Abundance of herbivorous insects on dwarf birch near the treeline in Alaska

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KOPONEN, SEPPO. Abundance of herbivorous insects on dwarf birch near the treeline in Alaska. Rep. Kevo Subarctic Res. Stat. 19. 19 – 24. 1984. – Herbivorous insects of *Betula glandulosa* and *B. nana* were collected using sweep netting in the Alaska Range, White Mountains (Eagle Summit) and Brooks Range – Arctic Slope in July, 1982. Sap-suckers dominated over leafchewers in number. Among suckers, aphids (*Euceraphis betulae*-complex) and psyllids *(Psylla betulaenanae)* were the most abundant groups. The number of aphids compared to psyllids was markedly high. Sawfly larvae predominated among chewers; also tortricid *(Epinotia solandriana)* and geometrid larvae were locally common. The numbers of chewers, especially sawfly larvae, varied less between sites than those of suckers. Birch leaves mined by larvae of the lepidopteran *Eriocrania semipurpurella,* the dominant miner species, were found commonly although in low numbers at sites in the spruce forest zone. No herbivorous beetles were found on dwarf birch foliage. Height of birch shrub correlated positively with the number of herbivores. Isolation and/or small area of birch habitat as well as high altitude and latitude of site correlated with low herbivore numbers.

KEY WORDS: – herbivorous insects – suckers – chewers – miners – *Betula* – dwarf birch – treeline – Alaska

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1. Introduction

Dwarf birch, especially *Betula glandulosa,* forms great birch shrublands in interior Alaska, both below and above the treeline of white spruce *(Picea glauca).* In northernmost Alaska, *Betula nana* (often hybridized with *B. glandulosa*) is a typical shrub at and north of the treeline (Viereck 1979).

The herbivorous insect fauna of dwarf birch in Alaska is poorly known. Only some notes on species feeding on dwarf birch have been published (e.g. MacLean & Hodkinson 1980). Birch herbivores were collected in three treeline areas of Alaska in 1982. The aim of the present paper is to give information about the abundance and distribution of herbivorous insect groups on dwarf birch foliage and to discuss the effect of geographical and ecological factors on herbivore abundance. These observations are discussed in relation to earlier research by the author (see Koponen 1983).

2. Study sites, materials and methods

Insect material was collected in three areas: Alaska Range (9 sites), White Mountains (4 sites) and Brooks Range – Arctic Slope (8 sites) (Fig. 1). In each area study sites were selected along a transect from spruce

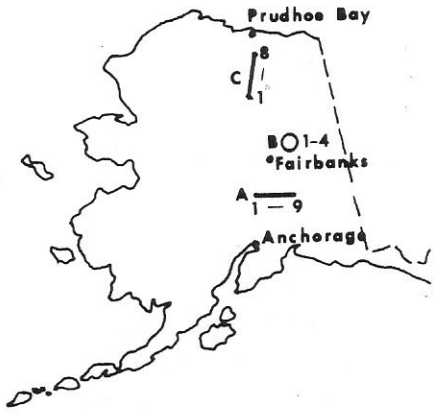

Fig. 1. Locations of the study areas and sites in Alaska; A = Alaska Range, B = White Mountains, C = Brooks Range – Arctic Slope (cf. Table 1).

forest with dwarf birch to a treeless arctic or alpine zone with low birch shrubs (Table 1). The Brooks Range – Arctic Slope transect was along the Trans-Alaska Oil Pipeline, and has been described by MacLean & Hodkinson (1980). All study sites are within the continental climatological area of Alaska, except the northernmost sites in the Brooks Range – Arctic Slope transect which are in the arctic zone.

The collecting periods were: 1) Alaska Range: July 19–20, 2) White Mountains (Eagle Summit): July 15 and 3) Brooks Range – Arctic Slope: July 2–7 (1982). Because of the differences in collecting times, caution must be exercised in making comparisons between study areas. These dates fall within the period of maximum arthropod density on hardwood trees in Alaska (Werner 1983).

Table 1. Study sites in Alaska, 1982.

site	km from the first site	altitude (m)	birch height (m)	description of the site
A. Alaska Range (63°30′N, 146–149°W, alt. 730–1200 m)				
1. Cantwell	0	730	1.0-2.0	dense birch shrub in spruce forest
2. Fish Creek	10	730	1.0-1.7	continuous birch vegetation in open forest
3. Lily Creek	35	900	1.2-2.0	birch shrubland at treeline of spruce
4. Watershed	70	1000	0.5-1.5	birch shrubland above treeline
5. Clearwater Creek	120	1100	1.0-2.0	typical birch shrubland above treeline
6. Maclaren Summit	165	1200	0.5-1.2	last isolated birch shrubs on alpine slope
7. Maclaren Summit-E	167	1200	0.5-1.2	patchily distributed birch shrubs
8. Rock Creek	175	1100	1.0-1.7	continuous birch shrubland above treeline
9. Tangle Lakes-W	180	1000	1.0-1.8	birch shrubland near isolated spruce wood
B. White Mountains, Eagle Summit (65°30′N, 145°25′W, alt. 900–1200 m, northeastern slope)				
1. Forest	0	900	0.5-1.0	birch shrubs in spruce forest
2. Treeline	4	1000	0.3-0.7	birch shrubs at treeline of spruce
3. Alpine slope	6	1100	0.1-0.3	low isolated shrubs on alpine slope
4. Alpine top	9	1200	0.1-0.2	low isolated shrubs on open windy mountain top
C. Brooks Range – Arctic Slope (67°30′ – 69°30′N, 149°W, alt. 170–800 m)				
1. Gold Creek, 67°31′N	0	400	1.0-1.5	birch shrubs in spruce forest
2. Sukakpak, 67°36′N	10	430	0.5-1.0	patchy birch shrubs on bog in forest
3. Treeline, 68°03′N	60	800	0.5	birch vegetation on slope at treeline of spruce
4. Toolik Lake, 68°38′N	130	750	0.3-0.5	isolated birch shrubs on dry tundra
5. Happy Valley-S, 69°05′N	200	320	0.2-0.3	low sparse shrubs on slope meadow
6. Happy Valley-N, 69°10′N	210	320	0.5	birch shrubs on tundra bog
7. Pump Station 2-S, 69°25′N	250	300	0.3	low shrubs on dry tundra slope
8. Pump Station 2-N, 69°30′N	260	170	0.4-0.5	shrubs on boggy coastal tundra plain

Table 2. Abundance of herbivorous insect groups on dwarf birch at Alaska Range sites, July 19–20 1982 (ind./50 sweep nets). The location of treeline is indicated by an asterisk.

herbivores	sites								
	1	2	3*	4	5	6	7	8	9
Aphidina	75	116	57	18	32	10	5	49	72
Psyllina	44	53	27	25	6	0	0	60	87
Cicadina	1	1	1	0	2	0	0	2	1
Heteroptera	4	6	0	1	1	0	0	0	1
Total suckers	124	176	85	44	41	10	5	111	161
Symphyta larvae	20	6	24	18	22	8	8	15	36
Geometridae larvae	5	2	7	2	5	8	4	5	5
Other Lepidoptera larvae	0	1	0	0	3	0	0	1	0
Total chewers	25	9	31	20	30	16	12	21	41
Total herbivores	149	185	116	64	71	26	17	132	202
Eriocrania mines	+	+	+	+	+	–	–	+	+

The material was collected using sweep netting. A sample included 50 net sweeps (consisting of five subsamples of ten sweeps). Only one or two samples were taken at each site. The herbivorous material comprised about 1700 individuals. In addition, the presence of mined leaves, especially by *Eriocrania* larvae, was recorded.

3. Results

Numbers of herbivorous insects collected from dwarf birch foliage are given in Tables 2–4. Sapsuckers dominated at most sites, especially in the spruce forest zone. Aphids (*Euceraphis betulae*-complex) were usually the most abundant group but psyllids were also locally numerous, *Psylla betulaenanae* Ossiannilsson, being the dominant species. *Psylla striata* Patch was found only in the Alaska Range. Heteropteran bugs and leafhoppers were caught in low numbers; mirids being the principal representatives. Little is known about the feeding biology of mirids but in the present work they are regarded as phytophagous. The most abundant leafhopper species were *Oncopsis albicollis* Hamilton, which was caught most frequently at southern sites of the Brooks Range, and *Colladonus youngi* Nielson, found in all three study areas. The Holarctic *Thamnotettix confinis* (Zetterstedt) occured in the Alaska Range, and *Coulinus usnus* Beirne was found at sites at the spruce treeline and arctic foothills of the Brooks Range.

Sawfly larvae, represented by several species, were the most common leafchewers. Most adult sawflies belonged to the subfamily Nematinae but a few individuals to the Tenthredininae. Larvae of several geometrid moth species were found including the well-known birch defoliator *Rheumaptera hastata* (Linnaeus). Tortricid larvae were locally abundant, especially at the southern sites of the Brooks Range. The dominant species was *Epinotia solandriana* (Linnaeus).

Table 3. Abundance of herbivorous insect groups on dwarf birch at Eagle Summit, White Mountains, July 15 1982 (ind./ 50 sweep nets). The location of treeline is indicated by an asterisk.

herbivores	sites			
	1	2*	3	4
Aphidina	33	31	21	2
Psyllina	106	8	1	0
Cicadina	4	0	0	0
Heteroptera	20	2	0	0
Total suckers	163	41	22	2
Symphyta larvae	8	12	4	3
Geometridae larvae	7	4	0	0
Other Lepidoptera larvae	1	5	0	0
Total chewers	16	21	4	3
Total herbivores	179	63	26	5
Eriocrania mines	+	+	–	–

Table 4. Abundance of herbivorous insect groups on dwarf birch at Brooks Range – Arctic Slope sites, July 2–7 1982 (ind./50 sweep nets). The location of treeline is indicated by an asterisk.

herbivores	sites							
	1	2	* 3	4	5	6	7	8
Aphidina	34	4	83	3	5	5	3	8
Psyllina	4	1	0	0	6	0	0	0
Cicadina	14	0	6	1	0	0	0	0
Heteroptera	5	0	2	1	0	4	0	3
Total suckers	57	5	91	5	11	9	3	11
Symphyta larvae	9	16	2	7	18	10	8	15
Geometridae larvae	5	1	6	0	0	0	0	0
Tortricidae larvae	1	3	10	0	0	1	0	1
Total chewers	15	20	18	7	18	11	8	16
Total herbivores	72	25	109	12	29	20	11	27
Eriocrania mines	+	+	+	–	–	–	–	–

The most abundant miner was *Eriocrania semipurpurella* (Stephens), a widely-distributed Holarctic microlepidopteran species. *Eriocrania* mines were found commonly in low numbers at all sites in the spruce forest zone but not north of the spruce treeline. However, *Eriocrania* mines were found at sites above the spruce line in the Alaska Range although not at the two highest sites which are at the altitudinal limit of dwarf birch shrubland (see Table 2). Other mining insect larvae, *Coleophora* and Nepticulidae species, were infrequent.

No signs of defoliation of dwarf birch could be observed. At the treeline site in the Brooks Range, bushes had partially turned brown due to feeding by larvae of the tortricid *Epinotia solandriana.*

In general, the abundance of chewers varied less than that of suckers. Although chewers were infrequent at the extreme alpine sites of Eagle Summit, they occurred in comparatively high numbers at the northernmost sites of the Arctic Coastal Plain: here sawfly larvae were particularly abundant (Tables 3 and 4).

Total number of herbivores declined with increase in latitude, altitude and distance from the spruce forest zone, and with decrease in birch cover and shrub height. These trends were less evident in numbers of sawfly larvae. The species richness of the herbivorous fauna was also lowest at extreme alpine and arctic sites.

Herbivore abundance was notably higher in the spruce forest zone of each of the three study areas. This trend is probably due to climatic factors and was most striking in the numbers of miners and suckers. An exception, the Sukakpak site in the Brooks Range with low herbivore abundance, was a bog differing from other localities in the forest zone.

Using stepwise regression analysis, insect numbers were compared with birch height, altitude, latitude and distance from spruce treeline (Table 5). In the Alaska Range, the highest correlations were between birch height and numbers of suckers (explaining 47 % of occurrence), chewers, psyllids and sawfly larvae; and between site altitude and aphids (explaining 63 %) and lepidopteran larvae. At Eagle Summit insect abundance was most strongly correlated with birch height and altitude of site (e.g. birch height explained 89 % in suckers and site altitude 88 % in aphids). In the northernmost study area, the Brooks Range – Arctic Slope, the correlations were generally low. Altitude of the site was the best explaining factor for sawfly larvae (explaining 50 % of occurrence), lepidopteran larvae and aphids; and distance from spruce forest treeline for suckers (explaining 30 %). In this sequence of sites with a long latitudinal gradient, latitude explained the occurrence of lepidopteran larvae at the 30 % level and that of suckers at 27 %.

Table 5. Correlations for number of herbivores and environmental factors using stepwise regression analysis.

herbivore group	altitude of site	height of birch	distance from treeline	latitude of site
A. Alaska Range				
Total herbivores	-0.610	0.734*	0.622	
Suckers	-0.655	0.683*	0.679*	
Aphids	-0.791*	0.706*	0.718*	
Psyllids	-0.358	0.543	0.521	
Chewers	0.065	0.563	-0.148	
Sawfly larvae	-0.010	0.550	-0.088	
Moth larvae	0.360	0.207	-0.310	
B. Eagle Summit, White Mountains				
Total herbivores	-0.929	0.945	0.959*	
Suckers	-0.894	0.942	0.937	
Aphids	-0.938	0.779	0.904	
Psyllids	-0.812	0.902	0.869	
Chewers	-0.811	0.781	0.733	
Sawfly larvae	-0.721	0.656	0.628	
Moth larvae	-0.865	0.866	0.802	
C. Brooks Range -- Arctic Slope				
Total herbivores	0.488	0.411	0.573	-0.5514
Suckers	0.533	0.390	0.545	-0.5220
Aphids	0.594	0.237	0.480	-0.4506
Psyllids	-0.233	0.272	0.192	-0.2046
Chewers	-0.084	0.318	0.432	-0.4344
Sawfly larvae	-0.699	-0.022	-0.225	0.1956
Moth larvae	0.604	0.304	0.602	-0.5733
Total material (A – C)				
Total herbivores	0.234	0.696***	0.468*	
Suckers	0.225	0.644**	0.473*	
Aphids	0.189	0.630**	0.487*	
Psyllids	0.261	0.520*	0.328	
Chewers	0.169	0.688***	0.198	
Sawfly larvae	0.034	0.597**	-0.007	
Moth larvae	0.315	0.363	0.465*	

4. Discussion

The present material includes some very widely-distributed birch herbivore species, e.g. *Euceraphis betulae*-complex, *Psylla betulaenanae, Thamnotettix confinis, Eriocrania semipurpurella, Epinotia solandriana* and *Rheumaptera hastata.* The three latter species are known to be defoliators of northern birch species, at least locally (Rafes & Sokolov 1976, Werner 1977, Holsten et al. 1980, Koponen 1981). Aphids collected from dwarf birch belonged to the *Euceraphis betulae*-complex, which in North America comprises a complex of sibling species or chromosomal races (R.L. Blackman pers. comm.). According to Blackman (unpubl.), the present material agrees well morphologically with aphids collected from *Betula glandulosa* in northern Canada.

The distribution of herbivorous insects of dwarf birch in Alaska is poorly known. The range of *Psylla betulaenanae* found by MacLean & Hodkinson (1980) fits well with the present material. In both cases the species was found to occur up to the northern parts of the artic foothills of the Brooks Range but it was not found at Pump Station 2 although dwarf birch is abundant there. In general, psyllids occur on willows at more northern sites than on dwarf birch and the psyllid fauna on willows is more diverse than that on birches (MacLean 1983).

There were pronounced effects of site altitude and latitude on herbivore numbers;

similar observations have been made on herbivores of mountain birch *(Betula pubescens* ssp. *tortuosa)* in northernmost Fennoscandia (Koponen & Iso-Iivari 1978). Herbivore numbers also appeared to be related to both distance from the spruce treeline and resource abundance (i.e. height of birch shrubs and area and isolation of birch habitat; cf. Teraguchi et al. 1981).

The number of herbivores per sample in the spruce forest zone of each study area was high (ca. 60–200 ind./sample). Herbivore numbers at sites above and north of the spruce treeline were similar to numbers collected from dwarf birch or low mountain birch, using the same method and sampling time, in subarctic birch woods in Lapland, Iceland and Greenland (Koponen 1983). Only at the most extreme alpine and arctic Alaskan sites was the herbivore abundance lower than the average for birch in these other subarctic areas.

The composition of the herbivore fauna in Alaskan forest area was similar, in general, to that found near the forest line in eastern North America (Schefferville in central Labrador peninsula, New Québec), where more than 80 % of the herbivores on *Betula glandulosa* were sapsuckers (Koponen 1980). The abundance of aphids relative to psyllids in the present Alaskan material seems to be markedly high; this might indicate a peak year in aphid numbers. Common to both the Alaskan and Labrador collections were the remarkable abundance of heteropterans (mirids) and sawfly larvae, the occurrence of *Eriocrania* miners, and the absence of herbivorous beetles on dwarf birch.

Acknowledgements. I wish to thank Ms Heli Hurme, Prof. Stephen F. MacLean, Jr., and the staffs of the Institute of Arctic Biology and of the Toolik Lake Field Station of the University of Alaska, Fairbanks, for their generous help during the field work. I am indebted to Dr. R.L. Blackman (British Museum, London) for identifying of aphids, Dr. K.G.A. Hamilton (Agriculture Canada, Ottawa) for identifying of leafhoppers, Prof. S.F. MacLean, Jr., for valuable comments and Mr Seppo Neuvonen for help in statistical analysis. Dr. Peter Crittenden kindly checked the English text. This work was supported financially by the Jenny and Antti Wihuri Foundation, Societas Entomologica Helsingforsiensis and the United States Educational Foundation in Finland.

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Accepted August 6, 1984