon tenuicorne* Le Conte
Nitidulidae	*Glischrochilus* sp.
Cucujidae	*Cucujus clavipes* *Pediacus* sp.
Anthicidae	*Anthicus* sp.

continued. . .

Table 18. Continued.

Family	Species
Coccinellidae	*Adalia frigida* Schn.
	Anetis 15-maculata mali Say.
	Anisocaliva quattuordecimguttata Linn.
	Anisosticra bitriangularis Say
	Coccidula suturalis Ws.
	Coccinella trifasciata Mots.
	C. transversuguttata richardsoni Brown
	C. hieroglyphica Linn.
	C. monticola Mulsant
	Hippodamia quinquesignata Kirby
	H. tredecimpunctata Linn.
	H. spp.
	Hyperaspis sp.
	Scymnus lacustris Le Conte
	Mulsantina hudsonica Casey
	Myzia pullata Say
	Psyllobora vigintimaculata Say
Meloidae	*Epicauta* sp.
	Meloe sp.
Cerambycidae	*Anoplodera aspera* Lec.
	A. minesotana Casey
	A. sexmaculata Linn.
	Asamum atrum Esh.
	Clytus sp.
	Cosmosalia chrysocoma Kirby
	Gnathacmaeops pratensis Laich.
	Hyperplatys aspera Say
	Monochamus scutellatus Say
	Neoclytus muricatulus Kirby
	Obera sp.
	Pronocera collaris Kirby
	Rhagium inquisitor Linn.
	Saperdera calcarata Say
Chrysomelidae	*Altica ambiens* Le Conte
	Altica spp.
	Bromius obscuris Linn.
	Chrysomela aeneicollis Schaeff
	Chrysomela sp.
	Disonychus sp.

continued . . .

Table 18. Concluded.

Family	Species
Curculionidae	*Cleonus* sp.
	Grypus sp.
	Hylobius sp.
	Lepyrus sp.
	Notaris sp.
	Magdalis sp.
	Scythropus sp.
	Sitona sp.
	Sphenophorus sp.
Scolytidae	*Cryphalus ruficollis* Hopkins
	Dendroctonus rufipennis Kirby
	Ips pini Say
	Orthotomicus caelatus Eichhoff
	Pityopthorus sp.

Table 19. Butterflies of the AOSERP study area.

Family	Species
Hesperiidae	*Amblyscirtes vialis* Edwards
	Polites coras Cramer
	Carteroscephalus palaemon mandam Edwards
	Pyrgus centaureae freija Warren
	Erynnis icelus Scudder and Burgess
	E. persius fredricki Freeman
	Thorybes pylades Scudder
Papilionidae	*Papilio glaucus canadensis* Rothchild and Jordon
	P. machaon hudsonianus Clark[a]
Pieridae	*Pieris protodice occidentalis* Reakirt
	P. napi oleracea Harris
	P. rapae Linnaeus[a]
	Colias interior interior Scudder
	C. alexandra christina Edwards
	C. philodice Godart
	C. hecla Lefebre
	C. gigantea gigantea Strecker
	Euchloe ausonides Lucas
	E. creusa Doubleday and Hewitson[a]
Lycaenidae	*Callophrys augustinus augustinus* Westwood
	C. polios Cook & Walton
	Lycaena thoe Guerin-Meneville
	L. mariposa Reakirt
	L. dorcas dorcas Kirby
	Lycaeides melissa melissa Edwards
	Plebejus saepiolus amica Edwards
	P. optilete yukona Holland
	Everes amuntula albrighti Clench
	Glaucopsyche lygdamus couperi Grote
	Celastrina argiolus lucia Kirby
Nymphalidae	*Limenitis arthemis rubrofasciata* Barnes
	L. archippus archippus Cramer
	Vanessa atalanta Linneaus
	V. cardui Linneaus

continued . . .

Table 19. Concluded.

Family	Species
	Nymphalis j-album Boisduval and Leconte
	N. milberti Godart
	N. antiopa antiopa Linnaeus
	Polygonia satyrus Edwards
	P. gracilis Grote
	P. faunus Edwards
	P. progne Cramer[a]
	Phycoides tharos Drury
	Boloria sele atrocostalis Huard
	B. toddi jenistai Stallings and Turner
	B. frigga saga Staudinger
	B. freija Thunberg
	B. eunomia dawsoni Barnes and McDunnough
	B. titania grandis Barnes and McDunnough
	Speyeria atlantis hollandi Chermock and Chermock
	Euptoieta claudia Cramer
Satyridae	*Oeneis macounii* Edwards
	O. chryxus caryi Dyar
	O. jutta ridingiana Chermock & Chermock
	Erebia disa mancinus Doubleday
	Erebia discoidalis Kirby

[a]From data in Bird et al. in prep.

Table 20. Moths of the AOSERP study area.

Family	Species
Aegeriidae	*Vespamima* sp.
Colephoridae	*Coleophora* sp.
Sphingidae	*Calasymbolus myops* Abbot and Smith *Haemorrhagia* sp. *Smerithus jamaicensis* Drury *Pachysphinx modesta* Harris *Smerinthus cerisyi* Kirby
Saturniidae	*Hyalophora cecropia* Linn.
Lasiocampidae	*Malacosoma disstria* Hubner
Notuidae	*Seoliopteryx libatrix* Linne
Arctiidae	*Apantesis virgo* Linn. *Apentesis* sp. *Lexis bicolor* Grote *Parasemia plantaginis* Linn.
Noctuidae	*Anarta cordigera* Thunber *Catocala relicta* Walker *Catocala* sp. *Euxoa* spp.
Liparidae	*Hemerocampa*
Hepialidae	*Sthenopis* sp.
Gracilariidae	*Phyllocnistis populiella* Chambers
Depranidae	*Oreta rosa* Walker

Table 21. Wasps, bees and ants (Hymenoptera) of the AOSERP study area.

Family	Species
Apidae	*Apis mellifera* Linn, *Bombus* spp. *Megabombus* spp. *Psithyrus* spp.
Chaleididae[a]	*Brachymeria* sp. *Spilochalcis* sp.
Dryninidae	*Gonotopus bicolor* Ashmead
Eulophidae[a]	*Euplectrus* sp. *Tetrasticus* sp.
Formicidae	*Camponotus pennsylvanicus* DeGeer *Formica* sp.
Halictidae	*Halictus* sp. *Sphecoides* sp.
Megachilidae	*Coelioxys* sp. *Megachile* sp. *Osmia* sp.
Megaspilidae[a]	*Lagynoides* sp.
Mymaridae[a]	*Gonatocerus* sp. *Polynema* sp.
Perilampidae[a]	*Perilampus*
Proctotrupidae[a]	*Codrus* sp. *Cryptoserphus* sp.
Pteromalidae[a]	*Asaphes* sp. *Cotolaccus* sp.
Scelionidae[a]	*Baeus* sp. *Scelio* sp. *Telenomus* sp.
Sphecidae	*Ammophila* sp. *Bembex americana* F. *Cercerus* sp. *Crabro* sp. *Philanthus bilunatus* sp. *Tachysphex* sp.
Torymidae[a]	*Torymus* sp.
Vespidae	*Ancistrocerus* sp. *Eumenes* sp. *Euodynerus* sp. *Parancistrocerus* sp. *Vespula maculata* Linn. *Vespula* sp.

[a] Identifications made by Gary Gibson, Department of Entomology, University of Alberta, Edmonton

Table 22. Flies (Diptera) of the AOSERP study area.

Family	Species
Calliphoridae	*Calliphora* sp. *Phormia* sp.
Cecidomyiidae	*Mayetiola rigidae* Osten Sacken *Rhabdophaga strobiloides* Osten Sacken
Ceratopogonidae	*Atrichopogon* sp. *Culicoides* sp. *Forcipomyia* sp.
Culicidae	*Aedes* sp. *Anopheles* sp. *Culex* sp.
Muscidae	*Musca domestica* Linn
Simulidae	*Simulium* spp.
Syrphidae	*Eristalis* sp.
Tabanidae	*Chrysops* spp. *Tabanus* spp.
Tachinidae[a]	*Actia interrupta* Curran *Aphria* sp. *Besseria brevipennis* (Loew) *Cylindromyia* sp. *Cyrtophloeba* sp. *Elfia palpigera* (Coq.) *Erynnia tortricis* (Coq.) *Exorista mella* (Walker) *Gonia* spp. *Gymnosoma* sp. *Leschenaultia* sp. *Madremyia* sp. *Microphthalma* sp. *Nowickia* spp. *Omotoma* sp. *Pararchytas* sp. *Peleteria* spp. *Periscepsia helymus* (Walker) *Ptilodexia* sp. *Siphona intrudens* (Curran) *Siphona lutea* (Townsend) *Tachinomyia* sp. *Winthemia* spp. *Zelia* sp.

[a] Identifications made by J. O'Hara, Department of Entomology, University of Alberta, Edmonton.

Table 23. Spiders (Araneida) of the AOSERP study area.[a]

Family	Species
Agelenidae	*Agelenopsis* spp.
Amarobiidae	*Amaurobius* sp. *Callioplus* spp. *Arctobius agelenoides* (em.)
Araneidae	*Araneus* spp. *Neoscona* spp.
Clubionidae	*Agroeca* sp. *Clubiona* spp. *Micaria* spp. *Phrurolithus-Phuruolimous* complex
Erigonidae	*Cornicularia* *Ceraticelus-Ceratinella* spp. *Hypselistes* *Ceratinopsis* *Erigone*
Gnaphosidae	*Gnaphosa* spp. *Zelotes* sp. *Orodrassus* sp.
Hahniidae	*Hahnia* spp. *Neoantistea* spp.
Linyphiidae	
Lycosidae	*Lycosa* spp. *Pardosa* spp. *Pirata* spp. *Tarentula* spp. *Trochosa terricola* Thorell
Salticidae	
Tetragnathidae	*Pachygnatha* sp. *Tetragnatha* sp.
Theridiidae	*Ctenius* spp. *Steatoda* sp.
Thomisidae	*Coryarachne* sp. *Misumena vatia* (Clerck) *Oxyptila* spp. *Philodromus* spp. *Xysticus* spp.

[a]Determinations by R.E. Leech.

Refugia and dispersal routes by flora and fauna have been proposed by many workers (Scudder 1979; Lindroth 1969b; Adams 1902; and others). Each researcher has a slightly different concept of where various floral and faunal elements survived the Wisconsin glaciation, but there is a general concensus of major refugia in Alaska and the Yukon and south of the ice sheets. Other refugia are postulated for the Anderson River area, northern Baffin Island, and the Saint Lawrence region.

When the continental ice sheet retreated, a large ice-free corridor developed east of the mountains, extending from southern Alberta north to the Yukon. Tundra and pioneer floras and faunas were present. As the climate continued to warm, the ice melted back, allowing an advance of these elements northward. Trees colonized much of the area, dispersing in from the southeast (Davis 1976; and others), and crossing the plains with a band of boreal-like forest.

Before vegetation could stabilize the ground, after the ice melt, strong winds blew unconsolidated material around. Much of the AOSERP study area is covered with wind-worked sands which are presently stabilized by jack pine forests.

Much of the information known about Pleistocene phytogeography has been summarized by Matthews (1979), Wright and Frey (1965), and Flint (1971). Recent environments of the great plains were described by Dort and Jones (1970).

When plants and animals emigrated from refugial areas, they may have appeared either to move as a unit within well-defined suture zones or they may have moved independently. Past forests and other biomes cannot be compared directly with those seen today. Jack pine, a common tree in present-day boreal forests, has shifted its distribution to the west (Davis 1976).

Current plant communities represent an assemblage of species which must be considered unique. Contemporary insect communities may respond independently or mirror particular plant communities or species in relation to environmental changes, and they too must be considered unique.

The AOSERP study area is considered to be part of the Boreal forest by most phytogeographers, and is placed in the Canadian faunal life zone by many biogeographers (see Scudder 1979).

All insects in the AOSERP study area have dispersed from distant refugia to colonize this area. Most insects encountered are clearly "boreal" conifer forest types in origin and will have moved north from the large conifer refugium south of the Wisconsin ice sheet. Many of these insects followed the forest northward and eastward. A few insects in the study area may have their origins traced to the Arctic steppe refugium of Alaska and the Yukon. One example is the Yukon blue, *Plebejus optilete*. Other insects will have migrated from the Alaska-Yukon refugia, but by far the majority followed the advancing "boreal" forest north. The origins of a few insects can be traced from grassland biomes, examples being ant lions (Myrmeliontidae) and many of the digger and sand wasps. Introduction of exotic species to date has been limited to the honeybee, household pests, and a few crop pests. With further development and disruption of natural habitats in the AOSERP study area, more exotics will be introduced which will colonize the region. Some indigenous species will increase (see Turnbull 1979).

3.5 INSECT FAUNA OF THE STUDY SITES

The insect fauna of each habitat is composed of generalists found throughout the sample sites and specialists that are restricted in distribution. Larval Diptera, particularly members of the Chironomidae and Fungivoridae, ants (Hymenoptera, Formicidae), and Collembola (Isotomidae and Poduridae) were abundant at almost every site. In this section, selected taxa are emphasized to characterize insect community organization and association at each site. Section numbers here correspond to site numbers.

3.5.1 <u>Riparian Forest</u>

This habitat type was located at the junction of the MacKay and Athabasca rivers on the flood plain. Mud found under bark of balsam poplars showed that flood waters recently have reached 2.25 m above the soil surface at the sample site. In spring of 1979, the site was flooded to a depth of 0.5 m. On 9 May there still were large chunks of ice sitting on the river banks and forest floor. A fresh layer of silt (2 to 2.5 cm) covered the ground. Soil cores showed that organic layers (leaves) alternated with layers of silt.

Vegetation at the site formed several strata. Mature 30 m balsam poplar (*Populus balsamea*), 40 m white spruce, and occasional 25 m balsam fir (*Abies balsamea*) formed the canopy. A zone of short trees and tall shrubs formed the next layer. The main trees involved were 12 m river alder (*Alnus tenuifolia*) and 6 m choke cherry (*Prunus virginiana*). Shrubs composed the next layer. These were primarily 3 m high bush cranberry (*Virburnum trilobum*) and 3 m red osier dogwood (*Cornus stolonifera*) with 3 m willows closer to the river. The herb layer was dominated by abundant 45 cm horsetails (*Equisetum* sp.) with a few grasses. Bare silt formed the ground cover in early spring but was covered by a few mosses later in the season. Proximity to the river created humid conditions favourable to many insects.

Insect populations were diverse and abundant here, with evidence of insect dispersal and colonization abilities. Many types of weevils were found on the vegetation. Cicadellids, coccinellids, Lepidoptera larvae, and aphids were also abundant. Numerous predaceous lampyrid larvae were noted climbing tree trunks to pupate. The ground teemed with predatory carabids which were more abundant here than at other sites. From early June to late August, hordes of mosquitos made sampling difficult. The bark of all dead trees examined bore buprestid beetle galleries in the cambium layer and round holes in the wood from cerambycid and scolytid beetles. Carpenter ant galleries were observed in several tree trunks, but no soil dwelling ants were found in extracted soil cores. Numbers of Diptera and Hymenoptera were within the range of variation of other sites.

3.5.2 White Spruce-Aspen Forest, Coniferous

This habitat is one of three which have similar vegetation, the others being Sites 3 and 6. This site, chosen in 1979, was dominated by mature white spruce (30 to 40 m) with several over-mature aspen (30 to 35 m). The ground cover was rather open. A sparce shrub layer consisted of few high bush cranberry, alder (*Alnus crispa*), and *Ledum groenlandicum* bushes. A spruce-herb stratum was present which consisted of some *Cornus canadensis*, fireweed (*Epilobum angustifolium*), and wintergreen (*Pyrola* sp.). A thick layer of feather mosses carpeted the ground except under spruce trees where there was a 1 to 6 m layer of needles. Mature aspen trees were dying with no replacement. A few aspen saplings were present but appeared to be dying from lack of direct sunlight. There were few spruce seedlings.

Deep shade and humid conditions favoured the presence of large numbers of mosquitos which, like in the riparian forest, made work at this site difficult. The diversity in the plant community was low. Collembola were more abundant in the soil than at any other site, but these were mostly tiny individuals so the average biomass was not large. Thrips were often recovered from soil as propupae and pupae. Ground-dwelling Coleoptera dominated the insect biomass of this site. The trophic structure of the insect community was saprovore based with predators being abundant.

A colony of ground-dwelling *Vespula* sp. was found at this site. Just below Site 2, in 1978, there was a paper wasp nest, shown in Figure 22, made by a colony of bald-faced hornets, *Vespula maculata* L. By 6 September, the founding queen and most workers had abandoned this nest, so it was collected and examined. The nest was 25 cm wide and contained five new young queens, one worker, and four drones. It had four tiers of combs. Cells in the first comb had produced two to three wasps each, judging from the capped layers of remains at the bottom of each cell. The second and third combs, at 14 cm and 13 cm in diameter, were larger than the 12 cm top comb, but cells here had been used only once and 194 cells had not been used at all. The bottom comb was 5 cm in diameter, and no adults had emerged from its 52 cells, although 17 were occupied by larvae. The combs had 987 cells altogether, of which 713 had produced more than 1000 adult wasps. These progeny were the offspring of one overwintered queen active since spring. Another colony of smaller wasps, *Vespula* sp., shown in Figure 23, occupied a hole 35 m above this site. Wasps such

Figure 22. Wasp nest made by a colony of *Vespula maculata* (L.).

Figure 23. Wasp nest in ground made by a colony of *Vespula* sp.

as these might be found at the drier habitats investigated. They are scavengers and insect predators.

3.5.3 Aspen Forest

Aspen trees (*Populus tremuloides*), 8 to 11 m tall, dominated this forest among which were occasional 5 to 6 m spruce (black and white). A patchily dense shrub layer consisted of 1 m buffalo berry (*Shepherdia canadensis*), rose (*Rosa acicularis*), and a few 3 m willows (*Salix* spp.). The herb stratum was composed of grasses, bunchberry, blueberry, and numerous mushrooms in the fall. Scattered mosses grew on the ground. The top 2 to 5 cm of soil was rich in organic material which overlaid a sandy till. The area was gently sloped and well drained.

In 1978, carabid beetle populations were the highest and Collembola populations were the second highest of all 12 sites. In 1979, the Collembola populations were about the average of the other sites, but these individuals were large and made the second highest measured average biomass. Carabid beetles were again important in terms of numbers and biomass, but ants dominated (54% of total) the insect biomass. Spider biomass on the ground was greater here than at any other site, which contrasts with the low spider biomass measured in 1978. It was noted in the 1978 report that the insect biomass/spider biomass ratio here (746/31 mg), was the largest of all the sites. It appears from the 1979 results that spiders invaded this site to exploit the advantage observed in 1978.

Forest tent caterpillars (*Malacosoma disstria* Hübner) caused slight to moderate defoliation of the aspens. Caterpillars fell constantly from the trees and were preyed on by the carabid beetle *Calosoma frigidum* Kirby, commonly known as a caterpillar hunter. Populations of this caterpillar hunter were highest in the aspen forest, reflecting the abundance of its food. Although these beetles kill many tent caterpillars, they do not control their populations because most caterpillars remain out of reach in the tree tops. Sarcophagid and tachinid flies heavily parasitize the tent caterpillars, providing some control of population levels. These flies can effectively attack the caterpillars in the tree tops.

Mushrooms were abundant in this habitat in September. These are a highly nutritious food and were heavily attacked by insects. Collembola were found feeding on the gills and staphylinid beetles fed inside the stem and cap. Fungivorid larvae, which dominate soil insect populations at almost every site, were also abundant in mushrooms, as can be seen in Figure 24. In the soil, they feed on fungal mycelia, while a mushroom body is a dense concentration of mycelia. Hence, what appears to be a unique phenomenon of maggots in mushrooms is actually an explicit example of the normal food habits of these soil dwelling larvae.

3.5.4 Black Spruce Bog

The black spruce bog was dominated by 4 to 6 m black spruce, some as old as 200 years. A low shrub stratum was dominated by 0.5 m Labrador tea (*Ledum groenlandicum*). Many dwarf shrubs such as bog cranberry (*Vaccinium vitis-idaea*), dwarf cranberry (*V. caespitosum*), and willow (*Salix* spp.) could be included in the herbaceous zone. Herbs were sparse. These included rushes (*Juncus* sp.), horsetails, and sundews (*Drosera rotundifolia*). Sundews are entomologically interesting plants. Insects usually eat plants, but this is a plant which "eats" insects. Bogs are short of fixed nitrogen in the soil so the sundew's predatory habit provides it with fixed nitrogen. A high water table limited the flora. Mosses were very abundant with sphagnum and other mosses forming hummocks on which many of the vascular plants grew.

In spite of bogs presenting sub-optimal growing conditions, many plants and animals are found only in bogs. Several species of bog butterflies were found here, including *Boloria frigga saga*, *Oeneis jutta ridingiana*, and *Erebia disa mancinus*. Certain ground beetles were restricted to bogs, such as *Dyschirius nigricornis* which lives in moss hummocks.

This habitat tended to have a low diversity of insects although their biomass was about average. In both 1978 and 1979, the

Figure 24. Mushroom (*Hebeloma* sp.) heavily attacked by fungivorid fly larvae (arrows) and staphylinid beetles.

pyrethrum foliage samples produced the smallest number of insects, with the lowest biomass, of the 12 sites. The combined spider biomass was the lowest of the 12 sites in 1978 and was low in 1979. It verified the low insect figures and suggested that insect production here is lower than at the other sites. These figures contrast sharply with the richness of the other wet habitats, like Sites 9, 10, and 12. Ubiquitous ants were a major part of the insect biomass collected at this site.

3.5.5 Mixed Coniferous Forest

The mixed coniferous forest was composed of 18 to 20 m jack pine, 2 to 10 m black spruce, 8 to 10 m white spruce, and a few aspens and birches less than 10 m. Scattered alder and birch formed an ill-defined shrub stratum. Bunchberry, grasses, lichens, blueberry and fireweed were scattered over the ground. A thin layer of moss covered the ground in most places. The soil was sandy and well-drained.

Early in spring 1979, a resident of Fort MacKay cut a number of jack pines into cord wood. This wood was piled and left to dry over the summer. Many species of wood borers and bark beetles were collected on these wood piles. Species of buprestids (*Buprestis maculiventris, B. nuttalli, Chrysobothris* sp., *Dicera tenebrosa,* and *Melanophila drummondi*), cerambycids (*Monochamus scutularis, Rhagium inquisitor, Anaplodera* sp., and *Neoclytus* sp.), and scolytids (*Ips pini*) were found colonizing the logs. Maximum activity on the logs occurred from mid-June to early July. Clerids, predators of scolytids, arrived on the logs early in the season. Later, in July and August, ichneumonid wasp parasites became common. These wasps parasitized wood borer larvae by pushing their ovipositors (up to several cm long in some species) through the bark and wood into the larvae.

Insect populations here were intermediate to those of the other forest sites in 1978, but were the second largest in biomass per square metre in 1979. Diptera larvae in the soil accounted for much of this biomass, while ants accounted for an even larger amount. The ratio of carnivores to potential prey biomass found by net sweep sampling was 1.06, the largest ratio calculated. This ratio exceeds the theoretical support limit of the prey population. The apparent cause of this high ratio was the pile of cord wood which attracted large numbers of predatory and parasitic insects. These were swept off their resting sites on vegetation and, because the static populations of insects in this habitat were low, this influx of carnivores overbalanced the ratio that was calculated.

3.5.6 Mixed Forest

This is the third aspen forest type. It had a highly diverse tree composition with 4 to 6 m poplar, 7 to 8 m birch, 10 m tamarack, 8 to 10 m white and black spruce, 10 to 12 m jack pine, and 8 to 10 m aspen. Aspens were the most abundant tree species. The shrub stratum consisted of 5 m willow, 4 m alder (*Alnus crispa*), and considerable numbers of 1 m buffalo-berry. A few other shrubs were present, including dogwood, rose, and Labrador tea, with bearberry, cranberry,and blueberry in the herb stratum. The herb stratum consisted of various grasses, twin flower (*Linnaea borealis*), some fireweed, and bunchberry. Few mosses and lichens grew on the soil surface. A rich, 2.5 to 3 cm organic layer of leaves covered the sandy ground. The site is a confusing mixture. It appears to be a young forest which has not sorted itself out via competition.

Insect population numbers and biomass at this habitat were intermediate to similar dry forest sites in 1978, but were lowest of the range in 1979. The herbivore load revealed by net sweep sampling was rather heavy, reflecting the diversity and complexity of the plant community which supported this herbivore population. In late 1978, some insect inhabitants that were found included soft scales (Coccidae) on grass stems. Several adjacent stems bore up to 14 scales which tended to be packed together and resembled white mold. Scales collected in early September proved to be masses of eggs beneath the body of the mother. These soon hatched into tiny crawlers which would have dispersed by walking to other plants before settling to develop into a scale. Two parasitic chalcidoid wasps and a fly were reared from the egg clusters. An ant mound was dug up but, by

6 September, the colony had retreated deeply into the ground and no ants were found down to a depth of 35 cm.

3.5.7 Non-Vegetated Area

This road-fill scrape would appear to be non-vegetated from an aerial photograph, but close examination showed that it had a thin cover of 1 m tall clover (*Melilotus alba*) and fireweed, various annuals, and some grasses. Sand, a porous, nutrient-poor substrate, formed the soil here. Its inability to retain moisture causes water stress to plants during periods of low rainfall. Also, it allows extremes in microclimate to develop. On the bare sand surface, temperatures may climb to 75°C even when the ambient air temperature is cool (Chapman et al. 1926).

Insects living on open sand areas must cope with extremes in temperatures, rapid fluctuation of temperatures, scarcity of water, abrasive action of the sand, and often a dearth of food (low primary production). These extremes limit the types and numbers of insects able to colonize a sandy non-vegetated area.

Few insects were found in soil samples at the non-vegetated site, reflecting the lack of a humus layer. No Collembola were collected here but they were found at every other site. Sweep net samples yielded greater than average numbers and biomass of insects due to the capture of bumblebees, wasps and flies visiting clover flowers. In general, insects which colonized the sand pit were usually larger and highly vagile insects. Carabids and tiger beetles (Cicindelidae) preyed on insects blown onto the sand from the surrounding forest or captured insects which fell off the rapidly growing clover plants. The lack of spiders in soil samples indicates that the predatory ground beetles are more effective competitors here. Predatory wasps (such as the sphecids *Ammophila* sp., *Cercerus* sp., *Crabro* sp., and *Podalonia* sp.) and spider wasps (Pompilidae) nested in the open sand but left the sand pit to hunt for prey in the surrounding forest. Much of the food web here depended on importation or passive transport (wind blown) of food. The net sweep samples showed a dearth of carnivores at this site, but pitfall trapping and observations indicated the opposite. It would be necessary to accurately sample the surface fauna to produce an acceptable trophic analysis of the fauna at this site. It is clear that the structure here differs from other sites. There were fewer but larger insects. This area was definitely not void of insect life.

3.5.8 Jack Pine Forest

Young jack pine (6 to 8 m) dominated this habitat but 2 to 6 m black spruce were dominant along the habitat edges. Few 3 to 4 m aspen were scattered through the forest. The shrub stratum was almost non-existent except for a few brushes of Labrador tea. Ground surface vegetation consisted of lichens, some mosses, cranberry, blueberry, bunchberry, fireweed, and a few grasses. The soil consisted of 2 to 3 cm of humus underlain by a clay-sand mixture.

Insect populations were below average in this comparatively arid habitat. No ants were found here in 1978 and few were found in 1979. The sandy soil appeared to be suitable for ground colonies. This partly reflects the low productivity of vegetation on the well-drained sand. Foliage inhabiting Collembola belonged to the families Entomobryidae and Sminthuridae while soil Collembola were mostly members of the Isotomidae and Poduridae. This was true for all habitats. Chermids (Homoptera), which are conifer-feeding aphids, were abundant in 1978 but not in 1979.

In the interval between 8 to 22 June 1979, approximately 40 g (wet weight) of adult Collembola, of the species *Proisotoma (Ballistrura) muskegensis*, were collected, mostly in one of the four pitfall traps at this site. This mass of Collembola had a minty odour. These observations are evidence that this species produced an aggregation pheromone for the purpose of mating. No sexual congress occurs in Collembola (K. Christiansen, personal communication, 1979). Rather, females pick up spermatophores which males deposit on stalks. The chance for a female to randomly blunder into a sperm garden when she is sexually ready must be low. Enter the phenomenon of a pheromone. Sperm gardens become advertised brothels to both sexes (as opposed to a lone wolf strategy) and both sexes become sexually active. The mass death of a sex-hungry horde of Collembola in a pitfall trap would rarely have a natural equivalent in an ecosystem.

Ground beetles captured in pitfall traps were primarily forest associated species, but a few riparian associated species were captured (such as *Chlaenius alternatus*). Another carabid, *Miscodera arctica*, usually a rare species, was collected in abundance at this site. Helodids were commonly found resting on the vegetation. Their larvae are aquatic (Arnett 1971), hence the adults flew in from the surrounding wetlands.

3.5.9 Semi-Open Tamarack Bog

Vegetation in this habitat was rather diverse. The woody plants were 1 to 3 m tamarack, 1 to 5 m black spruce, 2 to 3 m willow, and 1 to 2 m birch. Mosses, lichens, and diverse vascular plants formed a dense surface mat over organic debris. Water frequently pooled in troughs. This habitat probably has not reached a climax stage. It appears that the area was burned over about 20 to 25 years ago, leaving occasional charred snags protruding from the bog. Most of the trees at the site were young. A single 9 m spruce was present.

Fly larvae were abundant in the soil at this habitat, as were spiders (although their biomass was not great because these were smaller erigonids and linyphiids). This follows a pattern of fly dominance at the aquatic sites, except for the spruce bog, and accompanying spider populations to feed on these flies. Psocoptera were uncommon here compared to other sites, showing their habitat preference for trees with broad leaves. Ants were uncommon here due to a shortage of suitable dry nest sites. The biomass of sweep netted insects was low. No bog butterflies were captured here which contrasts to the black spruce bog. Very few ground beetles were collected and most of these were commonly found at other sites.

3.5.10 Fen

The dominant vegetation on the fen was 70 to 90 cm sedges (*Carex* sp.) with woody plants along the creek margin and edge of high ground. These were 2 to 3 m willow, 1 to 1.5 m birch (*Betula* sp.), a few 6 to 8 m tamarack, one 6 m black spruce, and 1 to 2 m black spruce. Aspen were found on high ground. The "ground" consisted of a floating mat of organic debris. Water was supplied by a brown water, muskeg drainage creek during 1978. An all terrain vehicle was driven through the fen in 1978, disturbing the organic mat in several places. No such disturbance occurred in 1979 and *Carex* grew back in some of the damaged areas.

The fen is almost a unique habitat in the AOSERP study area with many species of carabids collected only in this habitat. These include *Carabus maeander, Diachelia arctica, Blethisa julii, Elaphrus olivaceus*, *Loricera pilicornis*, *Agonum nigriceps*, *A. affine*, and others. Many other species were found which were also collected in other wetland habitats (riparian forest and deciduous shrub wetland). The high diversity of carabids reflects, in part, the long-term stability of the fen environment in combination with the large insect production. Decomposing vegetation, coupled with a high rate of primary production, provided food for the abundant insects found here.

Fly populations reached their highest in the fen. The biomass of each group of larvae was high, including that of the Ceratopogonidae. Members of this family of biting flies may feed upon other insects. One mosquito larva was washed into a pitfall trap here. Sweep samples confirmed the over-whelming abundance of flies and parasitic wasps in this habitat. These insects represent a large potential food source for insectivorous amphibians, birds, and shrews. Ants were also quite abundant here. Ant colonies were concentrated just above the water table in the fen vegetation and hence, they may be over-represented here as opposed to areas where colonies extend deeper into the ground (in other words, ant populations are actually under-represented at these other sites).

3.5.11 Lightly Forested Tamarack

Vegetation at this site was a cross between the open tamarack bog and black spruce bog. Trees present consisted of 5 to 6 m tamarack and 6 to 7 m black spruce. Shrubs were 2 m alder, 1 to 2.5 m willow, 1 m black birch (*Betula pumila*), and 30 cm Labrador tea. Ground cover consisted of peat and feather mosses, *Carex*, and cranberries. There was no apparent lichen cover. The soil consisted of a mat of organic debris. The water table was high but few pools formed in low areas.

Adult beetles contributed significantly to the insect biomass of this site. These were carabids and staphylinids, which are scavengers, predators, and fungivores, and fungivorous Pselaphidae. Ants again made a major contribution to the insect biomass.

Many insects found at this site were the same as those found in the black spruce bog. A few specimens of the bog butterflies *Boloria frigga saga*, *Erebia disa mancinus*, and *Oenis jutta ridingiana* were found. A rare butterfly in Alberta, the Yukon blue (*Plebejus optilete yukona*), was commonly found at this site and at no other sites in the AOSERP study area. Larvae are reported to feed on cranberries (Ehrlich and Ehrlich 1961). The bog carabid *Dyschirius nigricornis* was collected here. Two other species of carabids, *Agonum gratiosum* and *Pterostichus punctatissimus*, common to the black spruce, semi-open tamarack, and lightly forested tamarack bogs, were collected here.

3.5.12 Deciduous Shrub Wetland

The dense shrub vegetation here was dominated by 1 to 3.5 m willow and alder. A large number of spruce seedlings mixed with alder and willow seedlings grew on rotting logs. Under the willow and alder shrubs, an herb understory of grasses and horsetails was present. Mosses blanketed the ground. Poor drainage resulted in frequent flooding from rains. The soil was organic, similar to the type found in bogs. This site was once forested by tall white spruce but these trees were killed by a fire, leaving rotting trees strewn throughout the site.

Many of the insects captured here were a mixture of types. Riparian carabid species were present (*Agonum retractum* and *Elaphrus clairvillei*) and colonized the margins of pools. Some bog carabids (*Pterostichus punctatissimus* and *Dyschirius nigricornis*) and forest species (*Agonum decentis*) were found here. This mixture of insect elements is closely tied to the succession pattern back to a spruce forest. Riparian species were present because of frequent flooding similar to river banks. Bog species were present because of extensive development of a moss cover similar to that found in bogs. Forest species wandered in, attempting to colonize the site as it slowly reverts back into a spruce forest.

Diptera larvae dominated the insect biomass of this site both in 1978 and 1979. These were followed closely in biomass by ants in 1978, and exceeded slightly by beetles in 1979. Leafhoppers (Cicadellidae) and other Hemipteroidea made the third most significant group in terms of biomass at this site and were more significant here than elsewhere. These insects feed on flowing sap. Most of the *Gonotopus bicolor* (Dryinidae) parasites of leafhoppers were found at this site. Chrysomelid beetle adults and larvae were common on alder leaves here, but these dropped to the ground when disturbed and could be under-represented in foliage samples. Sweep samples indicated that insects at this site were more diverse than the average of the sites.

4. DISCUSSION

4.1 STANDING CROP NUMBERS AND BIOMASS

To determine standing crops of insects at the 12 study sites, soil was sampled quantitatively at every site and foliage at 10 sites to produce the data in Tables 3 to 6. These data are experimentally determined but they underestimate the actual standing crops of insects. This proposition is proven to some extent by the present data. Storage of specimens in alcohol caused weight loss. For light trap specimens, it was determined that specimens at capture weighed 1.16 times their alcohol storage weight. Therefore, the biomass of invertebrates reported in Tables 4 and 6 was increased 1.16 times from the weights given in Tables 27 to 82 of Appendix 7. The leaf and stem damage surveys revealed the presence of gall and scale insects which were not collected by the pyrethrum spray technique. Aphids were abundant on leaves, but the largest number found with the pyrethrum technique was 15 individuals$\cdot m^{-2}$, signifying extremely low collection rates.

Other investigators have analyzed the inefficiency of soil extraction techniques. Edwards and Fletcher (1971) showed conclusively that the techniques commonly used to extract soil invertebrates varied in efficiency and that Tullgren funnels, as were used in this study, recovered fewer invertebrates than did MacFayden high gradient funnels. Porter and Lousier (1975) extracted soil invertebrates from the AOSERP study area with a MacFayden system and reported Collembola populations of 1300 to 2300$\cdot m^{-2}$. The soil-dwelling Collembola populations reported here are 0 to 4848 individuals$\cdot m^{-2}$ for the 12 investigated sites. Inefficiency in sorting is an inherent problem. Willard (1972) found that his technicians recovered 67% of 1.5 mm beetle larvae he added to soil samples. He also reported a recovery rate of 48% of the enchytraeid worms added to soil cores and subsequently extracted in O'Connor funnels.

Further inefficiencies are inherent in insect sampling procedures. Individuals are killed and injured while cutting and handling soil cores. Unknown numbers simply do not leave the core.

Large-winged insects occasionally flew from pyrethrum soaked foliage and landed elsewhere. A great source of inaccuracy, illustrated in Figure 25, is the habitat area unsampled with pyrethrum. Tree foliage was sampled to 3 m; low foliage and foliage taller than 3 m were unsampled. There are no adequate methods available for sampling insect populations of these habitat layers, and the inadequate methods available are extremely labour intensive.

Sampling problems encountered during this study indicate that statistical analyses of the reported population data are inappropriate. Collembola, for example, appear to respond to weather. In wet periods, they disperse widely, even onto foliage; while in dry weather, they appear to aggregate in suitably humid sites (perhaps those in unsuitable sites die) and to travel deeper into the humus. It appears that greater numbers of carnivorous insects are collected than of herbivores and saprovores. Larger individuals are more likely to be collected than smaller ones. It must be realized that the mean numbers of animals reported in Tables 3 and 4 represent many different species and individuals at many different stages of development. Individuals of some species may complete development in a portion of a season and be unrepresented in soil samples during the rest of the season; while other individuals may develop very slowly and yet be continuously present (e.g., oribatid mites). Contagious distributions of individuals in favorable sites, as was shown for larvae of four fly families in Table 2, mean that parametric statistical treatments of this transformed data will have no predictive significance. Adequate statistical analyses of the population data reported would require more information than has been presented here, as well as a second volume of analyses equal to the size of the present report. The authors are not confident that such analyses would be meaningful.

The actual standing crops of insects may easily be twice the biomass, and more than twice the number, reported here. This reflects the present technology of insect population studies. The impact of insects on the rest of the ecosystem could be more accurately assessed if better sampling techniques were known. What was seen and

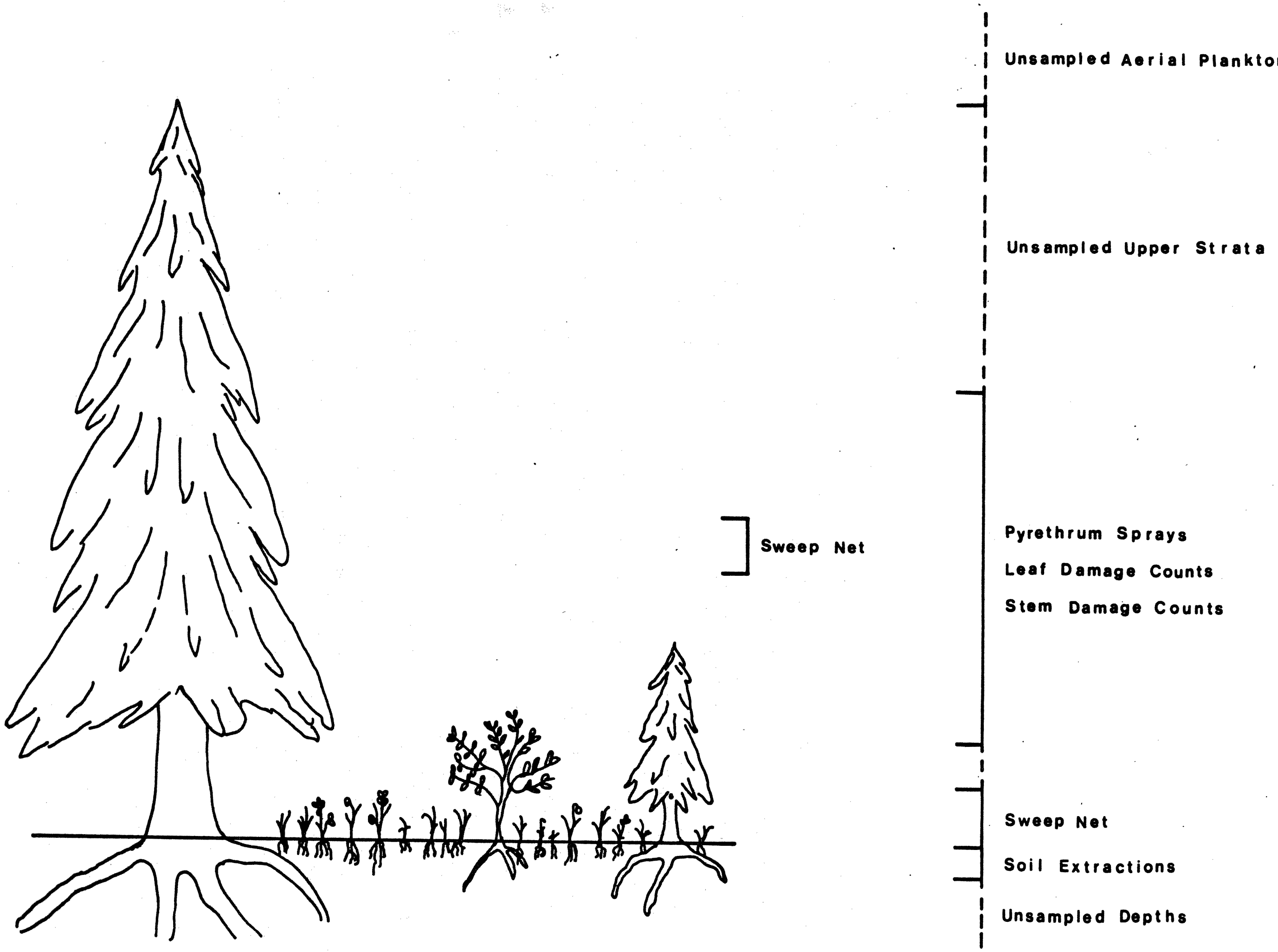

Figure 25. Habitat areas sampled in this survey versus those left unsampled.

measured was reported, but with the understanding that these data understate the significance of the insect fauna.

4.2 TROPHIC STRUCTURE OF INSECT COMMUNITIES

The trophic structure of an insect community varies with the habitat. Much entomological literature deals with agricultural insects. This abundance of literature can lead to general concepts about the structure of insect communities that emphasize destructive phytophagous insects and their parasites, but which do not necessarily apply to insect communities of undisturbed areas. For example, conclusions about the insect fauna associated with cultivated collards (Root 1973) emphasize herbivores, parasites, and predators. However, these plants were grown in cultivated soil, were irrigated and fertilized for rapid growth, and the plants were harvested at maturity. The soil insect community was disrupted by cultivation, the food resource was of high quality for herbivores, the diversity and quantity (especially for soil insects) of available food was reduced, and the community equilibration time was minimal. AOSERP vegetation conditions are quite unlike agricultural environments.

Within natural forest habitats, the trophic structure of the crown strata (Martin 1966), foliage canopy (Whitaker 1952; Reichle et al. 1973), and soil insect communities (Englemann 1968; Edwards et al. 1970) have been examined. The field layer insect fauna of a grassland (e.g., Evans and Murdoch 1968) may offer a parallel to the structure of the field layer fauna of forest understory vegetation. Trophic structures described in the cited above-ground investigations emphasize herbivore and parasite populations, while the soil studies focus heavily on saprovore interactions. A study of an Arctic ecosystem (Ryan 1977), where the complexity of interactions in the ecosystem were reduced, demonstrated that the main energy flow pathway of arctic insects was a decomposition food chain in the soil.

The trophic structure of AOSERP insect communities must be examined through literature on the feeding habits of these insects. Three trophic groups were recognized here: herbivores, carnivores, and saprovores. Herbivores are insects which consume and digest plant tissue which is usually live or recently killed. Carnivorous insect lifestyles are variable (Ealey et al. 1979) and include direct predation, internal parasitism which ultimately causes death to the host, and short-term parasitism such as blood feeding by mosquitoes. Predation may be opportunistic but not necessary for survival, as in the case of autogenous mosquitos which do not require a blood meal to produce eggs. Sporadic cannibalism and predation may be observed in insects which are not obligate carnivores. Many categories can be used to describe the remaining feeding habit types, but these will be limited here to the category of saprovore. A saprovore is an organism which requires some microbial action on its food before it is digested. Consumption of dead meat falls into a grey zone between the definition of carnivore and saprovore. Some larval muscoid Diptera have pharyngeal ridges which sieve fluid and bacteria-sized particles and exclude larger food chunks (Dowding 1967). In a putrid corpse, these larvae appear to feed on flesh, but may in fact derive significant nutrition from bacteria and bacterial wastes. These larvae could be called carnivores if found in meat and saprovores if found in soil litter. The actual diets of individuals of soil-dwelling species may be quite complex and include vegetable matter and freshly killed microinvertebrates as well as microbial products.

The trophic structure of insects at the 12 AOSERP sites was evaluated through combining the biomass data of Tables 5 and 6 with feeding habit information from Borror and DeLong (1971). Feeding habits were evaluated for the insect families listed in Table 13, then summarized by order. The proportions used are given in Table 24 (A). This information, multiplied by Tables 5 and 6 biomasses, gives an estimate of the biomass of herbivores, carnivores, and saprovores at each site.

The results of these calculations are given by site totals in Table 24 (B and C). In 1978, the accumulated total of herbivores was 1.07 g, of saprovores 0.78 g, and of carnivorous insects 0.87 g. Adding 0.38 g of spiders makes the carnivorous arthropod total 1.25 g. The total prey biomass of herbivores and saprovores was 1.85 g. The ratio of carnivore to prey biomass was 0.68. In 1979, the accumulated

Table 24. Evaluation of trophic levels of quantitatively sampled insect populations at 12 AOSERP study sites.

A. Percent of population energy derived at each trophic level.

Taxon	Herbivore	Saprovore	Carnivore
Collembola		100	
Psocoptera	10	90	
Hemiptera	80		20
Neuroptera			100
Coleoptera	10	60	30
Lepidoptera	100		
Diptera	20	70	10
Hymenoptera	10		90
Formicidae	40		60
Tenthredinidae	100		
miscellaneous insects	40	30	30
ARANEIDA			100

B. 1978 Average biomass found at each trophic level (A x average standing crop)

	Herbivore	Saprovore	Carnivore:Insect	Spider
Total	1.07 g	0.78 g	0.87 g	0.38 g

$$\frac{\text{carnivores}}{\text{potential prey}} = \frac{0.87 + 0.38}{1.07 + 0.78} = \frac{1.25}{1.85} = 0.68$$

C. 1979 Average biomass found at each trophic level (A x average standing crop)

	Herbivore	Saprovore	Carnivore:Insect	Spider
Total	1.99 g	2.22 g	2.63 g	0.75 g

$$\frac{\text{carnivores}}{\text{potential prey}} = \frac{2.63 + 0.75}{1.99 + 2.22} = \frac{3.38}{4.21} = 0.80$$

total biomass of herbivores was 1.99 g, of saprovores 2.22 g, and of carnivorous insects 2.63 g. Adding 0.75 g of spiders makes the carnivorous arthropod total 3.38 g. The total prey biomass of herbivores and saprovores was 4.21 g. The ratio of carnivore to prey biomass was 0.80.

The total biomass of the 12 sites is convenient to discuss as it represents the AOSERP area ecosystem. The discussion of this totalled set of data can be compared to data from individual sites.

The ratio of insectivorous arthropods to prey appears to exceed theoretical limits. Waldbauer (1968) reviewed insect feeding studies and presented data to show that insects convert about 65% of digested food into body tissue. Since all prey insects cannot be captured, nor can they be 100% consumed and digested, the carnivore to prey biomass ratios (0.68 to 0.80) are too high. There are several reasons why this ratio was obtained. Carnivores prey upon other carnivores which means that the carnivore biomass represents potential prey as well. At maximum, this would give ratios of 1.25 g carnivores/3.10 g prey = 0.40, and 3.38 g carnivores/7.59 g prey = 0.45, which are thermodynamically plausible. Carnivores actively hunt their food, while prey insects tend to conceal and not expose themselves to danger until mating and dispersal activities. Thus, carnivores are more likely to be exposed to and killed by insecticides than are the phytophagous insects that they feed upon (VandenBosch and Messenger 1973). The present authors have indicated that the standing crop biomass of insects may be double the values given here due to inherent sampling inefficiencies and habitat layers remaining unsampled. This exercise demonstrates that the carnivore trophic level may be over-emphasized relative to other trophic levels due to sampling bias. It also argues that the carnivore trophic level is exploited to near theoretical limits, supporting the proposition that insects are their own worst enemies.

In 1978, herbivores were the best represented trophic level, but this was not true for these samples in 1979 (Table 24). Sweep net samples in 1979 indicated that herbivores were the dominant trophic group (2.6 g herbivores vs. 2.9 g all other trophic levels collected).

Foliage feeding, seed gathering, and sapsucking insects form the bulk of this trophic level. Pollen and nectar feeding and the consumption of other plant parts appear to be less significant phenomena.

The saprovore trophic level was well-represented, with nearly as many saprovore insects as carnivore insects (in 1978, 2.83 vs.2.94 g; in 1979, 2.22 g vs.2.63 g). Animals in this group came predominantly from the soil, the habitat zone least efficiently sampled. Why should a large biomass of insects be found in this trophic level, one level removed from the primary production source? Why are there not more phytophagous insects and only a small biomass of saprovore insects? The answers exist in the nutritional requirements of animals versus the composition of vegetation. Animals are protein-based organisms. Protein must be obtained from the diet as animals cannot manufacture it themselves. Plants are cellulose structures. The plant world consists largely of wood, as in plant cell walls, lignin, bark, and xylem, etc. Protein is concentrated in the living, growing parts of plants, such as leaves, flowers, seeds, roots, and the cambium layer of bark. Plant protein is present in limited supply, protected by cellulose walls, while carbohydrates are available far in excess of the requirements of animals. Fungi and bacteria decompose vegetation, oxidizing carbohydrates, weakening wood structure, and concentrating protein in their own bodies. These microbes are then fed upon by saprovore insects. Thus, while insect saprovores are at least one trophic level removed from the primary food source, carbohydrate energy loss is not dietarily important to them. This saprovore pathway results in easier accessibility of protein food.

This exercise required generalizations about insect feeding habits. These may be disputed, especially the percent contribution to the diet of each trophic level. The decision to assign ant biomass to 40% herbivores and 60% carnivores in particular may have caused an overestimate of the carnivore biomass. Dietary plasticity may allow ants to be opportunistic carnivores when meat is available and herbivores when it is scarce. However, this approach does demonstrate the relative importance of carnivores may be over-estimated in ecosystem studies. It offers evidence that the role of saprovores may be under-estimated. These testable hypotheses represent a challenge to traditional concepts of herbivore-carnivore dominance of the trophic structure of an ecosystem.

4.3 INSECTS AS ENVIRONMENTAL MONITORS

The field of environmental monitoring to evaluate man-caused changes is quite new (Hilchie and Ryan 1980). The International Biological Program recently generated ecosystem studies in environments all over the world as part of a program to quantitatively evaluate the structure of ecosystems. These study sites were situated in areas unlikely to be disturbed for long periods of time so environmental changes could be measured on a global scale in the future. Insects have much potential as environmental monitors. For example, fruit flies, *Drosophila melanogaster* Meigen, have been used as experimental animals in genetics for years. By analogy, flies in natural environments have potential as monitors of mutagenic and teratogenic compounds, such as might occur in chemical dump sites.

In this study, insect numbers and biomass are being environmentally monitored. Major changes in the taxonomic composition of these insects, or changes (particularly reductions) in insect numbers and biomass, indicate environmental changes. Evaluation of these changes may be difficult because of the complexity of events in any ecosystem. Insect distributions are highly contagious which cause great variability in data and reduced predictive significance of data means. The solution to this problem appears to lie in taking large numbers of samples and in evaluating insects on a trophic level basis so that, while taxa may vary, equivalent functions within the ecosystem can be examined, which should stabilize fluctuations.

In their evaluation of insects as environmental monitors for the Syncrude lease, Porter and Lousier (1975) offered several suggestions. The value of some of these is disputed, including the use of the dung beetle *Aphodius* sp. and two species of March flies as environmental monitors. However, a program to monitor species of carabid beetles was initiated at the 12 AOSERP habitat sites, as these authors suggested. Carabidae of the AOSERP study area are perhaps the best known group of insects (with exception of the butterflies). There are 139 species known from the vicinity of the AOSERP study area, and representatives of 76 species were collected at the 12 sites. This preliminary pitfall trap study indicates carabid distributions in time and space and also reveals their relative and specific commonness.

Pitfall traps have been used successfully in biomonitoring studies (Freitag et al. 1969; Freitag and Hastings 1973; Freitag in press). They are inexpensive to set up and operate, capable of operating over a period of time in a wide variety of habitats, trap both nocturnal and diurnal arthropods, do not select for rare species or against common species, and give a good indication of surface activity. Carabid beetles possess features suggested by Jenkins (1971) as important for biomonitoring programs. They should be: (1) abundant, (2) cosmopolitan, (3) sensitive to pollution, (4) show a well-defined response, (5) non-target species, and (6) show changes by remote sensing. If one species of carabid is to be used, *Calathus ingratus* fulfills these criteria the best. In addition, a pitfall trapping program would be cost effective for the purposes proposed.

Emergence traps yield measurements of the productivity of winged insects (Ryan 1977). Declining plant productivity in the AOSERP area due to pollutants might not be as evident from examination of standing crop biomass as from a decline in the rate of insect production. Insect production declines will confirm independently any observations of reduced plant productivity. Populations of insect species which are vulnerable to pollutants will be reduced in emergence trap sample results. The rates of winged insect production will directly affect the great biomass of vertebrate insectivores which depend on these insects as food (see Ealey et al. 1979). Thus, emergence traps, shown in this study to be effective in the AOSERP study area, would monitor a critical biological phenomenon.

Porter and Lousier (1975) also suggested that pollutant SO_2 gas could weaken trees in the AOSERP study area, making them susceptible to insect attack (Stark et al. 1968; Wong and Melvin 1973). Among the insect groups likely to be involved in such attacks, the bark beetle family Scolytidae is the most potentially damaging to trees. For example, between 1939 to 1953, an estimated 11.25 x 10^6 m^3 of spruce were destroyed in a bark beetle outbreak in Colorado (Borden 1971). Because these beetles are so potentially damaging, the tree damage survey (Table 12) was initiated to determine present beetle infestation levels. None was found in this survey. A list of the species of bark beetles known from or likely to occur (Bright 1976) in the AOSERP study area is presented in Table 25. This information is a preliminary step for any program to monitor populations of these potentially destructive insects.

Environmental research in the AOSERP study area should begin to emphasize biomonitoring programs. Baseline ecosystem information has been collected. Now it appears that research emphasis should focus on detection of environmental changes which occur as a result of air pollution and human activities in the study area.

Table 25. Bark beetles (Scolytidae) which may occur in the AOSERP study area.

Bark Beetle	Tree Host: *Abies balsamea*	*Larix laricina*	*Picea glauca*	*Picea mariana*	*Pinus banksiana*	*Populus tremuloides*	*Salix* spp.
Carphoborus andersoni			+	+			None in AOSERP area
C. carri			+		+		
C. sansoni			+				
Cryphalus ruficollis[a]	+		+	+			
Crypturgus borealis			+	+			
C. pusillus	?		?				
Dendroctonus murrayanae			+		+		
D. punctatus		+	+				
D. rufipennis[a]			+				
D. simplex		+					
D. valens		+	+		+		
Dryocetes affaber		+	+	+			
D. autographus		+	+	+			
Gnathotrichus materiarius	?		?		?		
Hylurgops pinifex complex		+	+	+	+		
Ips borealis			+	+			
I. perroti					+		
I. perturbatus			+	+	+		
I. pini[a]					+		
Orthotomicus caelatus[a]		+	+	+	+		
Orthotomides lasiocarpa		+					
Phloeosinus pini			+	+	+		
Pityogenes hopkinsi			+		+		
P. plagiatus plagiatus				+	+		
Pityokeines minutus	+						
P. sparsus	+						
Pityophthorus albertensis[a]			+				
P. intextus			+	+	+		
Polygraphus rufipennis	+	+	+		+		
Scierus annectans			+	+			
Scolytus piceae	+	+	+	+			
Trypodendron lineatum	+	+	+	+	+		
T. retusum						+	
T. rufitarsus			+		+		

[a]collected in AOSERP study area in this study (*Pityophthorus* determined to genus only).

5. CONCLUSIONS

Natural insect communities of the AOSERP study area form a complex, loosely ordered continuum of populations. These, like vegetation communities, are influenced strongly by moisture. A gradient from wettest to driest habitat is paralleled by a gradient of insect numbers, biomass, and diversity in these same habitats, the fen being the wettest and jack pine and non-vegetated the driest sites on this gradient. Exceptions to this gradient are the depauperate spruce bog, and the diversity of the non-vegetated site. A parallel gradient exists for herbaceous sites having the greatest biomass of herbivores and the conifer sites having the highest percent of carnivore biomass. Several dominant families of insects are represented at nearly all sites. Among soil insect populations, this includes members of the Collembola family Isotomidae and the Diptera families Cecidomyiidae, Chironomidae, Fungivoridae (= Mycetophilidae and Sciaridae), and Ceratopogonidae. Greater variation exists in family diversity and population numbers of foliage inhabiting insects.

The trophic level to which the largest biomass of AOSERP study area insects belonged in 1978 was herbivore, while in 1979 carnivores were dominant,although sweep net samples yielded more herbivores. The biomass of carnivorous and saprovorous insects is quite similar. There is some indication that carnivores, which are more active than their prey, were collected disproportionately by the sampling methods used and thus their significance is overemphasized. Saprovore insects dwell primarily in soil and exploit fungi and bacteria as concentrated sources of protein food.

The present composition of the insect fauna of 12 representative habitat sites is described. These provide baseline data for monitoring future habitat changes. Biomonitoring programs involving insects are urged as future AOSERP projects. Several preliminary biomonitoring sites were tested in the field and are recommended for further study.

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7. APPENDIX

This Appendix presents data that are summarized in the main body of the report. Data in Tables 26 to 82 are the basis from which Tables 3 to 6 values were calculated. Tables 27 to 62 refer to soil invertebrate populations, and Tables 63 to 82 refer to above-ground insect populations. Tables 83 and 84 contain sweep net sample data for 1978, while the 1979 sweep data is presented in Figures 26 to 37. Emergence trap data are contained in Tables 85 to 90.

Table 26. Sample dates for O'Connor and Tullgren funnel soil extractions in 1978.

Habitat	Soil Cores Extracted: O'Connor Funnels	Soil Cores Extracted: Tullgren Funnels	Habitat	Soil Cores Extracted: O'Connor Funnels	Soil Cores Extracted: Tullgren Funnels
Riparian Forest	VIII-19 -24 IX- 5 -25	VIII-19 -24 IX- 5 -25	Non-vegetated	VIII-21 -26 IX- 3 -27	VIII-21 -26 IX- 3 -27
White Spruce-Aspen Forest	VIII-19 -24 IX- 6 -25	VIII-19 -24 IX- 6 -25	Jackpine Forest	VIII-21 -27 IX-20 -29	VIII-18 -27 IX-20
Aspen Forest	VIII-19 -25 IX- 2 -21	VIII-19 -25 IX- 2 -21	Semi-open Tamarack Bog	VIII-20 -29 IX-24	VIII-18 -29 -24
Black Spruce Bog	VIII-19 -21 IX- 1 -21	VIII-19 IX- 1 -21	Fen	VIII-23 -30 IX-20	VIII-23 -30 IX-20
Mixed Coniferous Forest	VIII-21 IX- 6 -23 -27	VIII-21 IX- 6 -23	Lightly Forested Tamarack	VIII-23 IX- 5 -20 -29	VIII-23 IX- 5 -20
Mixed Forest	VIII-19 -31 IX-23	VIII-19 -31 IX-23	Deciduous-shrub Wetland	VIII-23 IX- 4 -24 -28	VIII-23 IX- 4 -24

Table 27. Invertebrate population numbers and biomass per square metre determined by O'Connor and Tullgren funnel extractions. Riparian forest (Site 1), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m^{-2} to 2.5 cm	Individuals·m^{-2} estim. to 5.0 cm	Biomass·m^{-2} mg oven dry weight
INSECTA					
COLLEMBOLA	IA	T	761		14.5
Poduridae	IA	T	79		
Onychiuridae	IA	T	26		
Isotomidae	IA	T	642		
Sminthuridae	IA	T	13		
THYSANOPTERA					
Thripidae	A	T	26		
HOMOPTERA					
Chermidae	A	T	13		
COLEOPTERA					
Carabidae	I	T	60		21:8
Scarabaeidae	A	T	6		
Lampyridae	I	0	6	6	21.8
DIPTERA					
Ceratopogonidae	I	0	227	455	
Chironomidae	I	0	237	357	61.8
Bibionidae	I	0	92	92	
Fungivoridae	I	0	303	303	
Empididae	I	0	120	120	59.3
Dolichopodidae	I	0	13	13	
Cyclorrapha-all[a]	I	0	893	1209	26.3
(Anthomyiidae only)[b]	I	0	856	1083	
Trichoceridae	A	T	13		
Psychodidae	A	T	26		
Culicidae	A	T	90		
Mycetophilidae	A	T	66		
Sciaridae	A	T	66		65.8
Scatopsidae	A	T	13		
Cecidomyiidae	A	T	13		
Stratiomyiidae	A	T	13		
Phoridae	A	T	13		
Calliphoridae	A	T	13		
HYMENOPTERA					
Braconidae	A	T	26		
miscellaneous insects		T			7.9
total insects					279
ARANEIDA	IA	T	53		105.3
ACARINA	IA	T	8682		
PSEUDOSCORPIONIDA	I	0	13		
DIPLOPODA	I	0	40		
MOLLUSCA	I	0	26		
OLIGOCHAETA					
Enchytraeidae	IA	0	8274	9888	

[a] Includes Anthomyiidae, Muscoidea
[b] Uncertainty

Table 28. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions. White spruce-Aspen forest (Site 2), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals m^{-2} to 2.5 cm	Individuals m^{-2} estim. to 5.0 cm	Biomass m^{-2} mg oven dry weight
INSECTA					
COLLEMBOLA	IA	T	184		4.0
Poduridae	IA	T	13		
Isotomidae	IA	T	158		
Entomobryidae	IA	T	13		
PSOCOPTERA					
Psocidae	I	T	26		
THYSANOPTERA					
Thripidae	A	T	13		
HEMIPTERA					
Miridae	I	T	13		
HOMOPTERA					
Aphididae	I	T	13		
COLEOPTERA					
Elateridae	I	0	26		10.5
Carabidae	I	T	26		
Staphylinidae	I	T	13		38.1
Scarabaeidae	A	T	26		
LEPIDOPTERA					
Pterophoridae	A	T	66		195
DIPTERA					
Ceratopogonidae	I	0	40	40	
Chironomidae	I	0	263	287	42.1
Fungivoridae	I	0	1118	1118	
Rhagionidae	I	0	13	13	
Dolichopodidae	I	0	13	13	2.6
Cyclorrapha-all[a]	I	0	619	644	47.4
(Anthomyiidae-only)[b]	I	0	552	575	
Psychodidae	A	T	66		
Culicidae	A	T	26		
Mycetophilidae	A	T	53		
Sciaridae	A	T	118		94.7
Cecidomyiidae	A	T	66		
Anthomyiidae	A	T	40		
Muscidae	A	T	26		
other Muscoidea	A	T	40		
HYMENOPTERA					
Braconidae	A	T	26		19.7
Ichneumonidae	A	T	13		
Formicidae	A	T	40		30.3
miscellaneous insects		T			11.8
total insects					496
ARANEIDA	IA	T	158		38.1
ACARINA	IA	0	594	594	
MOLLUSCA	I	0	53		
OLIGOCHAETA					
Enchytraeidae	IA	0	2920	2993	

[a] Includes Anthomyiidae, Muscoidea
[b] Uncertainty

Table 29. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions, Aspen forest (Site 3), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m^{-2} to 2.5 cm	Individuals·m^{-2} estim. to 5.0 cm	Biomass·m^{-2} mg oven dry weight
INSECTA					
COLLEMBOLA	IA	T	658		17.1
Onychiuridae	IA	T	53		
Isotomidae	IA	T	592		
Entomobryidae	IA	T	13		
PSOCOPTERA					
Psocidae	I	T	26		
HOMOPTERA					
Aphididae	A	T	13		
Chermidae	A	T	26		
Psyllidae	A	T	13		
Fulgoridae	A	T	13		
COLEOPTERA					
Carabidae	I	T	329		
Staphylinidae	I	T	13		307
Scarabaeidae	I	T	13		
Staphylinidae	A	T	13		
Cryptophagidae	A	T	13		
Scarabaeidae	A	T	13		
LEPIDOPTERA					
Geometridae	I	T	13		
unknown	I	T	26		18.4
Tineidae	A	T	13		
Pterophoridae	A	T	40		60.5
DIPTERA					
Psychodidae	I	O	53	53	
Chironomidae	I	O	237	237	38.2
Fungivoridae	I	O	1275	1275	
Empididae	I	O	40	40	5.0
Cyclorrapha-all[a]	I	O	539	552	
(Phoridae)	I	O	120	133	28.9
(Anthomyiidae)[b]	I	O	369	369	
Tipulidae	I	T	13		
Culicidae	A	T	53		
Mycetophilidae	A	T	40		
Sciaridae	A	T	118		
Cecidomyiidae	A	T	40		68.4
Phoridae	A	T	26		
Agromyzidae	A	T	13		
Muscidae	A	T	40		
Calliphoridae	A	T	13		
HYMENOPTERA					
Proctotrupidae	A	T	13		
Eurytomidae	A	T	118		18.4
Braconidae	A	T	13		
Formicidae	A	T	104		71
miscellaneous insects		T			14.5
total insects					647
ARANEIDA	IA	T	105		3.9
ACARINA	IA	T	159		
DIPLOPODA	I	O	26		
OLIGOCHAETA					
Enchytraeidae	I	O	1316	1493	

[a]Includes Sepsidae, Phoridae, Anthomyiidae
[b]Uncertainty

Table 30. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions, Black spruce bog (Site 4), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m^{-2} to 2.5 cm	Individuals·m^{-2} estim. to 5.0 cm	Biomass·m^{-2} mg oven dry weight
INSECTA					
COLLEMBOLA			297		5.0
Poduridae	IA	T	104		
Isotomidae	IA	T	193		
THYSANOPTERA					
Thripidae	A	T	18		
HEMIPTERA					
Miridae	IA	T	35		
HOMOPTERA					
Cicadellidea	I	T	18		
Cercopidae	I	T	18		
COLEOPTERA					42.1
Carabidae	I	T	18		
Elateridae	I	T	18		
Staphylinidae	A	T	18		
Nitidulidae	A	T	35		
Pselaphidae	A	0	18		
LEPIDOPTERA					
Geometridae	I	0	18		0.7
Pterophoridae	A	T	158		96
DIPTERA					
Ceratopogonidae	I	0	13		
Chironomidae	I	0	515	609	27.6
Fungivoridae	I	0	410	726	
Therevidae	I	0	13		
Dolichopodidae	I	0	13		1.3
Cyclorrapha-all[a]	I	0	120		5.3
(Anthomyiidae only)[b]	I	0	120	183	
Culicidae	A	T	18		
Sciaridae	A	T	130		
Mycetophilidae	A	T	35		
Cecidomyiidae	A	T	18		89.5
Anthomyiidae	A	T	70		
Muscidae	A	T	35		
HYMENOPTERA					
Torymidae	A	T	18		
Braconidae	A	T	18		8.8
Formicidae	A	T	117		103
miscellaneous insects		T			33.3
total insects					413
ARANEIDA		T	176		7.9
ACARINA		T	1964		
"Ticks"		0	13		
OLIGOCHAETA					
Enchytraeidae		0	1894	2368	

[a] Includes Anthomyiidae, Muscoidea
[b] Uncertainty

Table 31. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions. Mixed coniferous forest (Site 5), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m^{-2} to 2.5 cm	Individuals·m^{-2} estim. to 5.0 cm	Biomass·m^{-2} mg oven dry weight
INSECTA					
COLLEMBOLA	IA	T	317		5.3
Poduridae	IA	T	18		
Onychiuridae	IA	T	140		
Isotomidae	IA	T	159		
THYSANOPTERA					
Thripidae	A	T	70		7.0
HOMOPTERA					
Aphididae	I	T	35		19.3
COLEOPTERA					28.1
Carabidae	I	T	88		
Staphylinidae	A	T	18		
DIPTERA					
Tipulidae	I	0	13	13	13.2
Chironomidae	I	0	436	755	40.8
Fungivoridae	I	0	698	698	
Bibionidae	I	0	13	13	3.9
Anthomyiidae[a]	I	0	395	455	27.6
Culicidae	A	T	18		
Psychodidae	A	T	18		
Mycetophilidae	A	T	70		19.3
Sciaridae	A	T	70		
Cecidomyiidae	A	T	18		
Anthomyiidae	A	T	18		
HYMENOPTERA					
Formicidae	A	T	88		73.7
Pteromalidae	A	T	18		22.8
Braconidae	A	T	53		
total insects					261
ARANEIDA	A	T	105		28.1
ACARINA	IA	0	708	802	
MOLLUSCA	I	0	13		
OLIGOCHAETA					
Enchytraeidae	IA	0	1474	2456	

[a]Uncertainty

Table 32. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions. Mixed forest (Site 6), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals$\cdot m^{-2}$ to 2.5 cm	Individuals$\cdot m^{-2}$ estim. to 5.0 cm	Biomass$\cdot m^{-2}$ mg oven dry weight
INSECTA					
COLLEMBOLA	IA	T	351		12.3
Onychiuridae	IA	T	158		
Isotomidae	IA	T	158		
Entomobryidae	IA	T	35		
PSOCOPTERA					
Psocidae	IA	T	18		
THYSANOPTERA					
Thripidae	A	T	18		
HEMIPTERA					
Lygaeidae	A	T	18		
unknown	I	T	18		
COLEOPTERA					
Carabidae	I	T	104		31.6
Staphylinidae	A	T	70		52.6
LEPIDOPTERA					
Pterophoridae	A	T	35		49.1
DIPTERA					
Psychodidae	I	0	18	18	
Chironomidae	I	0	193	193	19.3
Fungivoridae	I	0	297	297	
Dolichopodidae	I	0	18	18	
unknown Brachycera	I	0	18	18	7.0
Cyclorrapha-all[a]	I	0	158	224	5.3
(Anthomyiidae)[b]	I	0	104	104	
Mycetophilidae	A	T	18		
Sciaridae	A	T	140		70.2
Cecidomyiidae	A	T	18		
HYMENOPTERA					
Eurytomidae	A	T	18		
Formicidae	A	T	18		
miscellaneous insects					36.8
total insects					284
ARANEIDA	IA	T	70		109
ACARINA	IA	0	1367		
OLIGOCHAETA					
Enchytraeidae	IA	0	1193	1332	

[a] Includes Anthomyiidae, Muscoidea
[b] Uncertainty

Table 33. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions. Non-vegetated (Site 7), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m⁻² to 2.5 cm	Individuals·m⁻² estim. to 5.0 cm	Biomass·m⁻², mg oven dry weight
INSECTA					
THYSANOPTERA					
Thripidae	A	T	13		
HOMOPTERA					
Aphididae	I	T	13		
COLEOPTERA					172
Carabidae	A	T	13		
Staphylinidae	A	T	26		
Byrrhidae	A	T	13		
Nitidulidae	A	T	40		
LEPIDOPTERA					768
Notodontidae	A	T	13		
Pterophoridae	A	T	26		
DIPTERA					
Chironomidae	I	0	53	53	10.5 (Chironomidae + Fungivoridae)
Fungivoridae	I	0	13	13	
Psychodidae	A	T	13		
Mycetophilidae	A	T	40		
Sciaridae	A	T	79		38.2 (Psychodidae to Anthomyiidae)
Cecidomyiidae	A	T	26		
Muscidae	A	T	13		
Anthomyiidae	A	T	13		
HYMENOPTERA					13.2
Braconidae	A	T	40		
Eurytomidae	A	T	13		
miscellaneous insects					2.6
total insects					1005
ARANEIDA	IA	T	79		40.8
ACARINA	IA	0	26	26	
OLIGOCHAETA					
Enchytraeidae	IA	0	133	170	

Table 34. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions. Jack pine forest (Site 8), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m⁻² to 2.5 cm	Individuals·m⁻² estim. to 5.0 cm	Biomass·m⁻² mg oven dry weight
INSECTA					
COLLEMBOLA	IA		228		19.3
Onchiuridae	IA	T	140		
Isotomidae	IA	T	88		
THYSANOPTERA					
Thripidae	A	T	18		
HEMIPTERA	I	T	18		
HOMOPTERA					
Chermidae	IA	T	246		24.6
COLEOPTERA					38.6
Carabidae	I	T	53		
Staphylinidae	IA	T	53		
Elateridae	I	O	13	13	
DIPTERA					
Chironomidae	I	O	92	92	40.8 (Chironomidae, Fungivoridae, Bibionidae)
Fungivoridae	I	O	66	66	
Bibionidae	I	O	26	26	
Cyclorrapha-all[a]	I	O	224	272	3.9
(Anthomyiidae only)[b]	I	O	199	272	
Mycetophilidae	A	T	35		36.8 (Mycetophilidae, Sciaridae, Anthomyiidae)
Sciaridae	A	T	18		
Anthomyiidae	A	T	35		
HYMENOPTERA					
Eurytomidae	A		18		
Formicidae	A		18		
miscellaneous insects		T			35.1
total insects					199
ARANEIDA	IA	T	88		22.8
ACARINA	IA	T	2385		
OLIGOCHAETA					
Enchytraeidae	IA	O	3640	4262	

[a]Includes Muscidae, Anthomyiidae
[b] Uncertainty

Table 35. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions, Semi-open Tamarack bog (Site 9), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m^{-2} to 2.5 cm	Individuals·m^{-2} estim. to 5.0 cm	Biomass·m^{-2} mg oven dry weight
INSECTA					
COLLEMBOLA			106		5.3
Poduridae	IA	T	18		
Onychiuridae	IA	T	18		
Isotomidae	IA	T	70		
THYSANOPTERA					
Thripidae	A	T	18		
HEMIPTERA	I	T	18		
HOMOPTERA					14
Aphididae	A	T	18		
Chermidae	A	T	53		
COLEOPTERA					
Elateridae	I	O	35	35	17.1
Carabidae	IA	T	105		
Staphylinidae	A	T	105		71.9
Pselaphidae	A	T	18		
Cryptophagidae	A	T	18		
LEPIDOPTERA					
Geometridae	I	T	35		12.3
DIPTERA					
Ceratopogonidae	I	O	527	1579	
Chironomidae	I	O	2699	3315	51.3
Bibionidae	I	O	35	35	
Fungivoridae	I	O	177	177	
Empididae	I	O	18	18	19.7
Cyclorrapha-all[a]	I	O	53	123	84.2
(Anthomyiidae only)[b]	I	O	105	246	
Tipulidae	I	T	18		
Psychodidae	A	T	18		
Culicidae	A	T	18		
Mycetophilidae	A	T	18		56.1
Sciaridae	A	T	35		
Cecidomyiidae	A	T	18		
Muscoidea	A	T	18		
HYMENOPTERA					
Braconidae	A	T	18		
miscellaneous insects					26.3
total insects					358
ARANEIDA	IA	T	386		184
ACARINA	IA	O	9087	9282	
OLIGOCHAETA					
Enchytraeidae	IA	O	7924	8776	

[a]Includes Anthomyiidae, Muscoidea
[b] Uncertainty

Table 36. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions, Fen (Site 10), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m^{-2} to 2.5 cm	Individuals·m^{-2} estim. to 5.0 cm	Biomass·m^{-2} mg oven dry weight
INSECTA					
COLLEMBOLA			211		12.3
Poduridae	IA	T	158		
Onychiuridae	IA	T	18		
Isotomidae	IA	T	35		
HEMIPTERA					
Saldidae	A	T	18		
HOMOPTERA					
Cercopidae	A	T	18		
Chermidae	A	T	18		
COLEOPTERA					33.3
Carabidae	A	T	35		
Staphylinidae	A	T	18		
Orthoperidae	A	T	35		
Cryptophagidae	A	T	18		
LEPIDOPTERA					
Pterophoridae	A	T	18		
DIPTERA					
Psychodidae	I	O	7040	7735	
Ceratopogonidae	I	O	12312	18595	
Chironomidae	I	O	8776	9597	282.4
Bibionidae	I	O	18	18	
Fungivoridae	I	O	649	688	
Dolichopodidae	I	O	139	139	12.3
Muscidae	I	O	18	18	21.0
Anthomyiidae[a]	I	O	123	123	
Bibionidae	A	T	70		
Mycetophilidae	A	T	35		
Sciaridae	A	T	333		191.2
Cecidomyiidae	A	T	35		
Anthomyiidae	A	T	35		
HYMENOPTERA					
Cynipidae	A	T	18		
Formicidae	A	T	1649		2108
miscellaneous insects					24.6
total insects					2685
ARANEIDA	IA	T	70		29.8
ACARINA	IA	O	2402	2841	
CRUSTACEA					
COPEPODA	IA	O	4546		
OSTRACODA	IA	O	2314		
OLIGOCHAETA					
Enchytraeidae	IA	O	1124	1282	

[a]Uncertainty

Table 37. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions, lightly forested Tamarack (Site 11), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m^{-2} to 2.5 cm	Individuals·m^{-2} estim. to 5.0 cm	Biomass·m^{-2} mg oven dry weight
INSECTA					
COLLEMBOLA			264		3.5
Onychiuridae	IA	T	88		
Isotomidae	IA	T	176		
THYSANOPTERA					
Thripidae	IA	T	18		
HOMOPTERA					
Cercopidae	IA	T	18		
Chermidae	IA	T	35		
COLEOPTERA					
Carabidae	I	T	53		
Staphylinidae	I	T	18		
Elateridae	I	T	18		8.8
Carabidae	A	T	53		
Staphylinidae	A	T	35		210.5
Pselaphidae	A	T	281		
LEPIDOPTERA					
Geometridae	I	T	18		7.0
unknown	I	T	18		
DIPTERA					
Ceratopogonidae	I	O	328	328	
Chironomidae	I	O	290	530	25.0
Fungivoridae	I	O	211	211	
Empididae	I	O	13	18	13.2
Cyclorrapha-all[a]	I	O	327	631	
(Anthomyiidae only)[b]	I	O	158	158	
Psychodidae	A	T	35		
Culicidae	A	T	18		
Simuliidae	A	T	18		77.2
Bibionidae	A	T	18		
Sciaridae	A	T	70		
Cecidomyiidae	A	T	35		
Anthomyiidae	A	T	53		
HYMENOPTERA					
Pteromalidae	A	T	18		
Formicidae	A	T	53		387.6
miscellaneous insects					10.5
total insects					743
ARANEIDA	IA	T	298		47.4
ACARINA	IA	O	17008	31976	
OLIGOCHAETA					
Enchytraeidae	IA	O	1698	2365	

[a]Includes Anthomyiidae, Muscoidea
[b]Uncertainty

Table 38. Invertebrate population numbers and biomass per square metre, determined by O'Connor and Tullgren funnel extractions. Deciduous wetland (Site 12), 1978.

Taxon	Life stage Immature/Adult	Funnel Type	Individuals·m^{-2} to 2.5 cm	Individuals·m^{-2} estim. to 5.0 cm	Biomass·m^{-2} mg oven dry weight
INSECTA					
COLLEMBOLA			508		1.8
Poduridae	IA	T	35		
Onychiuridae	IA	T	105		
Isotomidae	IA	T	368		
THYSANOPTERA					
Thripidae	A	T	35		
COLEOPTERA					
Carabidae	I	T	105		29.8
Carabidae	A	T	35		
Hydrophilidae	A	T	18		
Limnebiidae	A	T	35		56.1
Staphylinidae	A	T	35		
Mycetaeidae	A	T	35		
LEPIDOPTERA					
Geometridae	I	T	18		7.0
Pterophoridae	A	T	18		12.3
Tineidae	A	T	18		
DIPTERA					
Ceratopogonidae	I	O	789	1127	
Chironomidae	I	O	1566	1859	53.9
Bibionidae	I	O	13	13	
Fungivoridae	I	O	278	300	
Cyclorrapha-all[a]	I	O	183	183	11.8
(Anthomyiidae only)[b]	I	O	92	92	
Psychodidae	A	T	18		
Culicidae	A	T	88		
Simuliidae	A	T	18		101.7
Bibionidae	A	T	18		
Mycetophilidae	A	T	70		
Sciaridae	A	T	18		
HYMENOPTERA					
Braconidae	A	T	18		10.5
Formicidae	A	T	140		147.3
miscellaneous insects					3.5
total insects					435
ARANEIDA	IA	T	281		152.6
ACARINA	IA	O	3315	3757	
OLIGOCHAETA					
Enchytraeidae	IA	O	5051	5935	

[a]Includes Anthomyiidae, Muscoidea, Muscidae
[b]Uncertainty

Table 39. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Riparian forest (Site 1).

Taxon	Funnel Type	V-15	V-31	V1-11	V1-25	V11-9	V11-27	V111-6	V111-23	1X-3	1X-20
COLLEMBOLA	T	8947	1316	1894	2842	1317	53	2054	263	474	842
Entomobryidae	T					158		158			53
Isotomidae	T	6726	1263	1684	1684	1053	53	1632	105	421	421
Onychiuridae	T							53			
Poduridae	T	1379	53	105	1105	53		53	158	53	368
Sminthuridae	T	842		105	53	53		158			
THYSANOPTERA	T										53
Phlacothripidae	T										53
HEMIPTERA nymphs	T							53			105
HOMOPTERA	T	106		53	53		53			53	
Aphididae	T			53							
Cicadellidae	T						53				
Phylloxeridae	T	53			53					53	
Psyllidae	T	53									
COLEOPTERA	T	159	53		106	158		105		159	210
Carabidae larvae	T	53	53							53	105
Lampyridae larvae	T				53						
Leptodiridae adults	T	53									
Scarabaeidae adults	T									53	
Staphylinidae larvae	T					105					105
Staphylinidae adults	T	53			53	53		105		53	
LEPIDOPTERA larvae	T		105								
DIPTERA larvae	TO	950	527	422	790	2159	1370	1684	791	527	631
Anthomyiidae	TO							53			53
Bibionidae	T	158	53	53	53	53					
Cecidomyiidae	0	316	158	105	53	316	316	105	158	210	210
Ceratopogonidae	0	53				158	158		53	53	
Chironomidae	0	211	211	211	105	737	316	105	158	158	105
Dolichopodidae	TO				105		158		53		
Empididae	TO	53			158	158	53		53	53	105
Fungivoridae	0	53	105		316	684	316	842	105		158
Muscidae	TO			53					158		
Ottitidae	0							474			
Stratiomyiidae	TO	53						105			
Tipulidae	TO					53	53		53	53	
undet. pupa											
HYMENOPTERA	T			53	105	53	53	53			263
Cynipidae	T						53				
Diapriidae	T					53		53			
Eulophidae	T				105						263
Proctótrupidae	T			53							
ARANEIDA	T		105	53	158			105	53	53	
ACARINA	T	11800	6300	8800	7500	7800	370	6630	--	6200	7600
PSEUDOSCORPIONIDA	T	263		105	158	53			105		
DIPLOPODA	T	53									
OLIGOCHAETA											
Enchytraeidae	0	3421	5578	7578	5421	16683	7736	5474	10263	11263	6684
Total Insecta	TO	10161	2001	2422	3896	3687	1529	3949	1054	1213	2104
Total Arthropoda	TO	22300	8400	11400	11700	11500	1900	10700	--	7500	9700

Table 40. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions, White spruce-Aspen forest (Site 2).

Taxon	Funnel Type	V-19	V1-3	V1-17	V1-28	V11-11	V11-29	V111-14	V111-27	1X-5	1X-23
COLLEMBOLA	T	2210	1579	4685	2474	421	1000	1527	3053	5316	26210
Entomobryidae	T			158					105	158	2158
Isotomidae	T	1474	1579	4095	2474	368	1000	1053	2842	5052	24052
Onychiuridae	T					53			53	53	
Poduridae	T	368		379				421		53	
Sminthuridae	T	368		53				53	53		
PSOCOPTERA	T		105		53		53				
THYSANOPTERA	T			53	2895	105	158		53	158	
Thripidae	T			53	2895	105	158		53	158	
HEMIPTERA nymphs	T				105			211	53	105	105
HOMOPTERA	T	263	105		53	105	211		316	368	106
Aphididae	T				53	105	53		105	368	53
Cicadellidae	T		105								
Coccidae	T								53		
Phylloxeridae	T	263					158		158		53
COLEOPTERA	T	424	789	158	53	105	53	106	527	211	369
Carabidae larvae	T		421		53	105	53		263		
Elateridae larvae	T	316								53	53
Elateridae adults	T								53		
Orthoperidae larvae	T										53
Staphyliniodae larvae	T	53						53	53	158	158
Staphyliniodae adults	T		368	158				53	158		105
undet. larvae	T	53									
LEPIDOPTERA larvae	T						53				
DIPTERA larvae	0	790	789	1253	633	1001	1211	1475	949	1521	1521
Anthomyiidae	0					158	53				
Cecidomyiidae	0	263	368	105	316	474	316	579	527	737	263
Ceratopogonidae	0			474	53				53	210	
Chironomidae	0	316	105	621	53	105	579	527	158		837
Empididae	0						53	158		258	158
Fungivoridae	0	158	316		211	211	105	211	211	316	263
Muscidae	0						105				
Rhagionidae	0					53					
Tipulidae	0	53		53							
Coleophoridae	T						53				
HYMENOPTERA	T	53		158		53	106	53	53	53	106
Diapriidae	T										53
Encyrtidae	T							53	53		
Eulophidae	T									53	
Formicidae	T			105		53	53				
Ichneumonidae	T	53									
Mymaridae	T										53
Proctotrupiodea	T			53							
Pteromalidae	T						53				
ARANEIDA	T	526	842	526	421	158	263	526	477	579	842
ACARINA	T	13700	12800	11600	9500	900	2500	7400	18400	19200	39200
DIPLOPODA	T	53								53	
HARPACTICOIDEA	0			1000							
OSTRACODA	0		53	53							
OLIGOCHAETA											
Enchytraeidae	0	2474	947	1789	1000	211	158	1842			
Total Insecta		3740	3367	6307	6266	1790	2845	3372	5004	7732	28417
Total Arthropoda		18000	17100	19500	16200	2848	5600	11300	23900	27600	68500

Table 41. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Aspen forest (Site 3).

Taxon	Funnel Type	V-12	V-27	V1-9	V1-23	V11-7	V11-23	V111-8	V111-24	1X-5	1X-22
COLLEMBOLA	T	2895	1948	5054	1421	422	105	895	421	3053	1842
Entomobryidae	T	53	158	211	158	53					
Isotomidae	T	2842	895	4000	1263	316	105	895	421	2842	1737
Onychiuridae	T									158	105
Poduridae	T		158	211						53	
Sminthuridae	T		737	632		53					
PSOCOPTERA nymphs	T		158		105	53	53	53			
THYSANOPTERA	T				53		53				
Phlaeothripidae	T				53		53				
HEMIPTERA nymphs	T		105	53	105		53	53			263
HOMOPTERA	T			316			579		316	53	
Aphididae	T			316			105		53		
Phylloxeridae	T						474		263	53	
COLEOPTERA	T	212		105			211	421	211	263	685
Carabidae larvae	T	53						158	158	158	211
Eucinetidae adult											53
Helodidae adult	T							53			
Leiodidae adult	T	53									
Nitidulidae adult	T	53									
Staphylinidae larvae	T						53	105	53	105	263
Staphylinidae adult	T	53		105			105	105			158
Tenebrionidae larvae	T						53				
LEPIDOPTERA larvae	T								53		
Geometridae larvae	T								53		
DIPTERA larvae	TO	843	159	421	369	1211	316	896	422	1211	527
Anthomyiidae	0							53			
Cecidomyiidae	0	263	53	263	105	473	158	474	211	948	316
Ceratopogonidae	0							158		105	
Chironomidae	0	105		105	53	579	158	53		158	158
Cyclorrapha	T	53									
Empididae	0		53			53					
Fungivoridae	0	316			53	53		158	211		53
Psycholdidae	0	53		53		53					
Rhagionidae	T		53								
Tipulidae	T	53			158						
HYMENOPTERA	T	211	2052	105		106	419	842	53	53	158
Chalcidoidea	T		105								
Diapriidae	T	53									
Diaspididae	T						53	105			
Encyrtidae	T								53	53	
Formicidae	T	158	1947	105		53	53	526			53
Ichneumonidae	T							53			
Mymaridae	T							53			
Platygasteridae	T					53	316	105			105
ARANEIDA	T	105	263	579	53	105	474	368	368	421	316
ACARINA	T	4000	10000	15000	5700	11300	6600	2400	--	2700	11200
DIPLOPODA	0	53									
OLIGOCHAETA											
Enchytraeidae	T	1211	1158	1211	3737	4210	158	4316	211	+	2579
Total Insecta		4161	4422	6054	2053	1792	1736	3160	1416	4633	3475
Total Arthropoda		8400	14700	21600	7806	13200	8800	5928	--	7800	15000

Table 42. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Black spruce bog (Site 4).

Taxon	Funnel Type	V-12	V-27	VI-9	VI-23	VII-7	VII-23	VIII-8	VIII-24	IX-5	IX-22
COLLEMBOLA	T	1074	4579	3159	158	316	105		947	737	3947
Entomobryidae	T			263							
Isotomidae	T	1011	632	1632		105	105		947	632	789
Onychiuriidae	T	63		211							53
Poduridae	T		3105	158	158					105	3105
Sminthuridae	T		842	895		211					
PSOCOPTERA	T						53				
HEMIPTERA nymphs	T		421	263				53			
HOMOPTERA	T				158	211		106	105	53	
Cercopidae	T							53			
Phylloxeridae	T							53	105	53	
undet. nymphs	T				158	211					
COLEOPTERA	T	252	106	106			264				
Carabidae larvae	T	126					158				
Elateridae larvae	T			53			53				
Phalacridae adults	T			53							
Ptiliidae adults	T	63									
Staphylinidae larvae	T	63	53				53				
Staphylinidae adults	T										
undet. larvae	T		53								
LEPIDOPTERA larvae	T	63						53			
DIPTERA larvae	TO	2957	579	632	632	1053	211	369	369	527	264
Cecidomyiidae	O	53		316	158	53		158	105	211	53
Certapogonidae	O	474	105		211	105			53	263	
Chironomidae	O	1682	263	158	105	842	53	158	158		211
Empididae	O									53	
Fungivoridae	O	527	158	158	158	53	105	53	53		
Psycholdidae	O	158	53								
Syrphidae	T						53				
Tipulidae	T	63									
HYMENOPTERA	T		1053	53	105	106	106		264	1105	372
Braconidae	T										53
Diapriidae	T					53					
Encyrtidae	T						53				53
Formicidae	T		1053	53	105				211	1105	263
Ichneumonidae	T						53				
Pompilidae	T					53					
Tenthredinidae	T								53		
ARANEIDA	T	189	158	421	158	105	53	158	211	316	263
ACARINA	T	6800	14800	36300	4800	2500	5200	5300	13200	9400	5200
PSEUDOSCORPIONIDA	T		53	158						53	
CHILOPODA	T			53							
OLIGOCHAETA											
Enchytraeidae	T	947	+	158	158	684	53	1000	263	+	368
Total Insecta		4346	6738	4213	1001	1686	739	581	1685	2422	4583
Total Arthropoda		11300	21700	41100	6000	4300	6000	6000	15100	12100	10000

Table 43. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Mixed conifer forest (Site 5).

Taxon	Funnel Type	V-13	V-28	V1-10	V1-24	V11-8	V11-25	V111-9	V111-23	1X-3	1X-20
COLLEMBOLA	T	1526	368	3527	316	1526	264	373	631	2789	1842
Entomobryidae	T			1000		211	53		105	1000	
Isotomidae	T	1197	368	1435	211	789	153	368		1789	1789
Onychiuridae	T			526	105		53		368		53
Poduridae	T	171		408				105	158		
Sminthuridae	T	158		158		526					
THYSANOPTERA	T				211	421	105	53		53	53
Phlaeothripidae	T				211		105	53		53	53
Thripidae	T					421					
PSOCOPTERA	T										53
HEMIPTERA nymphs	T			263		158		53			
HOMOPTERA	T				53	474	53	53			210
Aphididae	T						53				105
Cicadellidae	T					53		53			
Phylloxeridae	T				53						105
undet. nymphs	T					421					
COLEOPTERA	T	526	210	158	53		53	158	106	211	158
Carabidae larvae	T		105		53				53		158
Elateroidea larvae	T	368		158						158	
Staphylinidae larvae	T						53	158		53	
Staphylinidae adults	T	53	105						53		
undet. larvae	T	105									
LEPIDOPTERA	T	158									
Coleophoridae larvae	T	158									
DIPTERA larvae	TO	738	421	684	632	1211	1105	737	474	2105	6789
Cecidomyiidae	O	211	105	368	210	421	368	211	263	948	1105
Ceratopogonidae	O		105						53	474	
Chironomidae	O	158	53		316	632	210	105	53	474	
Empididae	O				53		53	53			
Fungivoridae	O	263	105	316	53	158	474	368	105	105	5684
Muscoidea	T	53									
Psychodidae	O									53	
Scatopsidae	O									53	
Tipulidae	T	53	53								
HYMENOPTERA	T	316		53	211	264			842	2684	53
Braconidae	T				53						
Eulophidae	T					53					
Formicidae	T	263		53		211			842	2684	
Pteromalidae	T										53
Tenthredinidae larvae	T				158						
Tenthredinidae adults	T	53									
ARANEIDA	T	158		263	211	105	105	526	211	316	368
ACARINA	T	38400	9400	11600	6900	10500	2600	2400		12400	14300
PSEUDOSCORPIONIDA	T					26					
MYRIAPODA	T									53	
OSTRACODA	O								53		
OLIGOCHAETA											
Enchytraiedae	O	7420	53	53	368		263	1000	1105	158	211
Total Insecta		3264	999	4843	1476	4054	1580	1374	2053	7842	9158
Total Arthropoda		41600	10400	16700	8600	14700	4300	4300		20600	23800

Table 44. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Mixed forest (Site 6).

Taxon	Funnel Type	V-13	V-28	V1-11	V1-25	V11-9	V11-27	V111-9	V111-25	1X-3	1X-22
COLLEMBOLA	T	1106	1894	2001	685	1421	211	158	1000	579	1474
Entomobryidae	T			474	211	211					
Isotomidae	T	1053	1789	474	474	842	211	158	842	579	1316
Onychiuridae	T	53	105								158
Poduridae	T			211					158		
Sminthuridae	T			842		368					
THYSANOPTERA	T				53	158		53	106		
Phlaeothripidae	T					53		53	53		
Thripidae	T				53	105			53		
PSOCOPTERA nymphs	T					53	53	53	53	53	105
HEMIPTERA	T			53	105			53			
Miridae	T			53							
undet. nymphs	T				105			53			
HOMOPTERA	T					53	53	53	106	632	105
Aphididae	T							53			105
Chermidae	T								53	632	
Phylloxeridae	T						53		53		
undet. nymphs	T					53					
COLEOPTERA	T	106	158	53	53			106	53	158	106
Carabidae larvae	T	53	158					53		105	
Elateridae larvae	T			53							
Scarabaeidae adult	T				53						
Staphylinidae larvae	T							53	53		53
Staphylinidae adult	T	53								53	53
DIPTERA larvae	TO	263	820	580	158	526	474	895	211	685	474
Anthomyiidae	0						105	105			
Bibionidae	T				53						
Cecidomyiidae	0	105	631	421	105	263	158	474		579	421
Ceratopogonidae	0			53							
Chironomidae	0			53		263			105		
Dolichopodidae	0								53		
Empididae	0			53				53		53	
Fungivoridae	0	158	189					263	53	53	53
Phoridae	0						211				
HYMENOPTERA	T		158	528	53		53	474	105	105	
Diapriidae	T			53					53		
Encyrtidae	T							105		105	
Formicidae	T		158	264	53		53	316	53		
Mymaridae	T			211							
Platygasteridae	T							53			
ARANEIDA	T	105	211	264	474	368	53	263	263	474	368
ACARINA	T	15900	9900	7400	--	3900	632	1400	3500	4900	5900
OLIGOCHAETA											
Enchytraeidae	0	1842	2148	316	368	789	211	368	1316	368	1158
Total Insecta		1475	3030	3215	1107	2211	854	1845	1634	2212	2264
Total Arthropoda		17500	13100	10900	--	6500	1500	3500	5400	7600	8500

Table 45. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren funnel extractions. Non-vegetated (Site 7).

Taxon	Funnel Type	V-13	V-28	V1-10	V1-24	V11-8	V11-25	V111-8	V111-25	1X-3	1X-20
COLLEMBOLA	T	579		53		684					
Entomobryidae	T					105					
Isotomidae	T	434		53		526					
Poduridae	T	145				53					
Sminthuridae	T										
ORTHOPTERA	T		53								
Acrididae	T		53								
THYSANOPTERA	T	53		105	53	53					
Phlaeothripidae	T	53		105	53						
Thripidae	T					53					
PSOCOPTERA nymph	T	53									
HEMIPTERA nymph	T	53	53								
HOMOPTERA	T		53				53	105			
Aphididae	T		53				53				
undet. nymph	T							105			
COLEOPTERA	T	53		106		106		53			264
Carabidae adult	T			53		53					
Chrysomelidae larvae	T			53							53
Curculionidae adult	T										158
Staphylinidae adult	T	53				53		53			53
LEPIDOPTERA larvae	T	53							53		
DIPTERA larvae	T	158								53	105
Cecidomyiidae	T	53								53	
Muscoidea	T	105									105
HYMENOPTERA	T	53					53	53	53		579
Braconidae	T								53		
Encyrtidae	T						53				
Formicidae	T										579
Scelionidae	T							53			
Proctotrupidae	T	53									
ARANEIDA	T										
ACARINA	T	632	53	158	158	--	--	211		53	
OLIGOCHAETA	0										
Enchytraeidae	0	1842	368								
Total Insecta		1055	158	264	53	843	106	211	106	53	948
Total Arthropoda		1687	211	432	211	--	--	422	106	106	948

Table 46. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Jack pine forest (Site 8).

Taxon	Funnel Type	V-11	V-26	V1-8	V1-22	V11-6	V11-24	V111-7	V111-22	1X-3	1X-19
COLLEMBOLA	T	789	3420	3158	211	53	211	264	369	268	373
Entomobryidae	T		105	211	158	53					105
Isotomidae	T	789	789	789			211	211	158	268	268
Onychiuridae	T								158		
Poduridae	T		263	211				53	53		
Sminthuridae	T		2263	1947	53						
THYSANOPTERA	T	53				268	106		53		53
Phlaeothripidae	T						53		53		53
Thripidae	T					268	53				
PSOCOPTERA nymphs	T	53						53			
HEMIPTERA	T		263		53		53				53
Geocoridae	T				53						
undet. nymphs	T		263				53				53
HOMOPTERA	T		422	53							105
Aphididae	T		53								
Cicadellidae	T		53	53							105
undet. nymphs	T		316								
COLEOPTERA	T	159	264	211	53	106	106			105	
Carabidae larvae	T	53								105	
Cucujidae adult	T					53					
Elateridae larvae	T		158	105		53					
Eupelmidae adult	T						53				
Ptiliidae adult	T	53									
Staphylinidae adult	T	53	53	53	53		53				
undet. larvae	T		53	53							
LEPIDOPTERA larvae	T		53	53			53				
Coleophoridae	T		53								
DIPTERA larvae	TO	370	105	474	240		106	369	474	317	264
Anthomyiidae	0								53		
Cecidomyiidae	0	53		421	80			211			211
Ceratopogonidae	0									53	
Chironomidae	0		105		80			105		158	
Empididae	0	53						53	105	53	
Fungivoridae	0	53		53	80		53		316	53	53
Stratiomyiidae	T	53									
Tipulidae	T	158									
Trichoceridae	0						53				
HYMENOPTERA	T			158				106		53	105
Braconidae	T							53			
Chalcidoidea	T			105							
Encyrtidae	T										105
Formicidae	T			53				53		53	
ARANEIDA	T	158	579	53	53	105	105	158	268	632	632
ACARINA	T	842	52500	33700	10000	4900	8300	7200	--	10400	49500
DIPLOPODA	0										
Geophilidae	U							53		53	
MOLLUSCA	0							53			
OLIGOCHAETA	0										
Enchytraeidae	0	632		789	1975	--	474	368	--	737	--
Total Insecta		1424	4422	4107	557	427	635	792	896	743	1053
Total Arthropoda		2400	57500	37900	10600	5400	9100	8200	--	11800	51200

Table 47. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Tamarack bog (Site 9).

Taxon	Funnel Type	V-16	V1-3	V1-17	V1-28	V11-11	V11-28	V111-14	V111-27	1X-5	1X-19
COLLEMBOLA	T	526	53	211	632		474	790	421	5947	1000
Entomobryidae	T									105	
Isotomidae	T	368		53	211		421	632	158	5421	1000
Onychiuridae	T	158	53				53	158	263	263	
Poduridae	T										
Sminthuridae	T			158	421					158	
HEMIPTERA nymph	T	53			53					53	53
HOMOPTERA	T	105	421		211		158			316	
Aphididae	T	105			53					316	
Cicadellidae	T		53								
Phylloxeridae	T		368				158				
undet. nymphs	T				158						
COLEOPTERA	T	158	53		53	53	158	53	474	158	106
Carabidae larvae	T					53			158		
Carabidae adults	T				53						53
Dytiscidae adults	T							53			
Elateridae larvae	T	53	53				53		105	53	
Nitidulidae adult	T								53		
Ptiliidae adult	T								53		
Staphylinidae adult	T	105					105		105	105	53
LEPIDOPTERA larvae	T		53						53		
Geometridae	T								53		
DIPTERA larvae	TO	2053	1159	737	685	528	159	7263	737	1736	1386
Cecidomyiidae	0	211	211	211	105			105	105	105	105
Ceratopogonidae	0	263	474		211	158		3315	316	947	526
Chironomidae	0	1526	474	105	316	211		3737	316	684	684
Dolichopodidae	0					53		53			
Empididae	0			105		53	53				
Fungivoridae	0	53		316	53	53		53			
Muscidae	T						53				
Stratiomyiidae	T						53				53
HYMENOPTERA	T	2263	368		105	53	105		158		53
Diapriidae	T										53
Encyrtidae	T								53		
Formicidae	T	2263	368		105		105		105		
Platygasteridae	T					53					
ARANEIDA	T	368	158	211	53	211	53	474	1158	368	368
ACARINA	T	7000	3800	11600	2100	1200	2200	11300	15600	14200	526
PSEUDOSCORPIONIDA	T							105			
OSTRACODA	0				105						
HARPACTICOIDEA	0	1894									
OLIGOCHAETA											
Enchytraeidae	0	3315	6211	2737	--	3789	842	2000	3000	1842	--
Total Insecta		5158	2107	948	1739	634	1054	8106	1843	8210	2580
Total Arthropoda		14500	6100	12800	4000	2000	3300	20000	18600	22800	3500

Table 48. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Fen (Site 10).

Taxon	Funnel Type	V-11	V-26	V1-8	V1-22	V11-6	V11-24	V111-7	V111-22	1X-3	1X-19
COLLEMBOLA	·	2737	252	16369	4421	263	211	5790	1684	1263	842
Entomobryidae	T			211	789					53	
Isotomidae	T	2737	63	15210	2579	53	158	5684	1684	1105	526
Onychiuridae	T							53		105	
Poduridae	T			53				53			316
Sminthuridae	T		189	895	1053	211	53				
PSOCOPTERA	T	105									
HEMIPTERA	T		63	106					53	53	
Lygaeidae	T			53							
Miridae	T			53							
Saldidae	T								53	53	
undet. nymphs	T		63								
HOMOPTERA	T	211		53	53		53			53	
Aphididae	T	211								53	
Cicadellidae	T			53	53		53				
COLEOPTERA	T	105		556	53			316	53		264
Carabidae larvae	T	105			53			53			
Hydrophilidae adults	T										53
Nitidulidae adults	T			105							53
Ptiliidae adults	T			53				105			158
Staphylinidae larvae	T			168							
Staphylinidae adults	T			105				158	53		
undet. larvae	T			105							
DIPTERA larvae	TO	13420	11895	7791	8816	16791	17313	18791	14737	12569	21267
Anthomyiidae	O		53					53		53	
Cecidomyiidae	O		105	895	606	158	53	211	53		368
Ceratopogonidae	O	2052	6421	4000	5289	2474	5368	12421	8631	6631	6795
Chironomidae	O	10789	4474	2737	2763	12474	8684	5684	5000	4263	11789
Culicidae	O									53	
Dolichopodidae	O		368			263	105	263	105		
Empididae	O			53							
Fungivoridae	O		53			53	53		105		
Muscoidea	T			53							
Phoridae	T			53							
Psychodidae	O	474	316			1316	2947	53	632	1263	1947
Rhagionidae	O				158			53		158	
Scatopsidae	O		105								
Stratiomyiidae	T										263
Tabanidae	O	105				53					
Tipulidae	TO						53		53	53	105
Trichoceridae	O							53	158	105	
HYMENOPTERA	T	53	63	421				84839	53	106	
Encyrtidae	T									53	
Formicidae	T		63	421				84839	53	53	
Proctotrupidae	T	53									
ARANEIDA	T	105			474	53	158	316		211	316
ACARINA	T	8000	1300	5600	5200	263	474	4500	--	3800	1895
OSTRACODA	O		1790	895	316	2158	474	684	1000	5053	1316
HARPACTICOIDEA	O	19947	158		343	4684	263	5947	2631		
MOLLUSCA	O										53
OLIGOCHAETA											
Enchytraeidae	O	53	53	158	947	4684	1000	3947	1263	790	263
Total Insecta		16631	12273	25316	13573	17054	17577	109736	16580	14044	22636
Total Arthropoda		44700	15500	31800	19900	23200	18900	121200	--	23100	26200

Table 49. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Lightly forested Tamarack (Site 11).

Taxon	Funnel Type	V-14	V-30	V1-12	V1-27	V11-10	V11-29	V111-13	V111-26	1X-5	1X-23
COLLEMBOLA	T	3790	263	1258	211			2316	210	211	211
Entomobryidae	T	211		316							
Isotomidae	T	2895	105		53			1895	105	105	211
Onychiuridae	T		158	53					105	53	
Poduridae	T			105							
Sminthuridae	T	684		684	158			421		53	
PSOCOPTERA Imm.	T			105							
HEMIPTERA	T		106	158				105	316		
Lygaeidae	T		53								
undet. nymph	T		53	158				105	316		
HOMOPTERA	T	684	105	211	2632	211	526	53		527	
Aphididae	T			211							
Chermidae	T									421	
Cicadellidae	T					53				53	
Phylloxeridae	T	684	105		2632	158	526	53		53	
COLEOPTERA	T	317	211	53			53	105	465	263	474
Carabidae larvae	T		53						158	53	105
Chrysomelidae	T								53		
Curculionidae adults	T	53									53
Elateridae	T	53								105	
Hydrophilidae adults	T		53								
Lampyridae adults	T								53		
Melandryidae adults	T							105			
Nitidulidae adults	T										211
Staphylinidae adults	T	158	105	53			53		211	105	105
Staphylinidae larvae	T	53									
LEPIDOPTERA larvae	T	105									
Geometridae	T	105									
undet.	T						105			53	
DIPTERA larvae	0	3264	3053	2422	580	1632	211	1632	1158	3421	3579
Cecidomyiidae	0	368	368	316	53	158	158	211	211	105	211
Ceratopogonidae	0	1316	1211	579	316	1211	53	316	105	2526	1526
Chironomidae	0	1474	1421	1211	158	263		947	842	737	1842
Dolichopodidae	0							53			
Empididae	0				53					53	
Fungivoridae	0	53		316				105			
Psychodidae	0	53									
Tabanidae	0		53								
HYMENOPTERA	T			53	106		53	105	4053	53	
Formicidae	T			53				105	4053		
Mymaridae	T				53						
Proctotrupidae	T				53					53	
Tenthredinidae larvae	T						53				
ARANEIDA	T	105	368	316	105	0	53	947	158	263	526
ACARINA	T	25300	13684	17100	7600	579	1600	15300	11100	9500	14500
PSEUDOSCORPIONIDA	T	53		105				211			
OSTRACODA	0		53								
HARPACTICOIDEA	0			53							
OLIGOCHAETA											
Enchytraeidae	0	1632	684	2368	--	--	105	1316	2263	--	3789
Total Insecta		8160	3738	4260	3529	1853	948	4316	6202	4528	4264
Total Arthropoda		33600	17900	21800	11200	2400	2600	20800	17500	14300	19300

Table 50. Soil dwelling invertebrate populations per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Deciduous wetland (Site 12).

Taxon	Funnel Type	V-14	V-30	V1-12	V1-27	V11-10	V11-28	V111-13	V111-26	1X-5	1X-23
COLLEMBOLA	T	1947	474	1705	2578	106	579	3579	1895	2896	2789
Entomobryidae	T	526			105					53	
Isotomidae	T	1368	421	884	1210	53	421	2895	1895	2737	2579
Onychiuridae	T						158			53	105
Poduridae	T	53	53	253						53	105
Sminthuridae	T			568	1263	53		684			
THYSANOPTERA	T			63			53			579	105
Thripidae	T			63			53			579	
Phlaeothripidae	T										105
HEMIPTERA	T	1158	53	505	211	53		53			
Saldidae	T							53			
undet. nymphs	T	1158	53	505	211	53					
HOMOPTERA	T	895	210		53						
Aphididae	T		105		53						
Cicadellidae	T		105								
Phylloxeridae	T	895									
COLEOPTERA	T	159	53	252		106	580	106	526	369	
Carabidae larvae	T			63		53	211			53	
Carabidae adults	T						53				
Dytiscidae adult	T			189							
Elateridae larvae	T	53									
Hydrophilidae adults	T						53				
Melyridae larvae	T							53			
Ptiliidae adults	T	53					105		421	158	
Staphylinidae adults	T		53			53	158	53	105	158	
undet. larvae	T	53									
LEPIDOPTERA larvae	T	53	53								53
DIPTERA larvae	TO	1947	2000	3526	948	8369	684	4738	1580	3633	2106
Anthomyiidae	O							53			
Cecidomyiidae	O	53		105	53	53		53	53	316	105
Ceratopogonidae	O	368	1158	1737	579	6421	263	1632	1000	3158	1053
Chironomidae	O	1526	684	1263	316	1421	368	1947	316		842
Dolichopodidae	O									53	53
Fungivoridae	O		53	421			53	211	53	53	
Muscidae	T									53	
Rhagionidae	O					158					
Stratiomyiidae	T					316		842	105		
Tipulidae	TO		105						53		53
HYMENOPTERA	T	53			53		53	211	106	53	159
Braconidae	T							53			53
Chalcidoidea	T	53									
Diapriidae	T				53		53				
Encyrtidae	T									53	53
Formicidae	T							158			
Mymaridae	T								53		
Platygasteridae	T								53		53
ARANEIDA	T	421	158	63	316	0	316	158	1158	474	947
ACARINA	T	16800	3300	12300	8200	1800	4800	9200	9200	9800	12400
PSEUDOSCORPIONIDA	T	53		63							
OSTRACODA	O		53	316				421			
HARPACTICOIDEA	O		1211		211		2316				
OLIGOCHAETA											
Enchytraeidae	O	--	632	578	421	468	684	4263	1263	--	4526
Total Insecta		6212	2843	6051	3843	8634	1949	8687	4107	7530	5212
Total Arthropoda		23500	6400	20000	12400	10600	7100	20800	14500	17800	18600

Table 51. Soil dwelling invertebrate biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Riparian forest (Site 1).

Taxon	V-15	V-31	VI-11	VI-25	VII-9	VII-27	VIII-6	VIII-23	IX-3	IX-20
COLLEMBOLA	16	3			21	3	11	3	53	9
THYSANOPTERA			11	26						3
HEMIPTERA										3
HOMOPTERA	5					5	3		3	
COLEOPTERA	37	5		74	42		21		316	5
larvae		5		53	42				295	5
adults				21			21		21	
LEPIDOPTERA larvae		42								
DIPTERA larvae	121	53	47	168	169	24	69	74	19	14
HYMENOPTERA						3				
ARANEIDA		3		21			3	5	5	
PSEUDOSCORPIONIDA	68			40	14			27		
Total Insecta	179	103	58	268	232	35	104	77	391	34

Table 52. Soil dwelling invertebrate biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. White spruce-Aspen forest (Site 2).

Taxon	V-19	VI-3	VI-17	VI-28	VII-11	VII-29	VIII-14	IX-27	IX-5	IX-23
COLLEMBOLA	26	5			11	5		21		
PSOCOPTERA		3	16	16						
THYSANOPTERA				21	3	3	9	3	95	42
HEMIPTERA								11		
HOMOPTERA	5	26			11	16				
COLEOPTERA	184	68	316	5	995	5	8	390	116	14
larvae	184	47	242		995	5	3	53	58	11
adults		21	74				5	337	58	3
LEPIDOPTERA larvae						42				
DIPTERA larvae	168	37	211	5	21	16	11	11	16	58
HYMENOPTERA	3		71		58	63	3	16	3	3
Formicidae			68		58	58				
ARANEIDA	174	42	311	16	3	26	21	47	37	53
Total Insecta	386	139	614	47	1099	150	31	452	229	117

Table 53. Soil dwelling invertebrates biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Aspen forest (Site 3).

Taxon	V-12	V-27	VI-9	VI-23	VII-7	VII-23	VIII-8	VIII-24	IX-5	IX-22
COLLEMBOLA	63		26	21		3	11	6	11	9
PSOCOPTERA					11	3	5			
THYSANOPTERA				3						
HEMIPTERA		11		3		5	3			3
HOMOPTERA			11	3		16		5	3	
COLEOPTERA	195	142	111	226		148	142	5	5	136
larvae	16			137		16	100	5	5	89
adults	179	142	111	89		132	42			47
LEPIDOPTERA larvae								74		
DIPTERA larvae	142	35	32	32	21	11	16	21	21	16
HYMENOPTERA	95	1379	332	16	37	37	263	3	5	68
Formicidae	84	1379	332		37		258			68
ARANEIDA	37	463	363	3	42	74	147	42	16	32
Total Insecta	495	1567	512	304	69	223	440	114	45	232

Table 54. Soil dwelling invertebrate biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Black spruce bog (Site 4).

Taxon	V-12	V-27	VI-9	VI-23	VII-7	VII-23	VIII-8	VIII-24	IX-5	IX-22
COLLEMBOLA	38			3		3		9	9	9
PSOCOPTERA						3				
		21	26		5					
HEMIPTERA						5				
							100			
HOMOPTERA				3					3	
COLEOPTERA	221	5	148			153				
larvae	190	5	137			153				
adults	31		11							
LEPIDOPTERA larvae	31									
DIPTERA larvae	144	53	32	42	3	374	21	5	5	16
HYMENOPTERA	3	721	100	53	1289	16		68	184	100
Formicidae		721	100	53	1286			58	184	95
ARANEIDA	82	11	58	5	21	3	16	37	5	16
PSEUDOSCORPIONIDA		14	40						14	
CHILOPODA			89							
Total Insecta	437	800	306	101	1297	556	121	72	201	125

Table 57. Soil dwelling invertebrate biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren funnel extractions. Non-vegetated (Site 7).

Taxon	V-13	V-28	VI-10	VI-24	VII-8	VII-25	VIII-8	VIII-25	IX-3	IX-20
COLLEMBOLA			5							
ORTHOPTERA		84								
THYSANOPTERA				3	5					
HEMIPTERA		5								
HOMOPTERA		16				3				
COLEOPTERA					47					147
adults					47					147
LEPIDOPTERA larvae	11							11		
DIPTERA larvae	32								3	100
HYMENOPTERA						3		6		163
Formicidae										163
Miscellaneous Insecta	26		74				16			
Total Insecta	69	105	79	3	52	6	16	17	3	410

Table 58. Soil dwelling invertebrate biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Jack pine forest (Site 8).

Taxon	V-11	V-26	VI-8	VII-22	VII-6	VII-24	VIII-7	VIII-22	IX-3	IX-19
COLLEMBOLA	16					3	3	5	3	
THYSANOPTERA					5	3	16	3		
PSOCOPTERA	3	16	16							37
HOMOPTERA									3	
COLEOPTERA	19	42	242		179	16			21	
larvae	3	26	221		179				21	
adults	16	16	21			16				
LEPIDOPTERA larvae		5				11				
DIPTERA larvae	1895	37	26	32		32	21	37	3	5
HYMENOPTERA			305			50			47	
Formicidae			+			47			44	
Miscellaneous Insecta				95						
ARANEIDA	58	32	5	5	5	5	53	16	311	3
Total Insecta	1933	100	389	127	184	115	40	45	77	42

Table 59. Soil dwelling invertebrate biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Tamarack bog (Site 9).

Taxon	V-16	VI-3	VI-17	VI-28	VII-11	VII-28	VIII-14	VIII-27	IX-5	IX-19
COLLEMBOLA	21	16	11			3	9	3		9
HEMIPTERA	37			11					26	3
HOMOPTERA		16				16				
COLEOPTERA	274	37		174	5	242		63	211	8
larvae	232	37			5	221		58	137	5
adults	42			174		21		5	74	3
LEPIDOPTERA larvae		32						3		
DIPTERA larvae	53	32	111	32	5	26	47	21	1874	16
HYMENOPTERA	405	211		100	3	21		35		3
Formicidae	405	211		100		21		32		
ARANEIDA	47	26	47	5	68	3	5	84	32	5
PSEUDOSCORPIONIDA							27			
Total Insecta	790	344	122	317	13	308	56	125	2111	39

Table 60. Soil dwelling invertebrate biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Fen (Site 10).

Taxon	V-11	V-26	VI-8	VI-22	VII-6	VII-24	VIII-7	VIII-22	IX-3	IX-19
COLLEMBOLA	21		268			11	32	11	3	11
PSOCOPTERA	16			11						
HEMIPTERA			79							
HOMOPTERA	26					11				
COLEOPTERA	332		74	3			37			
larvae	332		16	3			26			
adults			58				11	16		158
DIPTERA larvae	579	322	247	137	184	200	342	289	337	453
HYMENOPTERA	5	58	258				13516	42	26	
Formicidae		58	258				13516	42		
Miscellaneous Insecta		19			5					
ARANEIDA	3			53	958	11	-		68	63
Total Insecta	979	398	926	151	189	222	13927	358	366	622

Table 61. Soil dwelling invertebrate biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Lightly forested Tamarack (Site 11).

Taxon	V-14	V-30	VI-12	VI-27	VII-10	VII-29	VIII-13	VIII-26	IX-5	IX-23
COLLEMBOLA	21	16						3	21	3
PSOCOPTERA			26							
HEMIPTERA		37		16			16	3		
HOMOPTERA	5	5	42		21	5			5	
COLEOPTERA	148	105	110	16		74	84	205	115	63
larvae	74	21	21				42	58	89	16
adults	74	84	89	16		74	42	147	26	47
LEPIDOPTERA larvae	5					26			5	
DIPTERA larvae	68	195	53	37	3	16	32	3	47	95
HYMENOPTERA			47	3		5	68	3226	21	
Formicidae			47				68	3226		
ARANEIDA	11	63	84	3		3	32	5	11	-
PSEUDOSCORPIONIDA	14		27				54			
Total Insecta	247	358	278	72	24	126	200	3440	214	161

Table 62. Soil dwelling invertebrate biomass per square metre throughout the thawed ground period of 1979 determined by Tullgren and O'Connor funnel extractions. Deciduous wetland (Site 12).

Taxon	V-14	V-30	VI-12	VI-27	VII-10	VII-28	VIII-13	VIII-26	IX-5	IX-23
COLLEMBOLA	5	11			3	3	16	5	11	26
THYSANOPTERA			31			3			5	3
HEMIPTERA					21		21			
	16	3								
HOMOPTERA										
COLEOPTERA	37	5	1207		14	1768	27	37	21	
larvae	32		13		3	1705	21		5	
adults	5	5	1194		11	63	6	37	16	
LEPIDOPTERA larvae	5	11								11
DIPTERA larvae	42	190	74	42	337	11	1085	863	37	195
HYMENOPTERA	3			3		3	163	5	3	5
Formicidae							158			
Miscellaneous Insecta				11						
ARANEIDA	37	5	3	95		42	5	89	289	163
PSEUDOSCORPIONIDA	14		16							
Total Insecta	108	220	1312	56	375	1788	1312	910	77	240

Table 63. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage. Riparian forest (Site 1).

Taxon	VIII-24 Individuals m^{-2}	VIII-24 Biomass m^{-2} mg (oven dry)	IX-25 Individuals m^{-2}	IX-25 Biomass m^{-2} mg (oven dry)
INSECTA				
COLLEMBOLA				
Entomobryidae	0.2			
Sminthuridae	0.1			
PSOCOPTERA		5.5		1.1
Pseudocaeciliidae	0.3			
Psocidae	10.7		0.3	
THYSANOPTERA				
Thripidae	0.4			
HEMIPTERA		18.2		
Miridae	0.1			
Pentatomidae	0.2			
unknown nymph	0.1			
HOMOPTERA		21.4		2.1
Aphididae	8.4	(7.3)	0.7	
Cercopidae	0.2			
Cicadellidae	7.3	(11.6)	0.3	
Pseudococcidae	0.2			
Psyllidae	0.4		0.1	
NEUROPTERA				
Chrysopidae	0.1			
COLEOPTERA		7.6		8.6
Chrysomelidae	1.0		0.8	
Coccinellidae			0.1	
Curculionidae	0.1			
Helodidae			0.1	
Lampyridae			0.2	
Lathridiidae	0.2			
LEPIDOPTERA		19.5		10.0
Pterophoridae			0.1	(1.5)
Geometridae larvae	2.2		0.1 }	(8.5)
undet. larvae	0.3		0.2 }	
DIPTERA		4.5		5.2
Agromyzidae	0.1			
Anthomyiidae	0.2			
Bibionidae			0.9	
Cecidomyiidae	0.3			
Ceratopogonidae	0.1			
Chamaemyiidae			0.1	
Chironomidae	0.3			
Chloropidae	0.1		0.1	
Culicidae	0.2			
Empididae	0.1			
Muscidae	0.2			
Mycetophilidae	0.3		0.1	
Phoridae	1.7		0.1	
Sciaridae	2.0		0.1	
Simuliidae	0.1			
HYMENOPTERA		9.3		1.4
Diapriidae	0.3			
Encyrtidae	0.1			
Eurytomidae	0.1		0.1	
Ichneumonidae	1.2		0.1	
Platygasteridae	0.1			
Pteromalidae	0.5			
Tenthredinidae	0.2	(3.6)		
Torymidae			0.1	
miscellaneous insects		1.4		
total insects	40.7	87.4	4.7	28.4
ARANEIDA	14.0	43.0	4.3	49.3
ACARINA	8.1		0.3	

Table 64. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage. White spruce-Aspen forest (Site 2).

Taxon	VIII-24 Individuals m^{-2}	VIII-24 Biomass m^{-2} mg (oven dry)	IX-6 Individuals m^{-2}	IX-6 Biomass m^{-2} mg (oven dry)
INSECTA				
COLLEMBOLA				
Sminthuridae	0.1			
PSOCOPTERA		2.7		0.4
Pseudocaeciliidae			0.2	
Psocidae	4.2		8.2	
THYSANOPTERA				
Thripidae			0.3	
HEMIPTERA		21.5		104.1
Aradidae	0.1			
Miridae	0.1		0.1	
Pentatomidae	0.2		0.9	
undet. nymph			0.2	
HOMOPTERA		6.9		4.2
Aphididae	3.8	(3.0)	3.3	
Chermidae			0.1	
Cicadellidae	1.0			
Fulgoridae	0.1			
Pseudococcidae	0.1			
Psyllidae	0.4			
NEUROPTERA				1.1
Chrysopidae larvae	0.1		0.2	
COLEOPTERA		0.8		3.4
Carabidae			0.1	
Chrysomelidae	0.1			
Coccinellidae larva	0.1			
Lathridiidae	0.1		0.1	
LEPIDOPTERA		3.1		13.4
Geometridae larvae			0.3	
undet. larvae	0.4		0.2	
DIPTERA		9.8		3.9
Anthomyiidae	0.1		0.2	
Bibionidae	0.1			
Cecidomyiidae	0.1			
Chamaemyiidae	0.1			
Culicidae	0.1			
Dolichopodidae	0.2			
Lonchopteridae	0.1			
Muscidae	0.1			
Mycetophilidae	0.1		0.8	
Phoridae	0.6		0.8	
Sciaridae	1.2			
undet. larvae			0.2	1.4
HYMENOPTERA		16.5		2.5
Braconidae			0.1	
Cynipidae			0.2	
Diapriidae	0.1			
Eulophidae	0.1			
Eupelmidae			0.1	
Ichneumonidae			0.6	
Proctotrupidae	0.1			
Pteromalidae	0.1		0.5	
Tenthredinidae larvae	0.2	(16.0)	0.1	0.8
miscellaneous insects		0.3		0.5
total insects	14.3	61.6	17.8	133.5
ARANEIDA	6.1	30.6	7.6	44.3
ACARINA	1.2		1.1	

Table 65. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage: Aspen forest (Site 3).

Taxon	Individuals m^{-2}	Biomass m^{-2} mg (oven dry)
INSECTA		
PSOCOPTERA		0.2
Psocidae	0.1	
HEMIPTERA		4.1
Delphacidae	0.1	
Pentatomidae	0.3	
Nabidae	0.1	
HOMOPTERA		6.2
Aphididae	0.7	
Cercopidae	0.1	
Cicadellidae	0.1	
NEUROPTERA		1.9
Crysopidae larva	0.1	
Hemerobiidae	0.1	
COLEOPTERA		1.4
Lathridiidae	0.1	
LEPIDOPTERA		1.4
Pyralidae	0.1	
DIPTERA		6.3
Anthomyiidae	0.2	
Cecidomyiidae	0.1	
Chironomidae	0.1	
Empididae	0.1	
Muscidae	0.3	
Mycetophilidae	0.2	
Phoridae	0.1	
Simuliidae	0.1	
Sciaridae	0.7	
HYMENOPTERA		1.0
Diapriidae	0.1	
Encyrtidae	0.1	
total insects	4.0	22.5
ARANEIDA	2.3	23.1
ACARINA	0.1	

Table 66. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage: Black spruce bog (Site 4).

Taxon	Individuals m^{-2}	Biomass m^{-2} mg (oven dry)
INSECTA		
COLLEMBOLA		
Sminthuridae	0.3	
PSOCOPTERA		1.9
Psocidae	1.6	
HEMIPTERA		
Miridae	0.1	
HOMOPTERA		2.0
Cicadellidae	0.3	
COLEOPTERA		5.8
Lampyridae	0.1	
LEPIDOPTERA		1.8
Arctiidae larva	0.1	
DIPTERA		4.0
Cecidomyiidae	0.1	
Chloropidae	0.2	
Muscidae	0.5	
Mycetophilidae	1.0	
Simuliidae	0.3	
HYMENOPTERA		1.1
Eulophidae	0.1	
Eurytomidae	0.2	
Pteromalidae	0.2	
miscellaneous insects		0.1
total insects	5.1	16.7
ARANEIDA	3.6	18.2
ACARINA	2.0	

Table 67. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage. Mixed conifer forest (Site 5).

Taxon	VIII-21 Individuals m^{-2}	VIII-21 Biomass m^{-2} mg (oven dry)	IX-6 Individuals m^{-2}	IX-6 Biomass m^{-2} mg (oven dry)
INSECTA				
COLLEMBOLA				
Entomobryidae	0.3		0.3	
Isotomidae	0.3			
Sminthuridae	0.2			
PSOCOPTERA		14.2		14.3
Pseudocaeciliidae	3.9		0.4	
Psocidae	18.2		4.9	
THYSANOPTERA				
Thripidae			0.1	
HEMIPTERA		1.7		
Lygaeidae			0.5	
Miridae	0.1			
undet. nymph			0.2	
HOMOPTERA		5.0		8.1
Aphididae	2.2		2.2	
Cicadellidae	0.1		0.3	
Psyllidae			0.6	
NEUROPTERA		3.5		4.6
Chrysopidae	0.2		0.1	
Hemerobiidae			0.2	
COLEOPTERA		3.0		3.8
Cantharidae larva	0.1			
Coccinellidae			0.1	
Helodidae	0.3		0.1	
Lathridiidae				
LEPIDOPTERA		9.7		3.0
Gelechiidae	0.1			
Geometridae larvae	0.4			
Pyralidae	0.5		0.4	
undet. larva	0.2			
DIPTERA		24.4		39.5
Anthomyiidae	0.4		0.1	
Cecidomyiidae	0.3			
Ceratopogonidae	0.2			
Chironomidae			0.2	
Clusiidae	0.1			
Culicidae	0.1			
Muscidae	0.5		0.3	
Mycetophilidae	0.9		1.3	
Phoridae	1.5		0.1	
Psychodidae	0.1			
Sciaridae	1.6		0.8	
Simuliidae	0.5		0.1	
Syrphidae			0.6	
Tachinidae	0.1			
Tipulidae	0.3		0.1	
HYMENOPTERA		3.0		3.2
Braconidae	0.1		0.9	
Chalcididae?	0.2			
Cynipidae	0.1		0.2	
Encyrtidae			0.1	
Eulophidae	1.1			
Eurytomidae	0.2			
Ichneumonidae	0.3		0.1	
Pteromalidae	0.2		0.4	
miscellaneous insects		0.5		0.5
total insects	36.0	65.0	15.7	77.0
ARANEIDA	16.8	11.0	9.0	97.2
ACARINA	7.9		1.6	

Table 68. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage. Mixed forest (Site 6).

Taxon	VIII-31 Individuals m^{-2}	VIII-31 Biomass m^{-2} mg (oven dry)	IX-27 Individuals m^{-2}	IX-27 Biomass m^{-2} mg (oven dry)
INSECTA				
COLLEMBOLA				
Entomobryidae			0.2	
Sminthuridae	0.1			
PSOCOPTERA		2.4		3.1
Psocidae	0.8		1.1	
HEMIPTERA		9.1		4.6
Miridae	0.2		0.1	
Pentatomidae	0.1			
HOMOPTERA		5.3		2.9
Aphididae	0.5		1.6	(2.9)
Cercopidae			0.1	
Cicadellidae			0.1	
Delphacidae	0.2			
Fulgoridae	0.1			
Pseudococcidae			0.3	
Psyllidae	0.2			
NEUROPTERA				4.7
Chrysopidae			0.1	
COLEOPTERA		1.4		6.6
Coccinellidae	0.1		0.1	
Curculionidae	0.1			
Helodidae			0.6	
Lathridiidae	0.1			
LEPIDOPTERA		9.2		1.9
Arctiidae larvae			0.2	
Geometridae larvae	0.2			
DIPTERA		3.7		33.4
Bibionidae			0.2	
Clusiidae			0.1	
Dolichopodidae	0.1			
Heleomyzidae			0.5	
Muscidae	0.1			
Muscoidea			0.1	
Mycetophilidae	0.2			
Phoridae	0.3		0.3	
Sciaridae	0.8		1.0	
Simuliidae	0.2		0.2	
Syrphidae			0.2	
Tachinidae			0.1	
HYMENOPTERA		25.6		14.8
Braconidae			0.2	
Cynipidae			0.1	
Diapriidae	0.1		0.1	
Encyrtidae	0.1			
Eulophidae			0.1	
Eurytomidae			0.6	
Formicidae	0.4	(6.0)		
Ichneumonidae	0.2		0.8	
Proctotrupidae	0.1			
Pteromalidae			0.3	
Tenthredinidae larvae	0.2	(17.1)		
miscellaneous insects		0.1		0.6
total insects	5.5	56.8	9.4	72.6
ARANEIDA	2.5	35.1	8.7	91.2
ACARINA	0.9		0.2	

Table 69. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage. Jack pine forest (Site 8).

Taxon	VIII-26 Individuals m^{-2}	VIII-26 Biomass m^{-2} mg (oven dry)	IX-26 Individuals m^{-2}	IX-26 Biomass m^{-2} mg (oven dry)
INSECTA				
COLLEMBOLA				
Entomobryidae	1.0			
Sminthuridae	0.1			
ORTHOPTERA				7.2
Tetrigidae			0.1	
PSOCOPTERA		0.2		0.7
Psocidae	0.2		0.2	
HEMIPTERA		2.4		1.2
Miridae	0.1		0.1	
Pentatomidae	3.3			
Nabidae			0.2	
HOMOPTERA		2.7		4.2
Aphididae	0.1		0.9	(3.1)
Cicadellidae	0.1		0.1	
Fulgoridae	0.3		0.1	
Psyllidae	0.1		0.2	
undet. nymph	0.4			
NEUROPTERA				
Chrysopidae larvae			0.1	
COLEOPTERA		2.0		16.6
Helodidae	0.3		4.7	
LEPIDOPTERA		9.4		2.7
Geometridae larvae	0.1		0.1	
Pyralidae	0.2			
DIPTERA		6.4		24.6
Anthomyiidae			0.3	
Bibionidae			2.3	
Cecidomyiidae			0.1	
Chironomidae	0.1			
Chloropidae	0.2			
Dolichopodidae			0.1	
Empididae	0.2			
Muscidae	0.5			
Muscoidea	0.1			
Mycetophilidae	0.7		0.6	
Phoridae	0.5			
Sciaridae	0.6		1.1	
Sciomyzidae			0.2	
HYMENOPTERA		0.9		1.3
Braconidae	0.2			
Eulophidae	0.1			
Ichneumonidae			0.3	
Pteromalidae	0.2		0.4	
miscellaneous insects				1.5
total insects	9.7	24.0	12.2	60.0
ARANEIDA	2.8	15.4	6.1	33.8
ACARINA	0.1		0.7	

Table 70. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage. Tamarack bog (Site 9).

Taxon	VIII-23 Individuals m^{-2}	Biomass m^{-2} mg (oven dry)
INSECTA		
COLLEMBOLA		
Entomobryidae	0.1	
EPHEMEROPTERA		
Ephemerellidae	0.1	
PLECOPTERA		
Taeniopterygidae	0.1	
PSOCOPTERA		0.9
Psocidae	1.3	
THYSANOPTERA		
Thripidae	0.1	
HOMOPTERA		10.8
Aphididae	2.1	(2.4)
Cercopidae	0.1	
Cicadellidae	0.5	
Fulgoridae	0.2	
Psyllidae	0.8	
COLEOPTERA		18.3
Chrysomelidae	0.1	
Curculionidae	0.1	
Helodidae	2.0	
Lampyridae	0.1	
Lathridiidae	0.1	
LEPIDOPTERA		0.9
Geometridae larva	0.1	
DIPTERA		2.0
Cecidomyiidae	0.2	
Chamaemyiidae?	0.1	
Chironomidae	0.2	
Chloropidae	0.1	
Muscidae	0.4	
Mycetophilidae	1.0	
Otitidae	0.1	
Phoridae	0.4	
Sciaridae	0.2	
HYMENOPTERA		2.9
Ichneumonidae	0.1	
Pteromalidae	0.1	
Tenthredinidae larvae	0.2	(2.0)
miscellaneous insects		2.9
total insects	11.0	38.7
ARANEIDA	4.6	25.5
ACARINA	0.4	

Table 71. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage. Lightly forested Tamarack (Site 11).

Taxon	VIII-23 Individuals m^{-2}	VIII-23 Biomass m^{-2} mg (oven dry)	IX-28 Individuals m^{-2}	IX-28 Biomass m^{-2} mg (oven dry)
INSECTA				
COLLEMBOLA				
Entomobryidae			0.2	
PSOCOPTERA		1.9		1.1
Psocidae	0.4		0.7	
HEMIPTERA		8.2		5.5
Aradidae	0.2			
Miridae	2.0		0.6	
Nabidae			0.1	
HOMOPTERA		41.3		36.7
Aphididae	19.5	(27.3)	10.8	(33.0)
Cicadellidae	0.3		0.7	
Delphacidae	0.3			
Fulgoridae	0.9			
Psyllidae	0.8		0.1	
NEUROPTERA				
Chrysopidae	0.1			
COLEOPTERA		0.9		12.9
Coccinellidae	0.3		0.1	
Helodidae	1.4		2.9	
Hydrophilidae	0.1			
Lampyridae	0.1			
LEPIDOPTERA		11.4		68.7
Geometridae larvae	1.0			
Noctuidae			0.2	
Pyralidae	0.2			
undet. larva	0.1			
DIPTERA		6.4		2.5
Agromyzidae	0.1		0.8	
Cecidomyiidae	0.1		0.2	
Clusiidae			0.1	
Drosophilidae	0.2			
Muscidae	0.6		0.1	
Mycetophilidae	0.3		0.7	
Phoridae			0.1	
Rhagionidae	0.1			
Syrphidae larvae	0.2			
Tipulidae			0.1	
unknown larva			0.1	
HYMENOPTERA		9.5		53.1
Braconidae	0.1			
Diapriidae	0.1			
Eupelmidae			0.1	
Eurytomidae			0.3	
Formicidae	0.1	(3.1)		
Ichneumonidae	0.2		0.8	
Pteromalidae	0.1		0.6	
Tenthredinidae	1.0	(5.3)		
Vespidae			0.3	(46.1)
miscellaneous insects		0.1		0.1
total insects	30.9	79.7	20.7	180.6
ARANEIDA	8.2	43.7	5.7	32.3
ACARINA	0.3			

Table 72. Arthropod above-ground standing crops in 1978, as estimated by 10 m^2 pyrethrum spray samples of foliage. Deciduous wetland (Site 12).

Taxon	VIII-23 Individuals m^{-2}	VIII-23 Biomass m^{-2} mg (oven dry)	IX-26 Individuals m^{-2}	IX-26 Biomass m^{-2} mg (oven dry)
INSECTA				
COLLEMBOLA				
Entomobryidae	1.1			
ORTHOPTERA				
Acrididae			0.1	
PLECOPTERA		9.6		
Nemouridae	1.9			
PSOCOPTERA		4.8		3.6
Pseudocaecilidae	1.2			
Psocidae	1.5		1.1	
THYSANOPTERA				
Phlaeothripidae	0.7		0.3	
HEMIPTERA		5.8		23.6
Lygaeidae	0.3			
Miridae	0.3		0.8	
Pentatomidae			0.2	
undet. nymph	0.1		0.1	
HOMOPTERA		46.7		55.3
Aphididae	16.6	(5.9)	7.4	(20.6)
Cicadellidae	2.9	(26.4)	1.1	
Delphacidae	0.1		0.1	
Fulgoridae	2.7		1.6	
Psyllidae	2.5		1.4	
NEUROPTERA				
Chrysopidae larva	0.1			
COLEOPTERA		19.2		64.6
Chrysomelidae	0.2		1.2	
Coccinellidae	0.3		0.1	
Helodidae	0.3		1.2	
Lampyridae	0.1			
Lathridiidae	0.1		0.1	
Leptodiridae			0.1	
Staphylinidae			0.1	
LEPIDOPTERA		6.5		6.1
Pyralidae	0.1		0.1	
undet. larvae	0.4	(4.4)	0.1	(3.3)
DIPTERA		10.5		6.8
Bibionidae			0.1	
Cecidomyiidae			0.2	
Chironomidae	0.2			
Clusiidae			0.2	
Culicidae	0.1			
Dolichopodidae	0.1			
Drosophilidae	0.1			
Empididae	0.2			
Heleomyzidae	0.1		0.1	
Muscidae				
Mycetophilidae	0.1		0.3	
Phoridae	0.6			
Sciaridae	1.1		0.7	
Sciomyzidae	0.1			
Tachinidae			0.1	
Trichoceridae	0.7			
HYMENOPTERA		22.4		1.0
Cynipidae	0.2			
Eulophidae	0.1			
Formicidae	0.5	(12.4)		
Ichneumonidae	0.3		0.2	
Proctotrupidae	0.1			
Pteromalidae	0.3			
Torymidae	0.1			
Tenthredinidae	0.8	(7.3)		
miscellaneous insects		1.7		1.6
total insects	38.8	127.3	19.1	162.6
ARANEIDA	5.2	23.1	3.5	18.7
ACARINA	1.4		0.2	

Table 73. Arthropod populations and biomass on foliage, estimated by 10 m2 pyrethrum spray samples in 1979. Riparian forest (Site 1).

Taxon	Population m^{-2}				Biomass m^{-2} (mg oven dry)			
	VI-2	VII-2	VIII-4	IX-2	VI-2	VII-2	VIII-4	IX-2
COLLEMBOLA	0.1	0.4						
Entomobryidae	0.1							
PLECOPTERA						0.26		
Isoperlidae		0.4						
PSOCOPTERA	1.7	1.1		0.8	0.13	1.19		0.22
Pseudocaeciliidae	1.5			0.8				
Psocidae		1.1						
undet. nymphs	0.2							
HEMIPTERA		0.7	0.6	0.2		0.57	1.39	0.14
Lygaeidae				0.2				
Miridae		0.7	0.5					
Pentatomidae			0.1					
HOMOPTERA	9.0	8.5	0.6	1.1	3.15	2.38	0.48	0.41
Aphididae	3.8	1.9		0.3				
Cicadellidae	5.0	5.2	0.4	0.4				
Delphacidae		0.5						
Psyllidae		0.9	0.2	0.4				
undet. crawlers	0.2							
NEUROPTERA		0.1		0.1		0.08		0.36
Chrysopidae		0.1						
Hemerobiidae				0.1				
COLEOPTERA	1.5	0.6		0.3	1.54	2.14		2.05
Cantharidae		0.2						
Carabidae				0.1				
Chrysomelidae	0.8	0.2		0.1				
Coccinellidae	0.1	0.1						
Curculionidae	0.5			0.1				
Lathridiidae	0.1	0.1						
LEPIDOPTERA	0.3	0.8	0.3	0.9	1.55	13.00	0.19	7.29
Arctiidae			0.1					
Geometridae	0.1			0.6				
Nocturidae		0.3		0.1				
Tortricidae		0.1	0.1	0.1				
undet.	0.2	0.4	0.1	0.1				
DIPTERA	5.3	13.3	3.3	0.9	2.09	9.48	0.85	0.32
Anthomyiidae	0.2							
Cecidomyiidae		0.3	0.2					
Ceratopogonidae		0.2	0.1					
Chamaemyiidae		0.1						
Chironomidae		0.2	0.1					
Clusiidae			0.1					
Empididae		1.4	0.3	0.1				
Heleomyzidae		0.1						
Muscidae		9.0	0.5	0.2				
Muscoidea		0.5						
Mycetophilidae		0.2	0.2	0.1				
Phoridae	1.0	0.5	0.5	0.5				
Pipunculidae		0.2						
Piophilidae		0.1						
Sciaridae	3.7	0.5	0.6					
Sciomyzidae			0.1					
Syrphidae	0.3							
Tipulidae	0.1							
HYMENOPTERA		1.0	1.1	0.4		1.05	0.16	0.51
Braconidae		0.5	0.5	0.1				
Diapriidae			0.1	0.1				
Eupelmidae		0.1						
Ichneumonidae		0.2	0.3	0.2				
Pteromalidae		0.1	0.1	1.1				
Sphecidae								
Tenthrodinidae		0.1				0.66		
Torymidae			0.1					
Total Insecta	17.9	26.5	5.9	4.7	8.46	30.15	3.07	11.30
ARANEIDA	5.0	1.7	1.5	3.3	2.71	1.31	1.67	3.03

Table 74. Arthropod populations and biomass on foliage, estimated by 10 m^2 pyrethrum spray samples in 1979. White spruce-Aspen forest (Site 2).

	Population m^{-2}				Biomass m^{-2} (mg oven dry)			
Taxon	VI-3	VII-3	VIII-3	IX-1	VI-3	VII-3	VIII-3	IX-1
PLECOPTERA				0.1				0.06
Nemouridae				0.1				
PSOCOPTERA		0.1		1.5				0.32
Pseudocaeciliidae				0.4				
Psocidae				1.1				
HEMIPTERA		0.1	0.2				0.43	
Anthocoridae		0.1						
Miridae			0.2					
HOMOPTERA	0.5	8.3	0.6	1.2	0.13	5.83	0.79	2.90
Aphididae	0.1	3.3	0.1	0.1				
Cercopidae				0.1				
Cicadellidae		4.1	0.4	0.6				
Eriosomatidae		0.3						
Pseudococcidae				0.1				
Psyllidae	0.4	0.6	0.1	0.3				
NEUROPTERA	0.1	0.3	0.2	0.3	0.02		0.15	0.59
Chrysopidae	0.1	0.1						
Coniopterygidae		0.2						
Hemerobiidae			0.2	0.3				
COLEOPTERA	0.2	0.6	0.1	1.2	0.04	4.44	0.22	3.05
Chrysomelidae	0.1							
Coccinellidae		0.4		0.5				
Cryptophagidae				0.1				
Curculionidae			0.1					
Elateridae		0.1						
Helodidae				0.5				
Lathridiidae	0.1	0.1		0.1				
LEPIDOPTERA	0.1	0.1	0.2	0.7	0.07		2.31	1.16
Arctiidae				0.1				
Cosmopterygidae				0.3				
Geometridae				0.1				
Noctuidae			0.1	0.1				
Pyralidae			0.1	0.1				
undet.	0.1	0.1						
DIPTERA	2.7	3.8	1.4	1.7	0.92	1.33	1.40	0.71
Cecidomyiidae			0.3					
Chironomidae	0.8	0.7	0.1	0.2				
Chloropidae		0.1						
Empididae	0.1	0.9	0.1					
Heleomyzidae				0.1				
Muscidae		0.9	0.3					
Mycetophilidae	0.3		0.3	0.2				
Phoridae	0.2	0.2		0.4				
Sciaridae	0.8	1.0	0.2	0.3				
Sciomyzidae	0.4			0.2				
Syrphidae	0.1		0.1					
Tipulidae				0.3				
HYMENOPTERA	1.7	2.2	1.2	2.5	1.13	0.35	0.31	1.39
Braconidae		0.1	0.2	0.2				
Chalcididae				0.1				
Cynipidae			0.1					
Diapriidae	0.2		0.2	0.7				
Eulophidae		0.4	0.2					
Eupelmidae			0.1					
Formicidae			0.1	0.1				0.09
Ichneumonidae	0.6	0.1	0.2	0.7				
Platygasteridae	0.7							
Pteromalidae				0.7				
Tenthredinidae	0.1	0.6			0.82			
Torymidae	0.1	1.0	0.1					
Miscellaneous Insecta						2.07		
Total Insecta	5.3	15.5	3.9	9.2	2.31	14.02	5.61	10.18
ARANEIDA	6.4	2.1	2.5	8.5	5.20	2.94	5.04	15.3

Table 75. Arthropod populations and biomass on foliage, estimated by 10 m^2 pyrethrum spray samples in 1979. Aspen forest (Site 3).

Taxon	Population m^{-2}				Biomass m^{-2} (mg oven dry)			
	VI-2	VII-2	VIII-4	IX-2	VI-2	VII-2	VIII-4	IX-2
EPHEMEROPTERA		0.1				0.65		
Heptageniidae		0.1						
PSOCOPTERA	2.7	0.1		0.9	0.50	0.06		0.16
Pseudocaeciliidae				0.9				
Psocidae		0.1						
HEMIPTERA		0.4	0.6	0.7		0.30	0.61	0.54
Anthocoridae								
Aradidae			0.2					
Lygaeidae								
Miridae		0.4	0.4	0.7				
HOMOPTERA	0.8	2.3	1.2	0.3	0.35	3.69	1.89	0.19
Aphididae	0.1			0.1				
Cicadellidae	0.6	1.9	1.0	0.1				
Delphacidae				0.1				
Psyllidae	0.1	0.4	0.2					
NEUROPTERA				0.3				0.60
Chrysopidae				0.2				
Hemerobiidae				0.1				
COLEOPTERA	2.0	0.2	0.3	0.5	0.97	0.60	4.0	0.69
Chrysomelidae	1.2							
Coccinellidae		0.2	0.1					
Curculionidae	0.5							
Elateridae	0.1							
Helodidae	0.2		0.2	0.4				
Lampyridae				0.1				
LEPIDOPTERA	0.7	0.2		0.4	1.87	4.41		4.61
Cosmopterygidae				0.1				
Geometridae	0.1	0.1						
Lycaenidae	0.2							
Noctuidae		0.1		0.1				
Oecophoridae				0.1				
Pyralidae	0.4							
Tortricidae				0.1				
DIPTERA	0.8	3.0	3.5	3.7	0.06	2.64	1.84	2.33
Agromyzidae				0.1				
Cecidomyiidae			0.1	0.3				
Ceratopogonidae			0.1					
Chironomidae			0.2	0.1				
Chloropidae		0.1	0.1					
Clusiidae				0.3				
Cyclorraphoid	0.5	0.1						
Dolichopodidae		0.4						
Empididae		0.2	1.0					
Heleomyzidae				0.1				
Muscidae		2.0	0.6	0.2				
Mycetophilidae				0.4				
Phoridae			0.9	0.9				
Piophilidae				0.1				
Sciaridae	0.3	0.1	0.3					
Sciomyzidae			0.2	1.2				
Syrphidae		0.1						
HYMENOPTERA	0.4	0.7	3.1	1.4	0.10	0.34	0.85	0.89
Braconidae		0.1	0.4	0.1				
Cynipidae				0.1				
Diapriidae		0.1	0.3	0.1				
Eulophidae		0.2	1.2	0.1				
Eupelmidae				0.1				
Eurytomidae				0.1				
Formicidae	0.2							
Ichneumonidae			0.6	0.4	0.09			
Platygasteridae			0.1					
Pteromalidae	0.2	0.1	0.1	0.3				
Tenthredinidae		0.1				0.19		
Torymidae		0.1	0.4	0.1				
Total Insecta	7.4	7.0	8.7	8.2	3.85	12.69	9.19	10.01
ARANEIDA	2.8	0.8	3.4	3.8	2.78	0.73	2.98	5.57

Table 76. Arthropod populations and biomass on foliage, estimated by 10 m^2 pyrethrum spray samples in 1979. Black spruce bog (Site 4).

Taxon	Population m^{-2}				Biomass m^{-2} (mg oven dry)			
	VI-2	VII-2	VIII-4	IX-2	VI-2	VII-2	VIII-4	IX-2
PSOCOPTERA		0.4		0.1		0.03		0.01
Pseudocaeciliidae				0.1				
Psocidae		0.4						
HEMIPTERA		0.2						
Miridae		0.2						
HOMOPTERA	0.2	1.7	0.2	0.9		0.91	0.35	0.29
Aphididae		1.4	0.1					
Cicadellidae	0.1			0.8				
Cixidae		0.1						
Delphacidae	0.1			0.1				
Fulgoridae			0.1					
Psyllidae		0.2						
LEPIDOPTERA				0.1				0.01
Arctiidae				0.1				
DIPTERA	0.8	1.8	0.4	1.0	0.42	0.11	0.15	0.19
Chironomidae	0.5	1.1		0.2				
Chloropidae		0.3						
Muscidae		0.2	0.2	0.2				
Mycetophilidae	0.1			0.1				
Phoridae		0.1	0.2	0.2				
Sciaridae	0.2	0.1		0.3				
HYMENOPTERA	0.1	0.5	0.1	0.1		0.16	0.01	0.01
Braconidae			0.1					
Cynipidae		0.1						
Diapriidae				0.1				
Eulophidae		0.4						
Perilampidae	0.1							
Miscellaneous Insecta					0.10			
Total Insecta	1.1	4.6	0.7	2.1	0.52	1.21	0.51	0.51
ARANEIDA	1.9	1.4	0.9	1.9	1.20	2.94	0.69	1.19

Table 77. Arthropod populations and biomass on foliage, estimated by 10 m^2 pyrethrum spray samples in 1979. Mixed coniferous forest (Site 5).

Taxon	Population m^{-2} VI-2	VII-2	VIII-4	IX-2	Biomass m^{-2} VI-2	VII-2	VIII-4	IX-2
PSOCOPTERA		0.3	3.7	0.7		0.05	1.38	0.40
Pseudocaeciliidae			0.2					
Psocidae		0.3	3.5	0.7				
HEMIPTERA		0.3	2.0			0.18	0.82	
Miridae		0.3	2.0					
HOMOPTERA	0.2	1.6	0.4	0.3	0.26	0.33	0.21	0.13
Aphididae	0.1	1.5	0.1	0.1				
Chermidae		0.1						
Cicadellidae			0.2	0.2				
Delphacidae	0.1							
Phylloxeridae			0.1					
NEUROPTERA		0.3	0.1	0.2		0.24	0.08	0.25
Coniopterygidae		0.1						
Hemerobiidae		0.1	0.1	0.2				
COLEOPTERA		1.3	0.6	0.4		1.20	1.50	1.01
Chrysomelidae		0.1						
Cleridae		0.1						
Coccinellidae			0.5	0.2				
Cucujidae		0.1						
Elateridae		0.1						
Helodidae			0.1	0.1				
Orthoperidae				0.1				
Scolytidae		0.9						
LEPIDOPTERA		0.2		0.2		0.65		1.02
Geometridae				0.1				
Pyralidae		0.1						
Tineidae		0.1						
undet.				0.1				
DIPTERA	1.5	3.3	0.7	1.8	0.90	0.72	0.17	1.37
Ceratopogonidae		0.6	0.2					
Chironomidae	0.3	0.5						
Empididae		0.3		0.3				
Heleomyzidae				0.2				
Muscidae		0.3	0.3	0.1				
Muscoidea		0.3						
Mycetophilidae	0.2	0.1		0.6				
Phoridae		0.5		0.4				
Ptychopteridae				0.2				
Sciaridae	0.8	0.4	0.2					
Sciomyzidae		0.1						
Syrphidae	0.2	0.1						
Tipulidae		0.1						
HYMENOPTERA	0.2	0.5	2.1	0.3	0.05	0.25	3.11	0.44
Braconidae	0.1		0.3					
Diapriidae		0.1	0.1					
Diprionidae		0.1						
Eulophidae		0.2						
Eurytomidae	0.1							
Formicidae		0.1	0.1	0.2				0.40
Ichneumonidae			0.4					
Platygasteridae				0.1				
Pteromalidae			0.9					
Tenthredinidae			0.3				2.92	
Miscellaneous Insecta						0.24		
Total Insecta	1.9	7.5	9.6	3.9	1.21	3.62	7.27	4.62
ARANEIDA	3.3	1.9	7.2	3.1	16.6	2.40	9.35	3.42

Table 78. Arthropod populations and biomass on foliage, estimated by 10 m^2 pyrethrum spray samples in 1979. Mixed forest (Site 6).

Taxon	Population m^{-2}				Biomass m^{-2} (mg oven dry)			
	VI-2	VII-2	VIII-4	IX-2	VI-2	VII-2	VIII-4	IX-2
PSOCOPTERA	0.1	0.1		0.9		0.05		0.25
Pseudocaeciliidae				0.8				
Psocidae	0.1	0.1		0.1				
HEMIPTERA	0.1	0.6	2.9	1.3		0.25	6.71	3.85
Anthocoridae			0.3					
Lygaeidae				0.1				
Miridae	0.1	0.6	1.2	1.0				
Nabidae			0.1					
Pentatomidae			1.3	0.2				
HOMOPTERA	2.4	3.8	5.0	2.9		1.94	3.90	1.93
Aphididae	2.2	0.7	0.1	0.4				
Cicadellidae		1.2	1.2	0.3				
Eriosomatidae	0.1	0.2						
Psyllidae	0.1	1.7	3.7	2.2				
NEUROPTERA		0.2	0.1			0.62	0.14	
Hemerobiidae			0.1					
undet. larvae		0.2						
COLEOPTERA	1.5	0.5	0.4	0.9	3.73	1.13	0.60	2.23
Chrysomelidae	0.7							
Coccinellidae	0.1	0.4		0.4				
Elateridae	0.5							
Helodidae	0.2			0.4				
Lathridiidae				0.1				
Staphylinidae		0.1						
undet.			0.4					
LEPIDOPTERA	0.1	0.3	0.5	0.1	0.28	5.69	3.09	0.50
Geometridae		0.1	0.3	0.1				
Lasiocampidae		0.1						
Pyralidae			0.1					
Tortricidae		0.1						
undet.	0.1		0.1					
TRICHOPTERA		0.1		0.1		1.08		0.74
Limnephilidae		0.1		0.1				
DIPTERA	2.0	4.9	1.6	3.4	0.40	3.35	3.87	1.35
Agromyzidae			0.1					
Cecidomyiidae		0.1						
Ceratopogonidae	0.1			0.2				
Chirnomidae	0.3	0.2	0.1	0.1				
Chloropidae		0.4		0.1				
Empididae	0.1	1.2	0.1	0.3				
Muscidae		2.4	0.3	0.3				
Mycetophilidae	0.2	0.1		0.5				
Phoridae		0.1	0.5	1.3				
Pipunculidae			0.1					
Sciaridae	1.2	0.4	0.3	0.1				
Sciomyzidae				0.4				
Syrphidae	0.1							
Tipulidae			0.1	0.1				
HYMENOPTERA	0.9	0.5	1.1	1.6	0.55	0.16	0.92	1.87
Braconidae	0.1		0.1	0.1				
Eulophidae		0.3						
Formicidae	0.4		0.1	0.8	0.50		0.13	0.43
Platygasteridae	0.2		0.1					
Proctotrupidae				0.2				
Pteromalidae	0.2		0.7	0.5				
Sphecidae				0.1				
Tenthredinidae		0.1	0.1			0.10	0.68	
Torymidae		0.1		0.1				
Miscellaneous Insecta					0.86			
Total Insecta	7.1	10.9	11.6	11.2	5.82	14.27	19.23	12.72
ARANEIDA	5.5	1.9	2.7	5.3	2.61	1.49	2.60	9.22

Table 79. Arthropod populations and biomass on foliage, estimated by 10 m^2 pyrethrum spray samples in 1979. Jack pine forest (Site 8).

Taxon	Population m^{-2} VI-3	VII-3	VIII-3	IX-1	Biomass m^{-2} (mg oven dry) VI-3	VII-3	VIII-3	IX-1
COLLEMBOLA			0.2				0.02	
Entomobryidae			0.1					
Sminthuridae			0.1					
PSOCOPTERA		0.2	0.1	0.3			0.06	0.08
Pseudocaeciliidae		0.2						
Psocidae			0.1	0.1				
undet. nymphs				0.2				
HEMIPTERA		0.1	1.2	0.2			0.82	0.23
Anthocoridae		0.1	0.4					
Miridae			0.7	0.2				
Nabidae			0.1					
HOMOPTERA	1.1	3.8	1.4	1.4	0.44	0.25		0.26
Aphididae	0.9	3.4	0.4	0.7				
Cicadellidae	0.1	0.4	0.1	0.6				
Delphacidae	0.1							
Psyllidae			0.9	0.1				
NEUROPTERA			0.4				0.64	
Chrysopidae			0.4					
COLEOPTERA	0.5	0.6	0.5	0.4	1.32	2.98	0.79	0.18
Cantharidae		0.1						
Chrysomelidae		0.3						
Coccinellidae			0.1					
Elateridae	0.3	0.2						
Helodidae	0.1		0.4	0.4				
Staphylinidae	0.1							
TRICHOPTERA		0.2				1.23		
Limnephilidae		0.2						
LEPIDOPTERA	0.1	0.1	0.2	0.2	0.07	3.76	0.22	5.58
Lasiocampidae				0.1				
Noctuidae		0.1						
Olethreutidae	0.1							
Pyralidae			0.1					
undet.			0.1	0.1				
DIPTERA	4.3	10.1	5.3	1.3	1.37	7.71	3.35	0.57
Agromyzidae			0.1					
Anthomyiidae		7.1						
Cecidomyiidae			0.1					
Ceratopogonidae		1.4	0.1	0.1				
Chironomidae	1.0	1.0	0.8	0.2				
Chloropidae			0.6	0.2				
Cyclorraphoid			0.1					
Empididae	0.2	0.6	0.2	0.1				
Muscidae	0.3		1.9	0.1				
Mycetophilidae			0.3	0.2				
Phoridae			0.4	0.1				
Sciaridae	2.8		0.5	0.2				
Stratiomyiidae			0.1					
Tipulidae			0.1	0.1				
HYMENOPTERA	1.7	0.8	1.5	1.4	0.79	0.20	1.05	1.22
Argidae	0.2						0.08	
Braconidae	0.9	0.2	0.1	0.2				
Cynipidae				0.1				
Diapriidae			0.1					
Diprionidae			0.1					
Encyrtidae		0.1						
Eulophidae	0.2	0.3	0.3					
Eupelmidae			0.4					
Formicidae	0.2		0.1	0.9				1.09
Halictidae			0.2				0.56	
Ichneumonidae			0.2					
Platygasteridae	0.1							
Pteromalidae	0.1	0.2		0.1				
Torymidae				0.1				
Miscellaneous Insecta						1.49		
Total Insecta	7.7	15.9	10.8	5.2	3.99	17.62	6.95	8.12
ARANEIDA	6.8	5.7	5.7	4.4	9.51	4.88	6.28	4.99

Table 80. Arthropod populations and biomass on foliage, estimated by 10 m^2 pyrethrum spray samples in 1979. Semi-open Tamarack bog (Site 9).

	Population m^{-2}				Biomass m^{-2} (mg oven dry)			
	VI-3	VII-3	VIII-3	IX-1	VI-3	VII-3	VIII-3	IX-1
EPHEMEROPTERA			0.1				0.50	
Heptageniidae			0.1					
PSOCOPTERA		0.1	0.1	0.3		0.14	0.07	0.13
Psocidae			0.1	0.3				
undet. nymphs		0.1						
HEMIPTERA	0.5	6.3	1.5	1.7	2.27	2.81	1.05	1.22
Anthocoridae		5.5						
Aradidae			0.1					
Lygaeidae	0.3			0.6				
Miridae	0.1	0.8	1.4	1.1				
Pentatomidae	0.1							
HOMOPTERA	0.6	2.2	0.9	8.1	0.26	1.12	0.52	3.01
Aphididae	0.5		0.2	6.0				
Cercopidae	0.1							
Cicadellidae		1.7	0.3	0.3				
Fulgoridae				0.2				
Phylloxeridae				0.1				
Psyllidae		0.5	0.4	1.5				
NEUROPTERA				0.1				0.08
Chrysopidae				0.1				
COLEOPTERA	1.2	2.2	0.3	4.9	2.25	9.87	0.19	3.60
Cantharidae		0.1						
Chrysomelidae	0.4	2.0	0.1					
Curculionidae		0.1	0.1					
Elateridae	0.4							
Helodidae	0.4			4.8				
Lathridiidae			0.1					
Orthoperidae				0.1				
LEPIDOPTERA	0.4	0.1	0.1		0.34	0.34	0.20	
Geometridae	0.1							
Tortricidae	0.1		0.1					
undet.	0.2	0.1						
DIPTERA	4.5	2.7	1.1	1.6	2.06	1.50	1.18	0.37
Cecidomyiidae			0.1	0.3				
Ceratopogonidae				0.1				
Chironomidae	2.8	1.7	0.2	0.9				
Cyclorraphoid				0.1				
Empididae				0.1				
Heleomyzidae	0.2							
Muscidae	0.3	0.8	0.4	0.1				
Mycetophilidae	0.4	0.1						
Sciaridae	0.6		0.1					
Syrphidae	0.2		0.2		0.95			
Tipulidae		0.1	0.1					
HYMENOPTERA	1.3	1.4	0.5	0.9	1.69	7.48	0.81	2.80
Braconidae		0.1	0.1	0.4				
Cynipidae			0.1					
Daipriidae				0.3				
Formicidae	0.6				0.75			
Ichneumonidae	0.1	0.5	0.1	0.1				
Pteromalidae	0.2							
Tenthredinidae	0.4	0.8	0.2		0.81	7.23	0.70	
Vespidae				0.1				
Total Insecta	8.5	15.0	4.6	17.6	8.87	23.26	4.52	11.21
ARANEIDA	6.3	0.6	3.0	6.2	5.37	1.11	6.34	5.15

Table 81. Arthropod populations and biomass on foliage, estimated by 10 m^2 pyrethrum spray samples in 1979. Lightly forested tamarack (Site 11).

Taxon	Population m^{-2}				Biomass m^{-2} (mg oven dry)			
	VI-3	VII-3	VIII-3	IX-1	VI-3	VII-3	VIII-3	IX-1
COLLEMBOLA		0.1				0.03		
Sminthuridae		0.1						
EPHEMEROPTERA				0.1				0.13
PSOCOPTERA			0.3	0.1			0.14	0.04
Psocidae			0.3	0.1				
HEMIPTERA	0.7	0.7	0.4	0.4	0.58	0.13	0.69	0.27
Lygaeidae	0.3	0.1	0.3					
Miridae	0.4	0.2	0.1	0.4				
undet.		0.4						
HOMOPTERA	2.3	1.8	1.1	1.1	0.21	0.73	0.50	0.60
Aphididae	2.0	1.2	0.4	0.1				
Cicadellidae	0.2	0.1	0.4	0.6				
Fulgoridae		0.3	0.1					
Psyllidae	0.1	0.2	0.2	0.4				
NEUROPTERA		0.3		0.1		0.34		0.01
Chrysopidae		0.3		0.1				
COLEOPTERA	1.9	0.8	0.3	0.4	5.67	4.58	0.30	0.22
Chrysomelidae			0.1					
Coccinellidae	0.2	0.1	0.1					
Cryptophagidae		0.3	0.1					
Curculionidae				0.1				
Elateridae	0.8	0.1						
Helodidae	0.9			0.3				
Lathridiidae		0.1						
Lyctidae		0.1						
Staphylinidae		0.1						
LEPIDOPTERA	0.2	0.1	0.1		0.08	0.37	1.92	
Liparidae			0.1					
Tortricidae		0.1						
undet.	0.2							
DIPTERA	2.0	3.8	1.1	0.4	1.51	4.29	0.72	0.08
Cecidomyiidae				0.1				
Ceratopogonidae	0.2	0.1						
Chironomidae		0.6		0.1				
Cyclorraphoid		0.2						
Drosophilidae			0.1					
Empididae		0.2	0.1					
Muscidae	0.3	1.9	0.3	0.1				
Mycetophilidae		0.1		0.1				
Phoridae		0.4	0.4					
Pipunculidae		0.1						
Sciaridae	1.2	0.1	0.1					
Syrphidae	0.3	0.1	0.1		0.72			
HYMENOPTERA	0.9	1.6	1.6	0.5	1.13	0.36	0.70	0.25
Braconidae	0.1	0.1		0.1				
Cynipidae			0.5					
Diapriidae	0.2		0.1	0.1				
Encyrtidae		0.1						
Eupelmidae				0.1				
Formicidae	0.4	0.2	0.3		1.08	0.24	0.24	
Ichneumonidae	0.1		0.1	0.1				
Platygasteridae	0.1							
Pteromalidae		1.2	0.3					
Tenthridinidae			0.1	0.1			0.44	0.18
Torymidae			0.2					
Total Insecta	8.0	9.2	4.9	3.1	9.18	10.83	4.97	1.78
ARANEIDA	8.5	2.7	4.5	2.8	4.03	1.47	3.09	1.56

Table 82. Arthropod populations and biomass on foliage, estimated by 10 m^2 spray samples in 1979. Deciduous shrub wetland (Site 12).

Taxon	Populations m^{-2}				Biomass m^{-2} (mg oven dry)			
	VI-3	VII-3	VIII-3	IX-1	VI-3	VII-3	VIII-3	IX-1
PLECOPTERA			0.4	0.3			0.28	0.12
Nemouridae			0.4	0.3				
PSOCOPTERA		0.1		0.5		0.02		0.22
Pseudocaeciliidae				0.1				
Psocidae				0.4				
undet.		0.1						
HEMIPTERA		0.7	0.6	0.5		0.65	0.68	2.27
Miridae		0.7	0.5	0.4				
Pentatomidae			0.1	0.1				
HOMOPTERA	0.4	68.7	14.3	3.9	0.20	32.40	8.65	2.04
Aphididae	0.2	9.4	0.1	0.1				
Cicadellidae		7.7	3.8	0.7				
Eriosomatidae		51.1		0.1				
Fulgoridae				0.1				
Psyllidae	0.2	0.5	10.4	2.9				
COLEOPTERA	0.5	0.2	0.7	1.0	0.74	5.80	0.78	2.79
Cantharidae		0.2						
Chrysomelidae	0.1		0.4	0.6				
Coccinellidae	0.2		0.3	0.1				
Helodidae	0.2			0.3				
TRICHOPTERA	0.1				0.08			
Limnephilidae	0.1							
LEPIDOPTERA	0.1	0.2	0.1	0.1	0.06		0.07	0.63
Geometridae				0.1				
Gracilariidae			0.1					
Tortricidae	0.1							
undet.		0.2						
DIPTERA	1.5	2.7	0.4	0.9	1.74	6.80	0.21	0.35
Chironomidae	0.2		0.1					
Cyclorraphoid		0.5						
Drosophilidae				0.1				
Empididae	0.4	0.1		0.2				
Muscidae	0.3	0.7	0.2					
Mycetophilidae		0.3		0.1				
Phoridae				0.3				
Pipunculidae				0.1				
Sciaridae	0.3	0.9	0.1	0.1				
Syrphidae	0.2	0.2						
Tipulidae	0.1							
HYMENOPTERA	0.7	1.0	0.9	0.3	0.30	0.49	2.94	0.23
Argidae			0.1					
Braconidae	0.1	0.1	0.1					
Diapriidae				0.1				
Dryinidae			0.1					
Formicidae	0.2	0.1	0.3	0.1			0.35	0.11
Ichneumonidae		0.2	0.1	0.1				
Mymaridae		0.1						
Platygasteridae	0.2							
Pteromalidae	0.1							
Sphecidae		0.2						
Tenthredinidae		0.3	0.1				0.61	
Torymidae	0.1							
Vespidae			0.1				1.85	
Miscellaneous Insecta						0.84		
Total Insecta	3.3	73.6	17.4	7.5	3.12	47.00	13.61	8.65
ARANEIDA	1.6	1.3	0.5	1.6	1.39	0.98	2.98	0.68

Table 83. Sweep net sample results, 1978. Number of families represented in twenty-five 180° ground and head height sweeps.

Site	Date	Level[a]	Collembola	Psocoptera	Thysanoptera	Hemiptera	Homoptera	Neuroptera	Coleoptera	Lepidoptera	Diptera	Hymenoptera	Insect Families
Riparian Forest	VIII-19	G		2		2	4	1			11	7	27
		H	1	2		1	3		1	2	7	8	25
	VIII-24	G	1	1			4			1	6	7	20
		H	1	1			2		1	1	5	3	14
	IX-25	G	1	1			3		1		5	1	12
		H					3	1		1	2	1	8
white Spruce-Aspen Forest	VIII-19	G		2		1	2				13	10	28
		H		1		1	2				5	1	10
	VIII-24	G		1			3				7	5	16
		H		1			2			1	4	2	10
	IX-6	G	1	1		2	3		2	1	7	7	24
		H	1	1			2			1	5	5	15
	IX-25	G	1	2			1		2		4	6	16
		H	1				2				2		5
Aspen Forest	VIII-19	G	1	1			2	1			8	12	25
		H	1	1		1	3			1	9	8	24
	IX-2	G	1	1			3		1		4	5	15
		H				1	1				4	4	10
	IX-21	G		1		1	1	1		1	6	2	13
		H				1					3		4
Spruce Bog	VIII-19	G	1	1			3				7	6	18
		H	1	1			1				3	1	7
	IX-1	G									1		1
		H	1								1		2
	IX-21	G					1		1		3	1	6
		H	1				1					1	3

continued...

Table 83. Continued.

Site	Date	Level[a]	Collembola	Psocoptera	Thysanoptera	Hemiptera	Homoptera	Neuroptera	Coleoptera	Lepidoptera	Diptera	Hymenoptera	Araneida	Total Insects	Total Insect mass (mg oven dry)
Mixed Coniferous Forest	VIII-21	G	2	1		1	4				18	7		33	8.4
		H		2			1				3	2		8	3.4
	IX-6	G	8	1			4		1		39	20	7	73	9.6
		H	5	4		1	4	1	1		18	6	5	40	8.1
	IX-27	G	18	4		1	5	1	1		11	2	34	43	4.8
		H	7	6			21		1		9		6	44	4.1
Mixed Forest	VIII-19	G	2				2				21	12	2	37	4.8
		H	1	1		2	22			4	29	13	8	72	27.6
	VIII-31	G				4					12	8	1	24	45.1
		H		4		3	5			1	38	12	22	63	18.3
	IX-27	G	7			2	4				30	2	15	45	12.4
		H					9		1		13	3	3	26	6.1
Non-vegetated	VIII-21	G				5	25			1	25	10	1	66	12.7
		H			1		7		1		11	4	1	24	45.6
	IX-3	G				2	4		1		25	16	5	48	12.0
	IX-27	G	1				2		1		6		1	10	0.8
		H							1		2	1	2	4	1.5
Jackpine	VIII-18	G	1				2				25	12	4	40	6.4
		H					3				84	3		90	103.9
	VIII-27	G				3					7	6	8	16	12.2
		H	1			1	1			1	7	9	2	20	8.2
	IX-20	G				1					48		5	49	29.0
		H							1	1	14	2	3	18	13.4
	IX-26	G	1			1					22	2	2	26	5.2
		H	1			1	1	1			15		6	19	7.0

continued...

Table 83. Concluded.

Site	Date	Level[a]	Collombola	Psocoptera	Thysanoptera	Hemiptera	Homoptera	Neuroptera	Coleoptera	Lepidoptera	Diptera	Hymenoptera	Araneida	Total Insects	Total Insect mass (mg oven dry)
Semi-open Tamarack Bog	VIII-18	G	5				4				17	3		29	9.0
		H	1	1			4			1	65	2	2	74	5.6
	VIII-29	G		1			7		3		2	2	10	15	10.5
		H					2		2		2	1	6	7	6.3
	IX-26	G		1			1		1		1		2	4	1.3
		H		1			18		5		2	1	3	27	12.0
Fen	VIII-22	G	17	3	6	15	144		10	1	191	96	4	484	82.8
	VIII-30	G	2		11	2	59		3		39	36	10	152	58.4
	IX-20	G		1			21		11		51	1	4	85	35.8
Lightly Forested Tamarack	VIII-23	G	4	1		2	8				1	8	6	24	5.0
		H	3	2			8				1	4	1	18	9.5
	IX-5	G	14				4			1	52	7	2	78	7.8
		H	13				24				3	5	2	45	5.3
	IX-20	G									3	4	2	7	2.4
		H					3		4		4		5	11	6.1
	IX-26	G	4				9		1		94	3	5	111	7.4
		H	6	1			15		1		14	1	4	38	7.6
Deciduous-shrub wetland	VIII-23	G	2		3		13		2		50	29	12	99	22.6
		H	1	1			28				9	2	2	41	11.5
	IX-5	G	3		1		11			1	37	6	10	59	8.6
		H	4	1			50		2		50	5	8	112	23.4
	IX-26	G	1	1		2	7		1		21	4	6	37	9.0
		H				1	34	1	3		15		3	54	12.2

[a]ground and head height.

Table 84. Sweep net sample results, 1978. Number of specimens collected in twenty-five 180° ground and head height sweeps, and the insect biomass.

Site	Date	Level[a]	Collembola	Psocoptera	Thysanoptera	Hemiptera	Homoptera	Neuroptera	Coleoptera	Lepidoptera	Diptera	Hymenoptera	Araneida	Total Insects	Total Insect mass (mg oven dry)
Riparian Forest	VIII-19	G		10		33	8	1			43	25	16	120	26.2
		H	5	13		1	34		1	6	103	21	8	184	32.2
	VIII-24	G	4	9			21			1	29	10	14	74	8.2
		H	2	17			38		1	1	117	3	16	177	12.1
	IX-25	G	2	3			5		1		15	1	22	27	7.8
		H					25	1		1	12	4	25	43	9.5
white Spruce-Aspen Forest	VIII-19	G		4		1	10				103	51	15	169	21.2
		H		3		1	3				27	1	6	35	10.7
	VIII-24	G		1			4				52	18	4	75	12.0
		H		3			2			1	16	3	2	25	7.3
	IX-6	G	4	4		2	13		2	2	45	25	14	97	14.7
		H	1	1			98			1	21	7	9	129	9.7
	IX-25	G	3	4			7		2		34	12	41	62	18.1
		H	1				18				27		11	46	15.9
Aspen Forest	VIII-19	G	6	3			6	1			78	44	5	138	11.7
		H	2	1		1	6			1	29	19	14	59	14.7
	IX-2	G	1	1			3		1		15	13	25	34	7.8
		H				1	1				6	7	2	15	6.0
	IX-21	G		1		2	1	1		1	20	2	9	28	13.8
		H				1					4		8	5	3.5
Spruce bog	VIII-19	G	5	1			8				23	16	5	52	6.0
		H	2	1			1				7	3	2	14	1.9
	IX-1	G									2		4	2	0.3
		H	2								1			3	0.5
	IX-21	G					2		1		4	2	6	9	6.6
		H	1				1					2	2	4	0.2

continued...

Table 84. Continued.

Site	Date	Level[a]	Collembola	Psocoptera	Tysanoptera	Hemiptera	Homoptera	Neuroptera	Coleoptera	Lepidoptera	Diptera	Hymenoptera	Insect Families
Mixed Coniferous Forest	VIII-21	G	1	1		1	3				6	4	16
		H		2			1				2	2	7
	IX-6	G	1	1			2		1		6	7	18
		H	2	2		1	2	1	1		4	4	17
	IX-27	G	1	1		1	2	1	1		4	2	13
		H	1	1			1		1		2		6
Mixed Forest	VIII-19	G	1				2				4	6	13
		H	1	1		1	3			2	8	6	21
	VIII-31	G				3					5	3	11
		H		1		2	3			1	8	6	21
	IX-27	G	1			1	4				4	2	12
		H					2		1		4	2	9
Non-vegetated	VIII-21	G				2	3			1	9	8	23
		H			1		1		1		6	3	12
	IX-3	G				2	2		1		7	8	20
	IX-27	G	1						1		3		6
		H					1		1		2	1	4
Jackpine	VIII-18	G	1				2				8	4	15
		H					2				6	3	11
	VIII-27	G				1					6	4	11
		H	1			1	1			1	6	4	14
	IX-20	G				1					5		6
		H							1	1	5	2	9
	IX-26	G	1			1					8	1	11
		H	1			1	1	1			4		8

continued...

Table 84. Concluded.

Site	Date	Level[a]	Collembola	Psocoptera	Thysanoptera	Hemiptera	Homoptera	Neuroptera	Coleoptera	Lepidoptera	Diptera	Hymenoptera	Insect Families
Semi-open Tamarack Bog	VIII-18	G	1				2				6	3	12
		H	1	1			2			1	4	2	11
	VIII-29	G		1			2		1		2	2	8
		H					2		2		2	1	7
	IX-26	G		1			1		1		1		4
		H		1			3		1		1	1	7
Fen	VIII-20	G	2	1	2	2	4		5	1	21	9	47
	VIII-30	G	2		2	1	3		2		8	6	24
	IX-20	G		1			3		5		10	1	20
Lightly Forested Tamarack	VIII-23	G	1	1		2	3				1	6	14
		H	1	1			2				1	4	9
	IX-5	G	1				2			1	3	5	13[b]
		H	2				3				3	2	10
	IX-20	G									2	1	3
		H					2		2		4		8
	IX-26	G	1				3		1		5	2	12
		H	1	1			3		1		3	1	10
Deciduous-shrub wetland	VIII-23	G	1		2		4		2		10	11	31[b]
		H	1	1			4				4	1	11
	IX-5	G	1		1		4			1	6	3	16
		H	1	1			3		1		6	4	16
	IX-26	G	1	1		1	3		1		8	3	18
		H				1	3	1	2		2		9

[a]ground and head height.

[b]plus a trichopteran and plecopteran, respectively.

Table 85. Emergence trap 1. Record of numbers, types, and dates of collection of insects and spiders from 1 m^2 of ground in an aspen forest, 1979.

Taxon	21/26-V	26-V/2-VI	2/10-VI	10/17-VI	17/30-VI	30-VI/10-VII	10/15-VII	15/22-VII	22/29-VII	29-VII/7-VIII	7/13-VIII	13/20-VIII	20/28-VIII	28-VIII/4-IX	4/15-IX	15/22-IX	22/29-IX	Accumulated Total
ORTHOPTERA														1				1
Acrididae														1				1
PSOCOPTERA	2							2									1	5
Pseudocaeciliidae								2									1	3
Psocidae	2																	2
THYSANOPTERA			2				1											3
Thripidae			2				1											3
HEMIPTERA	1					1	1	1						1				5
Lygaeidae	1							1										2
Miridae						1	1											2
HOMOPTERA	1		4	1	1	3	1	11	2	2	2		2		7	2	5	44
Aphididae	1		3					9	2	2	1		2		5	2	2	29
Cercopidae								1							1			2
Cicadellidae			1	1	1	3	1	1										8
Dipsocoridae											1							1
Psyllidae															1			1
NEUROPTERA							1											1
Coniopterygidae							1											1
COLEOPTERA	9	4	1	1	6	3	2	2	5	6	1	2	1				3	46
Anobiidae					1													1
Carabidae		1						2			1							4
Chrysomelidae	4	2					1											7
Cryptophagidae							1											1
Curculionidae			1						1									2
Elateridae	4				4	1												9
Lampyridae		1																1
Lathridiidae				1		1				2		1					1	6
Nitidulidae						1											1	2
Scaphidiidae	1				1													2
Staphylinidae									4	4		1	1				1	11
LEPIDOPTERA					1	2		1	4	2								10
Noctuidae					1				1									2
Tineidae								1	1									2
undet.						2			2	2								6
DIPTERA	4	6	8	3	10	19	42	28	7	1	2	7	2	2	2	118	33	294
Anthomyiidae		1	1		1													3
Bibionidae							2									116	33	151
Cecidomyiidae		1				10	7	13	1	1	1		1					35
Ceratopogonidae	3		3			1	2	1										10
Chironomidae	1	4	1				6	10	4			2						28
Chloropidae					3													3
(Cyclorrapha)													1					1
Empididae					1	1												2
Heleomyzidae			2			1			1									4
Muscidae				1														1
Mycetophilidae												1						1
Phoridae							1		1			2			1			5
Piophilidae				1														1
Sciaridae				1	4	5	23	2			1	1		2	1	2		42
Sciomyzidae					1	1	1	2										5
Tachinidae			1															1
Tipulidae												1						1
HYMENOPTERA	1	1	3	6	11	6		3	3	4	4	22	1		3		1	69
Braconidae			1		1					1								3
Diapriidae					1	3					2							6
Encyrtidae								1										1
Formicidae			1	5	9	3		1	3	3	2	22	1		3		1	54
Ichneumonidae	1		1	1				1										4
Vespidae		1																1
Total Insecta	17	11	18	11	29	34	47	48	21	15	9	31	6	4	12	120	43	476
ARANEIDA	3		1	1		3	2	3			2	2		2	1	1	3	24

Table 86. Emergence trap 2. Record of numbers, types, and dates of collection of insects and spiders from 1 m^2 of ground in an aspen forest, 1979.

Taxon	21/26-V	26-V/2-VI	2/10-VI	10/17-VI	17/30-VI	30-VI/10-VII	10/15-VII	15/22-VII	22/29-VII	29-VII/7-VIII	7/13-VIII	13/20-VIII	20/28-VIII	28-VIII/4-IX	4/15-IX	15/22-IX	22/29-IX	Accumulated Total
ORTHOPTERA														1				1
Acrididae														1				1
PSOCOPTERA							1		1	1								3
Pseudocaeciliidae							1		1	1								3
HEMIPTERA												1						1
HOMOPTERA		3	1		1	3	1	10	3	3		2		2	1	1		31
Aphididae		3						8	3	3				1		1		19
Cercopidae								1										1
Cicadellidae			1		1	3	1	1				1		1	1			10
Membracidae												1						1
NEUROPTERA							1											1
Coniopterygidae							1											1
COLEOPTERA	9	1	1		5		2		1	2	1	1	3		3		1	30
Carabidae	1																	1
Chrysomelidae	2	1																3
Coccinellidae													1					1
Elateridae	1		1															2
Lampyridae	4																	4
Lathridiidae	1				2		1		1			1			1			7
Meloidae					1													1
Nitidulidae										1							1	2
Scaphidiidae					1													1
Staphylinidae					1		1			1	1		2		2			8
LEPIDOPTERA				1		2	1	1	1									6
Gracilariidae				1		1												2
Oecophoridae						1	1											2
Pyralidae								1										1
DIPTERA	4	10	8	14	14	13	21	33	14	7	2	5	1	4	7	77	71	305
Anthomyiidae						1												1
Bibionidae															5	73	69	147
Cecidomyiidae					3	5	6	5	7	5	1	1		2				35
Ceratopogonidae	3	10	2	4			3											22
Chironomidae	1							15	4			4			1			25
Chloropidae				1											1			2
Empididae				1		1	1	1										4
Heleomyzidae			1	1			9											11
Muscidae			2	4	7											1		14
Mycetophilidae													1					1
Phoridae								2	1	1				1			1	6
Piophilidae				2														2
Pipunculidae							1											1
Psilidae					2													2
Psychodidae				1														1
Sciaridae					2	2	1	10	2	1	1					3	1	23
Sciomyzidae						4												4
Syrphidae														1				1
Tachinidae			2															2
Trichoceridae			1															1
HYMENOPTERA	2	2	4	4	5	6	5	2			8	6		3	6	7	2	62
Braconidae			1			1	1											3
Chalcidoidea												1						1
Diapriidae				1			1											2
Formicidae	2	2	2	3	4	4	2	2			4	5		3	5	7	2	47
Ichneumonidae			1		1						1				1			4
Mymaridae						1					2							3
Pteromalidae							1				1							2
Sphecidae												1						1
Total Insecta	15	16	14	19	25	24	32	46	20	13	11	16	4	10	17	85	74	441
ARANEIDA			1	1		1				1								4

Table 87. Emergence trap 3. Record of numbers, types, and dates of collection of insects and spiders from 1 m^2 of ground in a mixed conifer forest, 1979.

Taxon	21/26-V	26-V/2-VI	2/10-VI	10/17-VI	17/30-VI	30-VI/10-VII	10/15-VII	15/22-VII	22/29-VII	29-VII/7-VIII	7/13-VIII	13/20-VIII	20/28-VIII	28-VIII/4-IX	4/15-IX	15/22-IX	22/29-IX	Accumulated Total
ORTHOPTERA										1								1
Acrididae										1								1
PSOCOPTERA												1				1		2
Pseudocaeciliidae												1				1		2
HEMIPTERA												1		1		1		3
Pentatomidae												1		1		1		3
HOMOPTERA						1		2	1			1	1	2	1			9
Aphididae								2							1			3
Cicadellidae						1							1	2				4
Cixidae												1						1
undet.									1									1
NEUROPTERA				1														1
Hemerobiidae				1														1
COLEOPTERA	2	2		1	3	1	1	3	1	2		2				1	3	22
Carabidae					1	1		3		1		2					1	9
Chrysomelidae		1																1
Curculionidae				1														1
Elateridae	1						1											2
Lampyridae	1																	1
Latiridiidae					1												1	2
Nitidulidae		1								1						1	1	4
Staphylinidae					1				1									2
LEPIDOPTERA					2	5	4	2						1			1	15
Gracilariidae					1	5												6
Noctuidae					1		1										1	3
Nymphalidae							1											1
Pyralidae							1											1
Tineidae							1	2						1				4
DIPTERA		16	6	3	4	25	7	12	1	1	2	3	2		39	209	64	394
Anthomyiidae			2													1		3
Bibionidae															39	208	64	311
Cecidomyiidae			1	1			1	7			2	1	1					14
Ceratopogonidae							1	1										2
Chironomidae					1													1
Cyclorrapha										1								1
Dolichopodidae					1													1
Empididae		1				1	1		1									4
Heleomyzidae						6	2											8
Muscidae				1	1			2										4
Mycetophilidae		11																11
Phoridae								1										1
Piophilidae				1														1
Sciaridae		3	3			8	2					2						18
Sciomyzidae						10		1										11
Sepsidae					1													1
Tipulidae													1					1
Trichoceridae		1																1
HYMENOPTERA	1		2	1	4	3		1		1	2	211				1	2	229
Braconidae						1												1
Diapriidae					1						1							2
Formicidae	1		2	1	3	1				1	1	211				1	2	224
Ichneumonidae																		
Mymaridae								1										1
Total Insecta	3	18	7	6	13	35	12	20	3	5	4	218	3	4	40	213	70	660
ARANEIDA		1	1				2	1				2	1	3			3	17

Table 88. Emergence trap 4. Record of numbers, types, and dates of collection of insects and spiders from 1 m^2 of ground in a mixed conifer forest, 1979.

Taxon	21/26-V	26-V/2-VI	2/10-VI	10/17-VI	17/30-VI	30-VI/10-VII	10/15-VII	15/22-VII	22/29-VII	29-VII/7-VIII	7/13-VIII	13/20-VIII	20/28-VIII	28-VIII/4-IX	4/15-IX	15/22-IX	22/29-IX	Accumulated Total
PSOCOPTERA									1				1	2			2	6
Pseudocaeciliidae													1	2			2	5
Psocidae									1									1
THYSANOPTERA			1															1
Thripidae			1															1
HEMIPTERA	1					1	2	1	1		1							7
Lygaeidae									1									1
Miridae								1			1							2
Pentatomidae	1					1	2											4
HOMOPTERA			1		1		1	1		2			2	3	3	2	2	18
Aphididae							1			1				2			2	6
Cercopidae													1					1
Cicadellidae					1			1					1	1	3	1		8
Cixidae			1															1
Psyllidae										1						1		2
NEUROPTERA			1				1											2
Coniopterygidae							1											1
Hemerobiidae			1															1
COLEOPTERA	1	5	1		1	1	5		2	1		4	4			2	1	28
Carabidae						1	3			1								5
Chrysomelidae		4																4
Lathridiidae			1				1											2
Nitidulidae																2	1	3
Staphylinidae	1	1			1		1		2			4	4					14
LEPIDOPTERA			1	1		2	6	2	2									14
Blastobasidae							1											1
Gracilariidae						2												2
Noctuidae							1	1										2
Oecophoridae							3											3
Pyralidae								1										1
Tineidae							1		1									2
undet.			1	1					1									3
DIPTERA	2	14	3	5	13	27	4	13	3	4	2	5	4	3	2	125	81	310
Anthomyiidae						2												2
Bibionidae															2	125	81	208
Cecidomyiidae				2		4	2	6		2	2	2						20
Ceratopogonidae						2												2
Chironomidae		1	1						1	1		1	1					6
Cyclorrapha														1				1
Dolichopodidae								1										1
Empididae		1			6	4	1	1		1		1						15
Muscidae				1	5	1		1										8
Mycetophilidae		7						2										9
Phoridae		2						1										3
Piophilidae				1														1
Pipunculidae	1		2															3
Rhagionidae					1			1										2
Sciaridae		1			1	11	1		2			1	1	2				20
Sciomyzidae		2				2												4
Syrphidae				1														1
Tachinidae	1																	1
Thereuidae						1												1
Tipulidae													2					2
HYMENOPTERA	1		3	1	1	4	2	3	2	3	21	4	2	2			1	50
Braconidae	1		1			1												3
Chalcidoidea									1									1
Diapriidae						1	1					1						3
Eulophidae								1										1
Formicidae			2	1		2			1	3	18	2	2	1				32
Ichneumonidae					1			1									1	3
Mymaridae								1			3	1						5
Proctotrupidae														1				1
Thysanidae							1											1
Total Insecta	5	19	11	7	16	35	21	20	11	10	24	13	13	10	5	129	87	436
ARANEIDA	4		1	2	2	1	2	4	1			2	3	3				25

Table 89. Emergence trap 5. Record of numbers, type, and dates of collection of insects and spiders from 1 m^2 of ground in a spruce forest, 1979.

Taxon	21/26-V	26-V/2-VI	2/10-VI	10/17-VI	17/30-VI	30-VI/10-VII	10/15-VII	15/22-VII	22/29-VII	29-VII/7-VIII	7/13-VIII	13/20-VIII	20/28-VIII	28-VIII/4-IX	4/15-IX	15/22-IX	22/29-IX	Accumulated Total
PSOCOPTERA																		2
Pseudocaeciliidae							1				1							2
HEMIPTERA																		3
Miridae							2	1										3
HOMOPTERA																		16
Aphididae						1	1	1	1					1				5
Cercopidae								4	3									7
Cicadellidae											1	1					1	3
Cixiidae												1						1
NEUROPTERA																		3
Coniopterygidae			1															1
Hemerobiidae								1				1						2
COLEOPTERA																		15
Carabidae			1															1
Chrysomelidae	2		3															5
Curculionidae	1																	1
Elateridae	1																	1
Nitidulidae	1		1		1					1								4
Staphylinidae				1					1			1						3
LEPIDOPTERA																		6
Noctuidae										1	1				1			3
Tineidae									1									1
undet.											2							2
DIPTERA																		141
Anthomyiidae		1						1										2
Bibionidae												1						1
Cecidomyiidae					4	12	11	11	1	1		5						45
Ceratopogonidae		2				2												4
Chironomidae						1		6	2	1		5						15
Chloropidae						1												1
Cyclorrapha														1				1
Empididae			1		2	3	1	1	1	1								10
Heleomyzidae						1					1							2
Muscidae						1												1
Mycetophilidae	5		7				2							1	3		1	19
Nematocera												3						3
Phoridae								2			2							4
Pipunculidae					1					1								2
Sciaridae	2		2		2	6	2	2			1		1					18
Sciomyzidae						1	5	2		2								10
Syrphidae					1													1
Tipulidae			1															1
Trichoceridae														1				1
HYMENOPTERA																		15
Chalcidoidea								2										2
Diapriidae																	1	1
Dryinidae								1										1
Formicidae		1			1							5						7
Ichneumonidae	1																	1
Mymaridae						2												2
Pteromalidae						1												1
Total Insecta	13	4	17	1	12	32	25	35	10	8	9	23	1	4	4	0	3	201
ARANEIDA	3	1		1			4	4			4			4			15	36

Table 90. Emergence trap 6. Record of numbers, types, and dates of collection of insects and spiders from 1 m^2 of ground in a spruce forest, 1979.

Taxon	21/26-V	26-V/2-VI	2/10-VI	10/17-VI	17/30-VI	30-VI/10-VII	10/15-VII	15/22-VII	22/29-VII	29-VII/7-VIII	7/13-VIII	13/20-VIII	20/28-VIII	28-VIII/4-IX	4/15-IX	15/22-IX	22/29-IX	Accumulated Total
PSOCOPTERA																		
Pseudocaeciliidae						7	3									1		11
THYSANOPTERA																		
Thripidae							3	2	1									6
HEMIPTERA																		
Miridae						4	1					1						6
Pentatomidae						1												1
HOMOPTERA																		
Aphididae						1								1				2
Cercopidae								1		1								2
Cicadellidae							1								1			2
Cixiidae							1											1
undet.									10									10
NEUROPTERA																		
Hemerobiidae		1			1					2	3		1		1			9
COLEOPTERA																		
Carabidae			1														1	2
Chrysomelidae	2					2												4
Curculionidae	1																	1
Elateridae	1		1				2											4
Lampyridae															1			1
Lathridiidae							1	1			1							3
Leptodiridae															1	1		2
Nitidulidae	1			3				1				1				1	1	8
Staphylinidae						2		1	3	5	1		3		2	1		18
LEPIDOPTERA																		
Geometridae											2							2
Pyralidae							1											1
Tineidae							1											1
DIPTERA																		
Agromyiidae			1		2	1					1							5
Anthomyiidae												1						1
Bibionidae										5	1							6
Cecidomyiidae					3	6	9	19		8	7	1				1		54
Ceratopogonidae		7				3	1											11
Chironomidae								16	1		4	4			1			26
Chloropidae						2												2
Cyclorrapha													1	1				2
Dolichopodidae							1	2										3
Empididae				1	2	2	1	2										8
Heleomyzidae			2				1		1		1							5
Muscidae					2	2			5			1						10
Mycetophilidae	5		10	4	2	1		1	1				2	1	1	1	2	31
Phoridae							1				1							2
Piophilidae						1												1
Pipunculidae			1										1					2
Psilidae				1														1
Psychodidae				3														3
Sciaridae	2		1		3	9	5					1	3					24
Sciomyzidae								1		3								4
Syrphidae				1														1
Tachinidae		1																1
Therevidae							1											1
Tipulidae															1			1
Trichoceridae						3								1				4
HYMENOPTERA																		
Braconidae				1														1
Chalcidoidea								1										1
Diapriidae											1					1		2
Dryinidae											1							1
Eulophidae									1		1							2
Formicidae					1		2	1			1				3	1		9
Ichneumonidae	1																	1
Mymaridae							4			1	1							6
Pteromalidae									1									1
Total Insecta	13	9	17	14	16	47	40	49	24	25	27	10	11	4	12	8	4	330
ARANEIDA	3	2	1		1	3	4	6			3	2	2	4	1		4	36

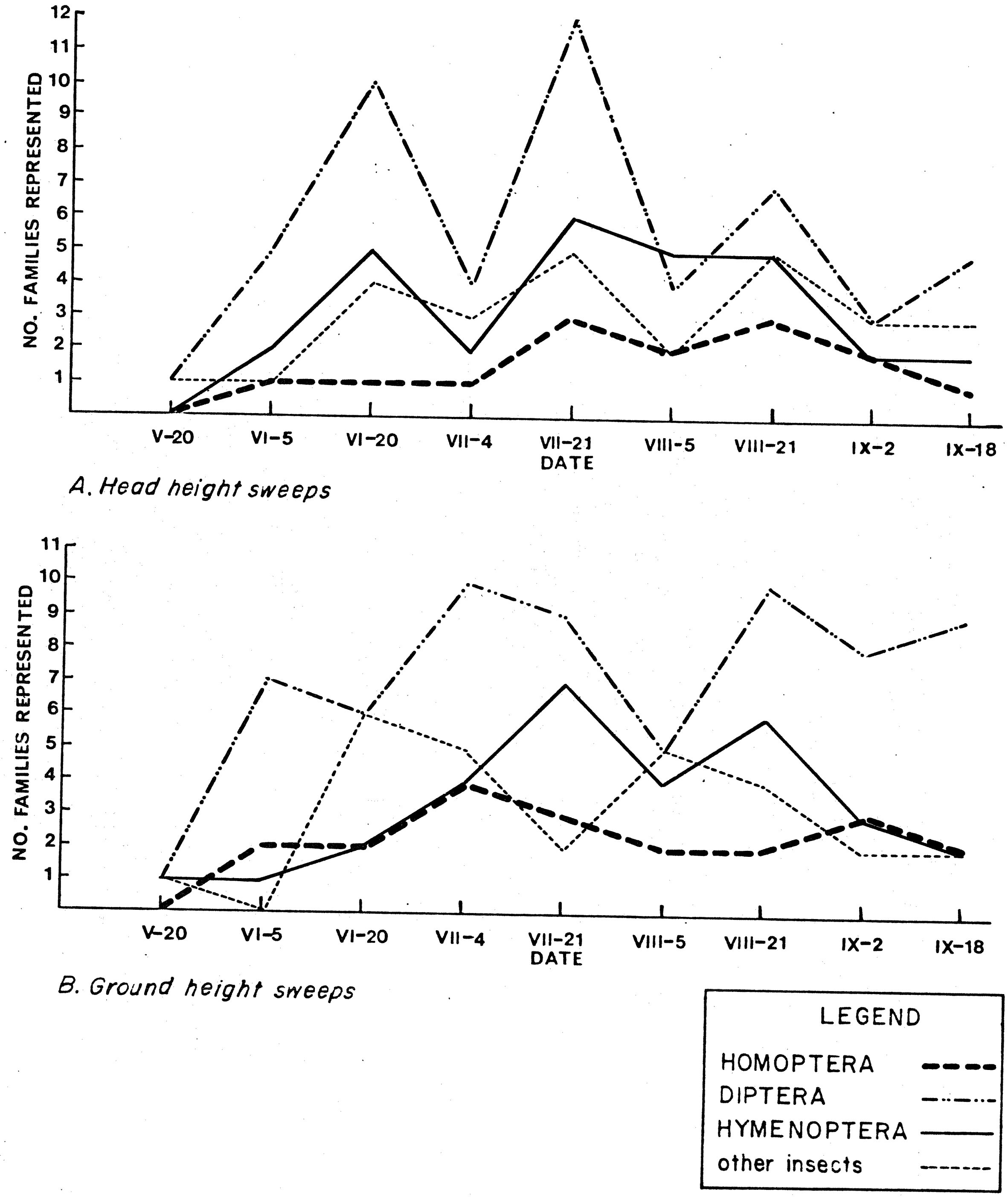

Figure 26. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Riparian Forest (Site 1).

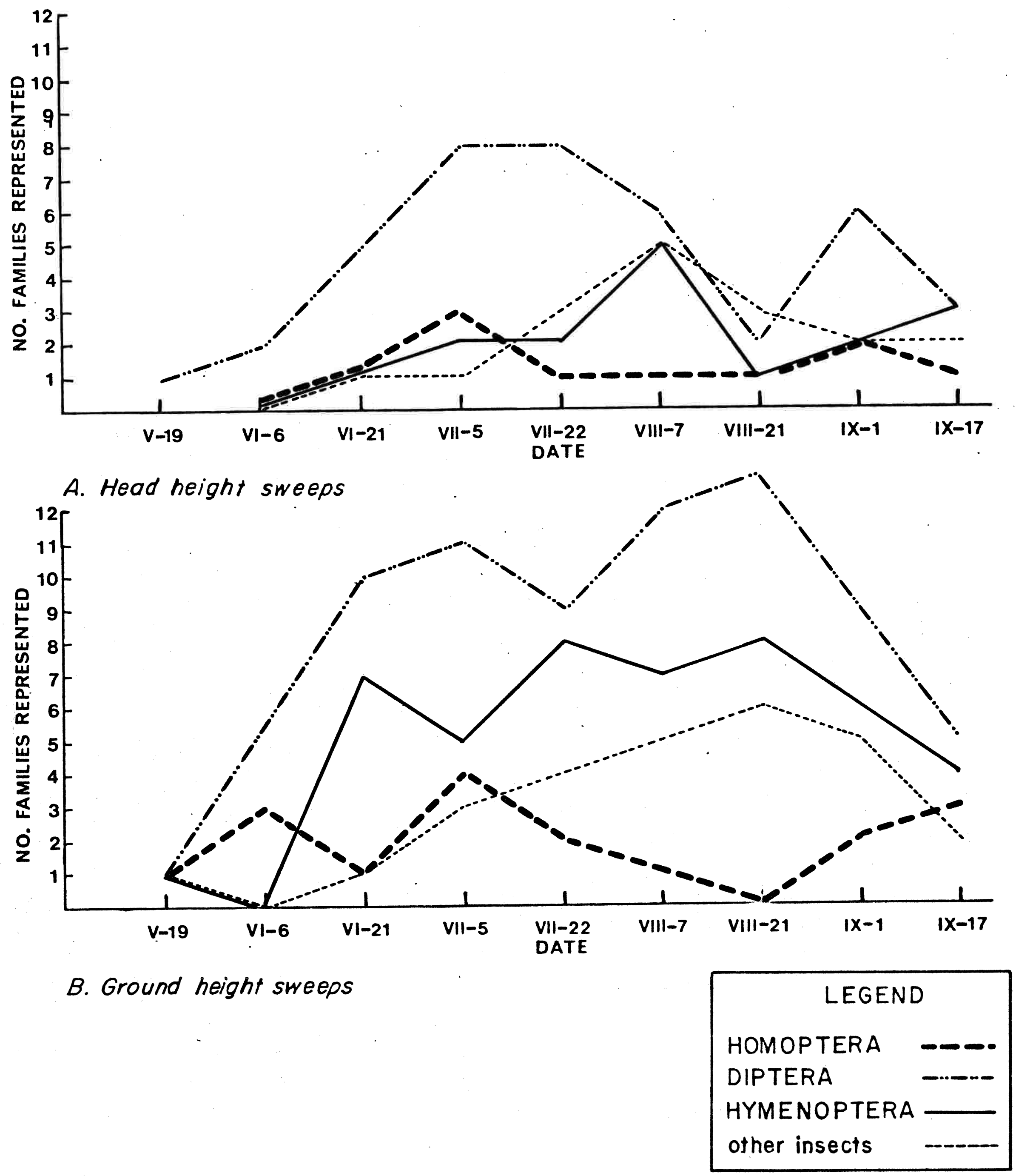

Figure 27. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. White Spruce (Site 2).

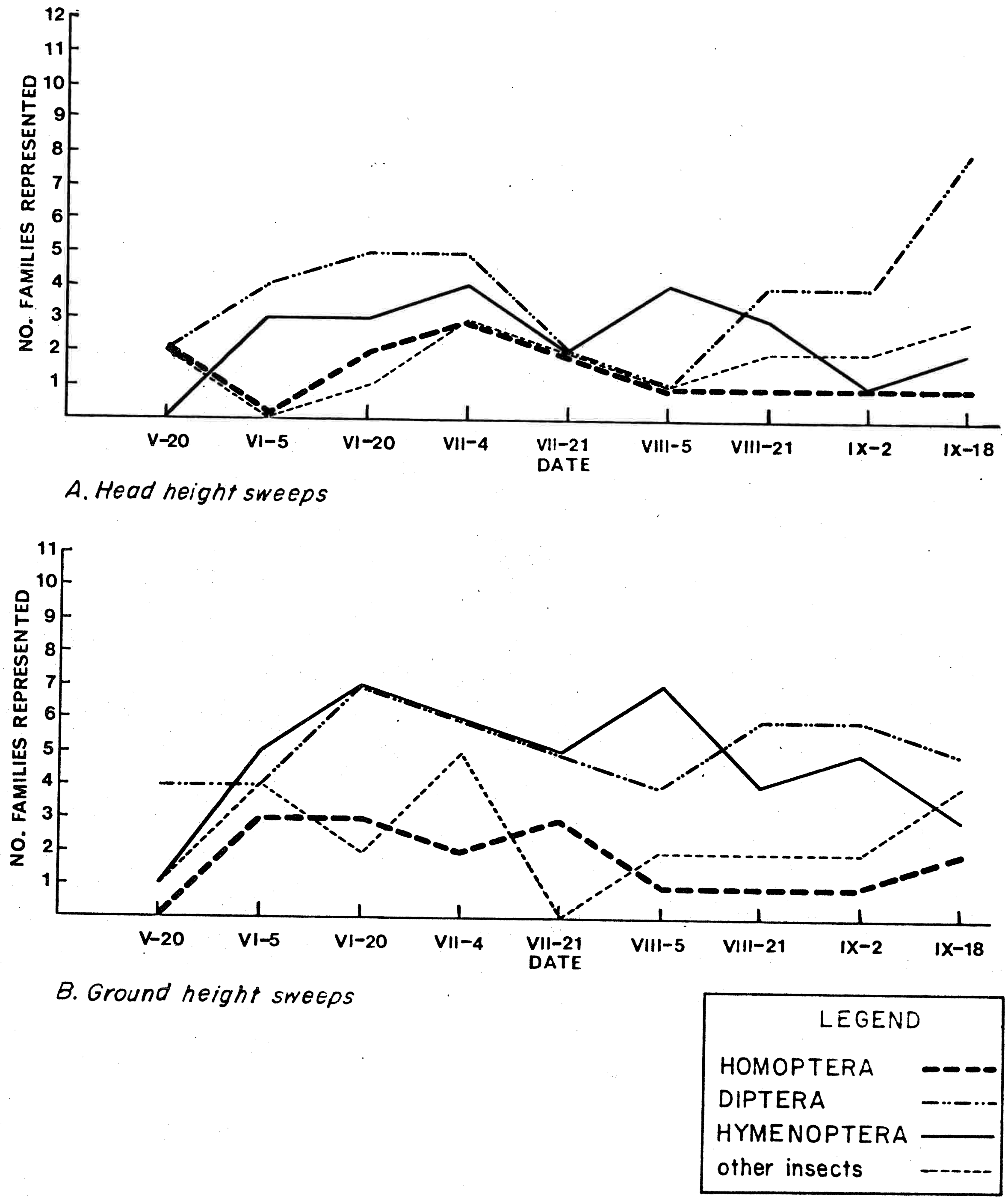

Figure 28. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Aspen Forest (Site 3).

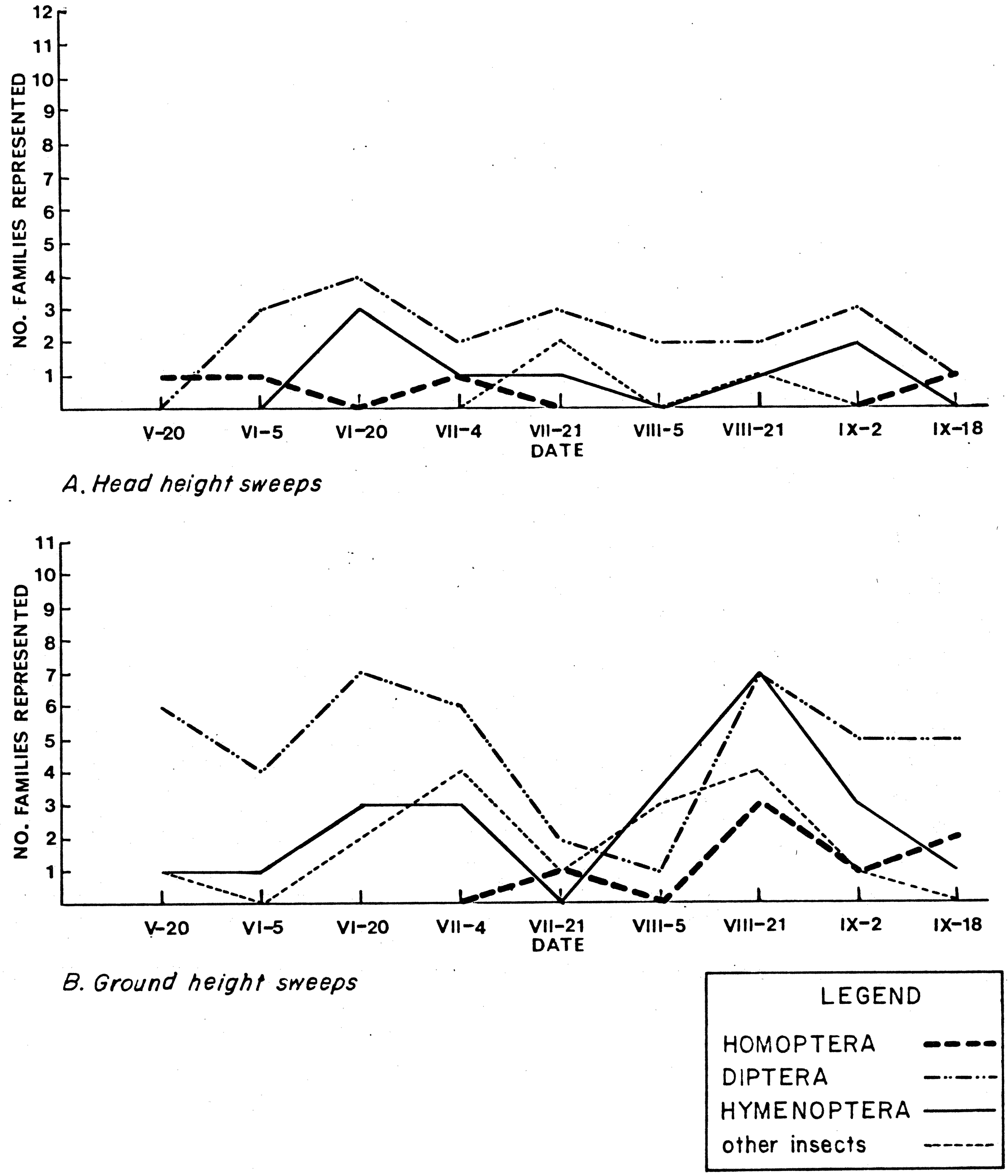

Figure 29. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Black Spruce Bog (Site 4).

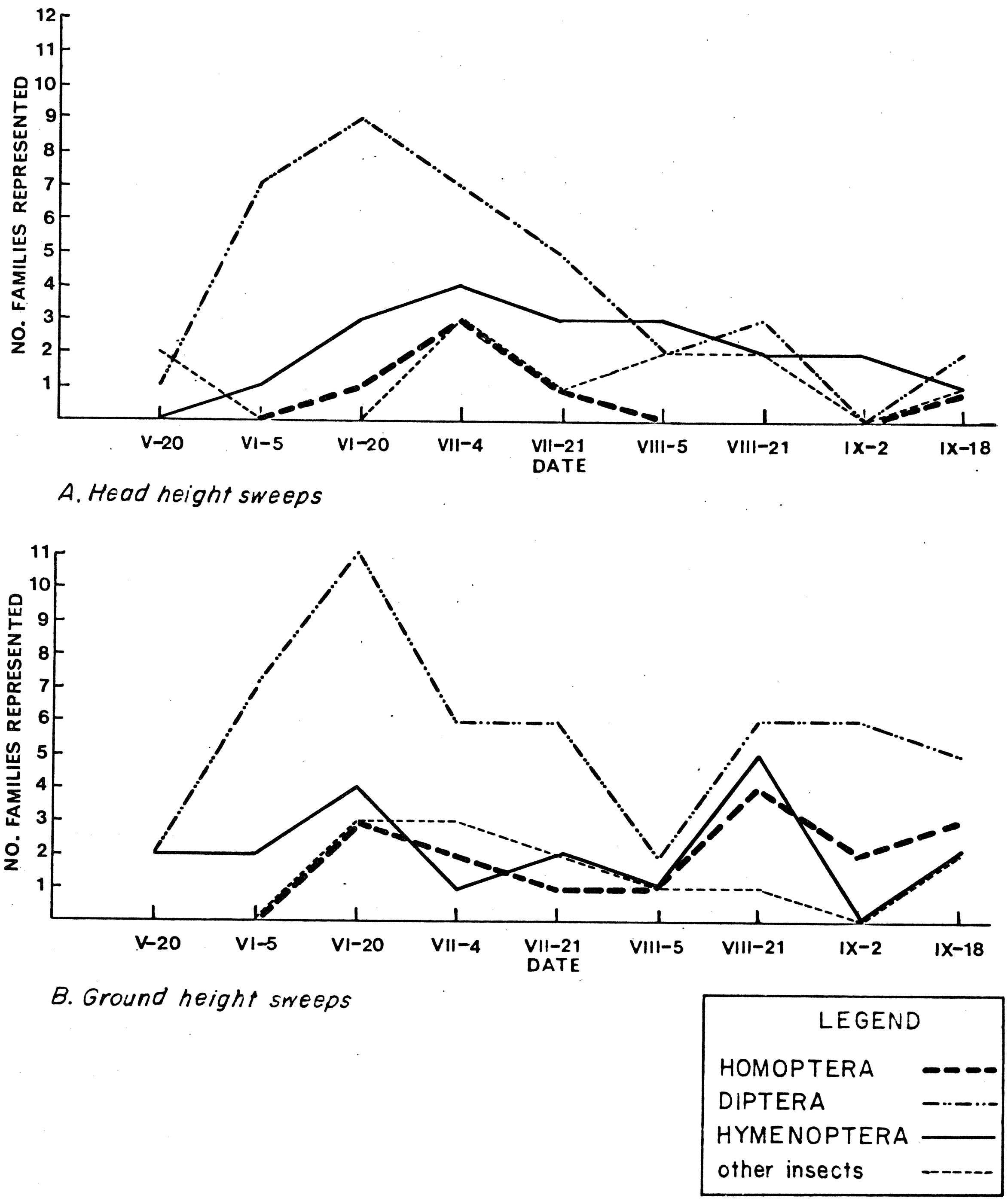

Figure 30. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Mixed Coniferous Forest (Site 5).

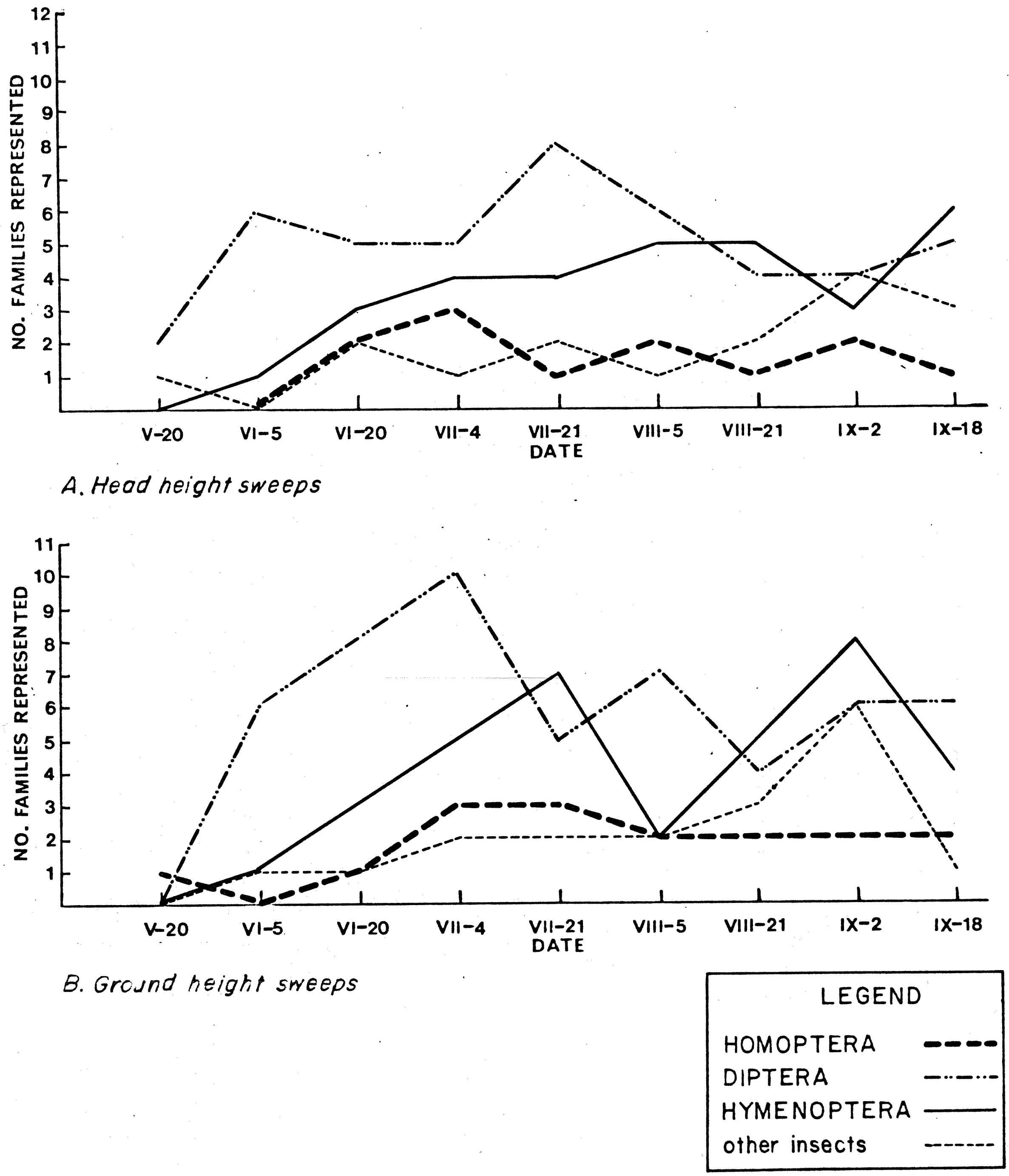

Figure 31. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Mixed Forest (Site 6).

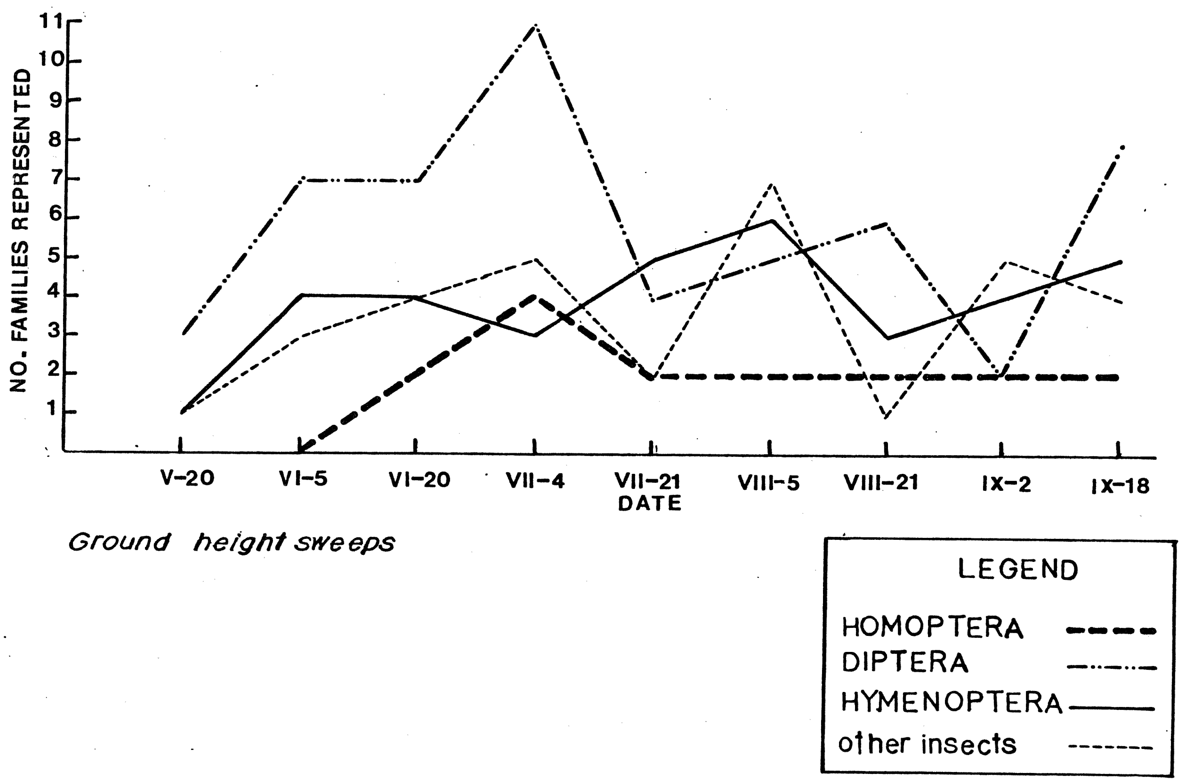

Figure 32. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Disturbed area (Site 7).

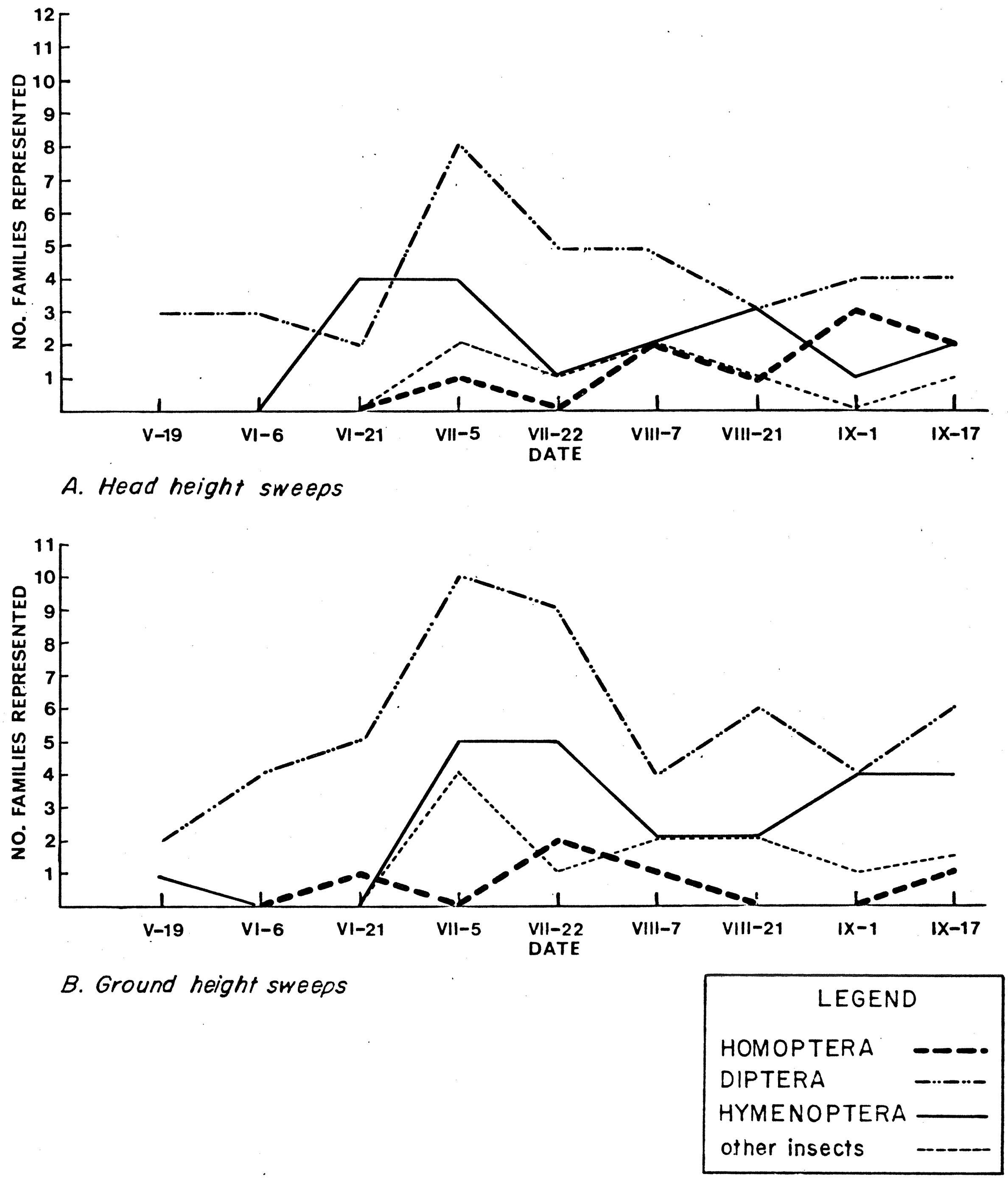

Figure 33. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Jack Pine Forest (Site 8).

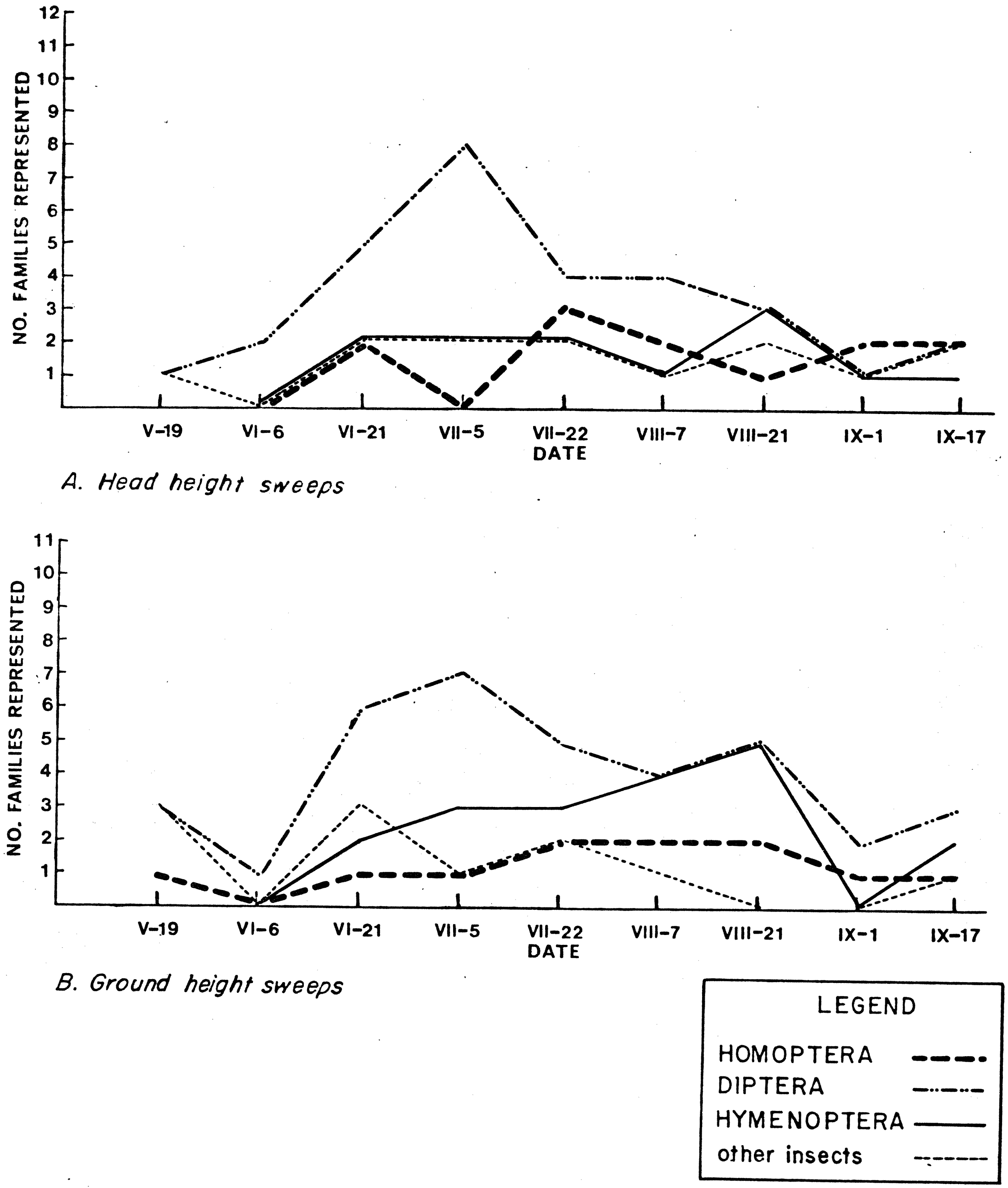

Figure 34. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Tamarack Bog (Site 9).

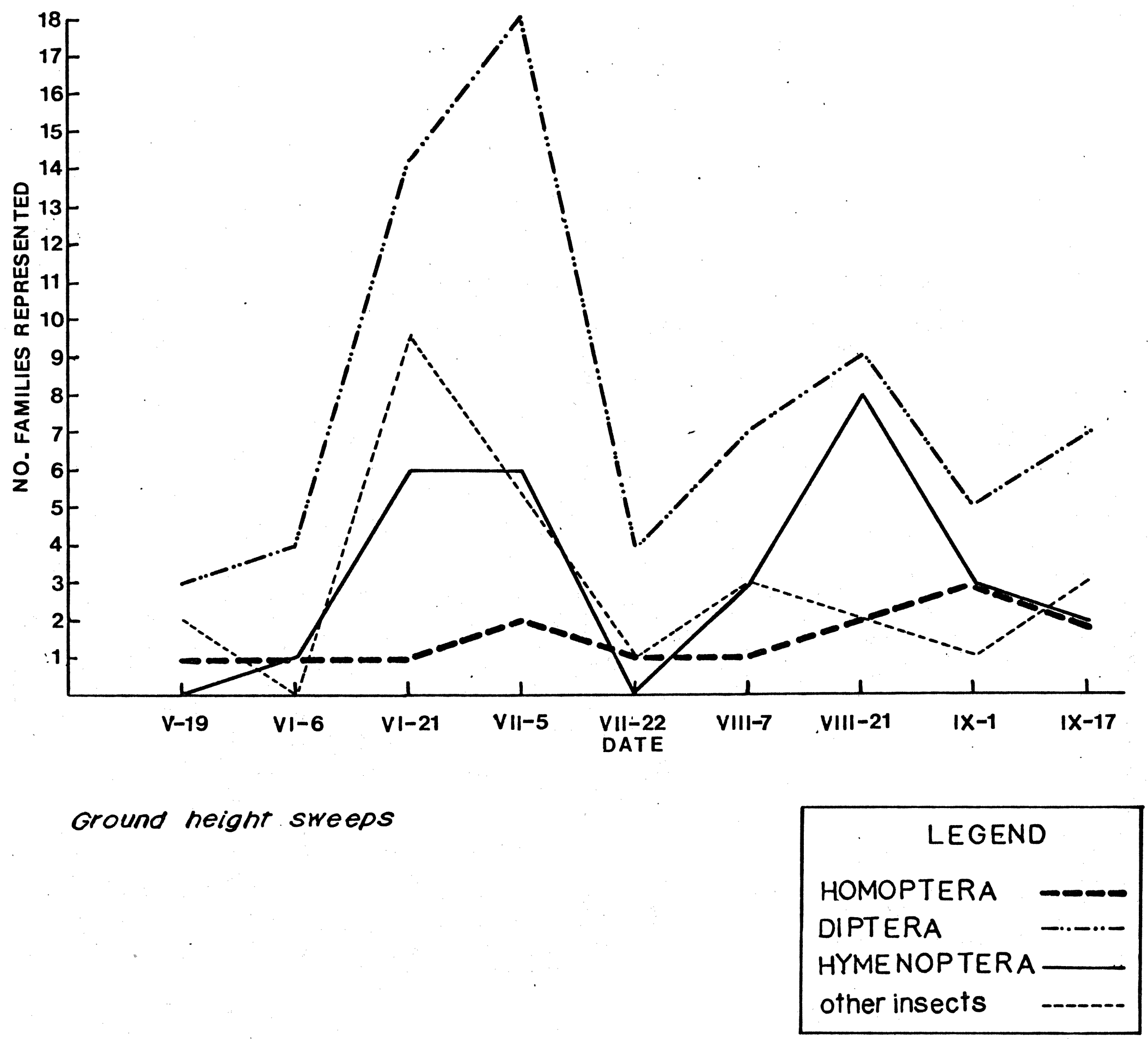

Figure 35. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Fen (Site 10).

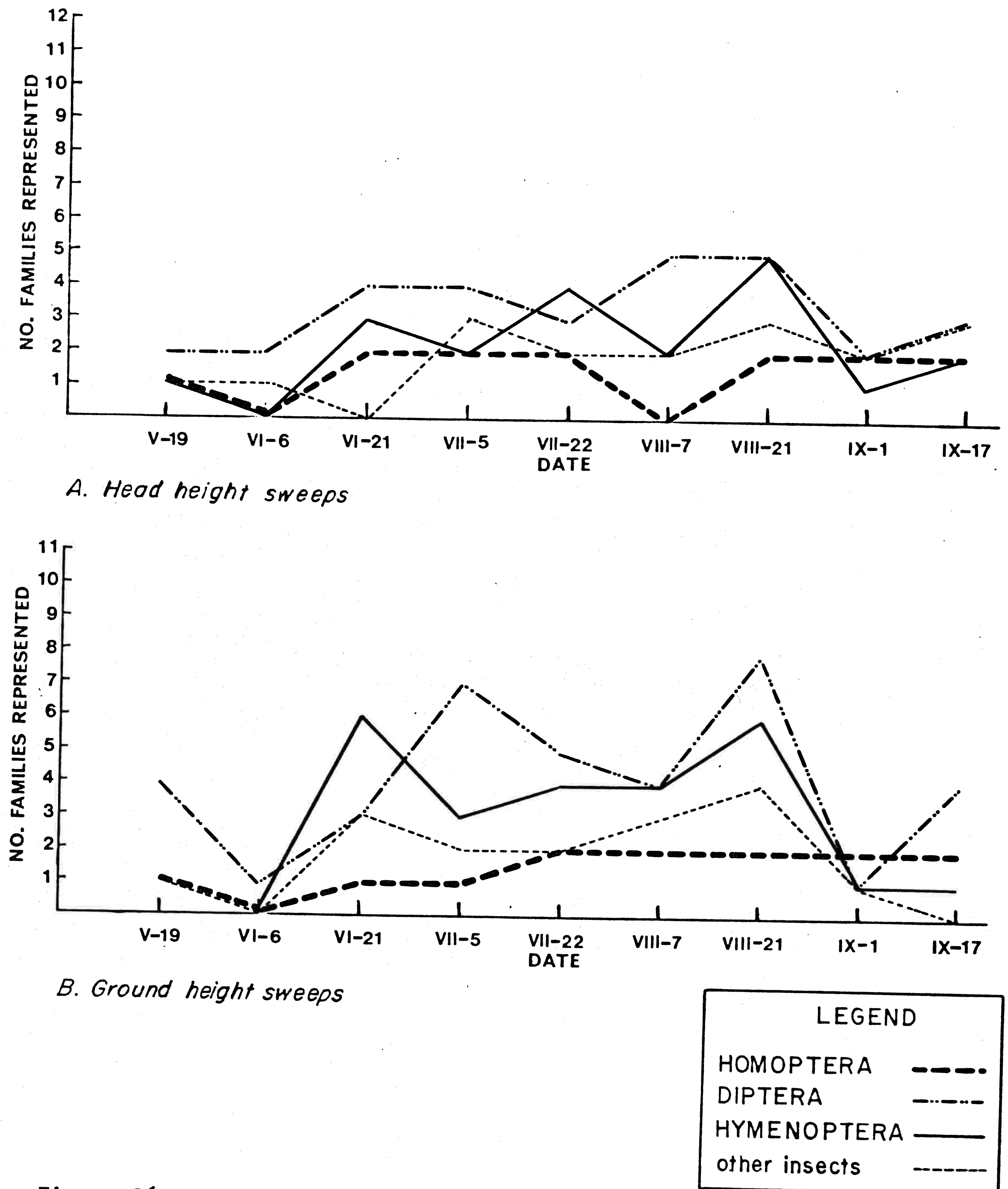

Figure 36 . Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Tamarack Forest (Site 11).

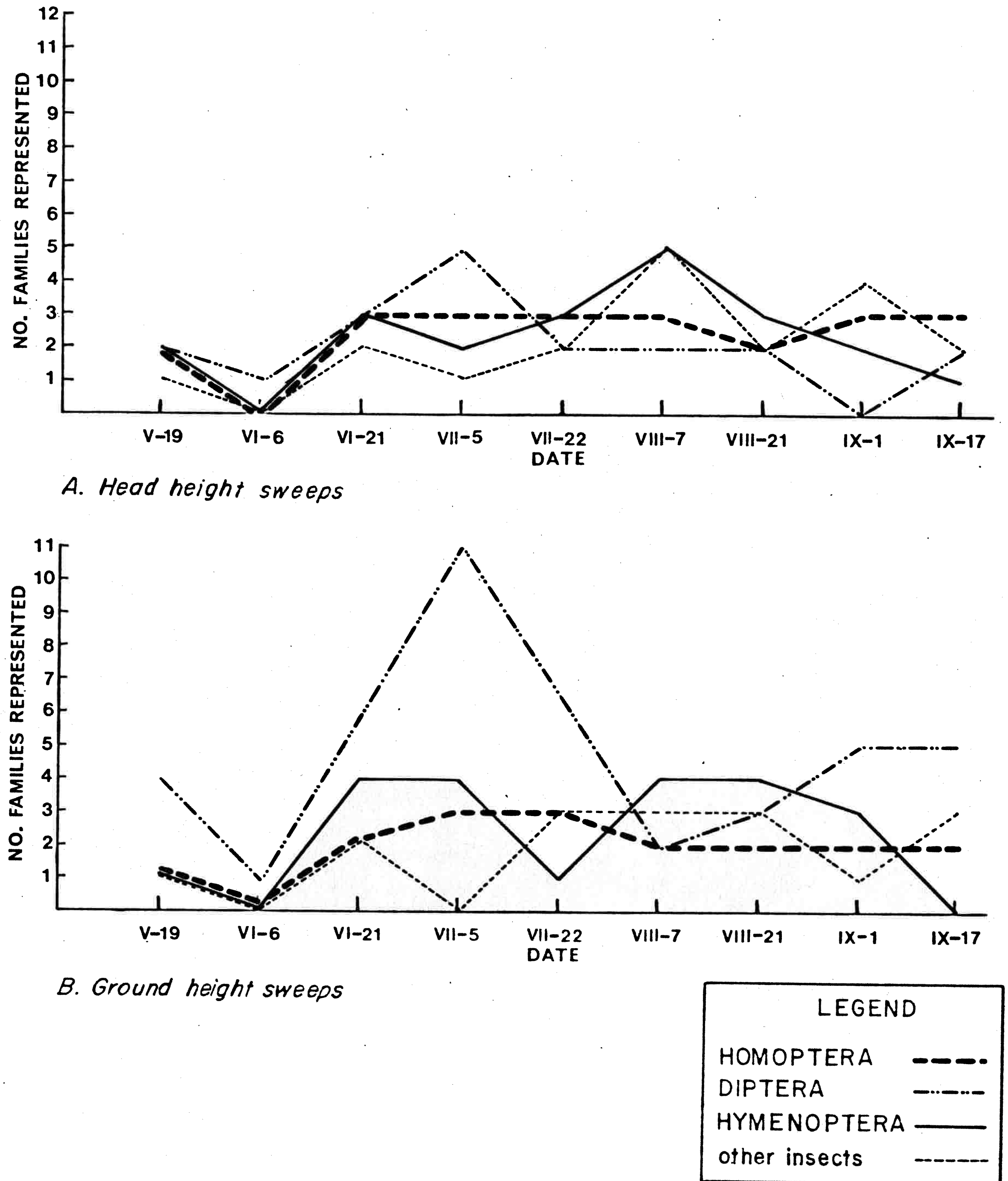

Figure 37. Insect sweep net sample results plotted to show diversity of insect families collected throughout the 1979 season. Deciduous Wetland (Site 12).

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