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THE DISTRIBUTION OF PSYLLIDS (HOMOPTERA: PSYLLOIDEA) IN ARCTIC AND SUBARCTIC ALASKA

S. F. MacLean, Jr.* and I. D. Hodkinson†

ABSTRACT

Psyllids—small, pholem-feeding insects—were collected from the vegetation at 23 sites along a transect across arctic and subarctic Alaska, from the arctic coast at Prudhoe Bay to Fairbanks. Seventeen psyllid species were collected from willows (*Salix* spp.); nine additional species were collected from other host plants. The *Salix*-feeding psyllids extend nearly to the arctic coast, and are as rich in species in arctic as in subarctic Alaska. The richness of psyllid species on other host plants increases from the arctic to the subarctic portions of the transect, and increases further in Alaska south of the transect. Holarctic and Amphi-Beringean species dominate the psyllid fauna of the arctic; Nearctic species dominate the subarctic and more southerly areas. Comparable distribution patterns are seen in the psyllid fauna of Fennoscandia.

INTRODUCTION

Surprisingly little is known of the richness of species and the factors responsible for the distribution of any but the most familiar of organisms (i.e., vertebrate animals and vascular plants) in Alaska. Recent construction of the trans-Alaska pipeline, which traverses Alaska from the Arctic Ocean at Prudhoe Bay to the North Pacific at Valdez, provides a means of expanding our knowledge of the Alaskan fauna and flora. This paper describes the distribution of psyllids (Homoptera: Psylloidea) along the northern half of this transect (Prudhoe Bay to Fairbanks), and compares this with similar data for Scandinavia compiled from the literature.

Psyllids are small, phloem-feeding insects. They are almost entirely restricted to dicotyledenous plants, with most species restricted to a single genus of host plants. Recent studies have increased the number of psyllid species known from Alaska from 8 to 39 (Hodkinson, 1978, plus one additional species reported here). Results of an ecological study of willow-feeding psyllids in arctic Alaska have been reported elsewhere (Hodkinson et al., 1979).

DESCRIPTION OF THE TRANSECT

The transect begins at Prudhoe Bay on the coastal plain of arctic Alaska (Figure 1). This is an area of low surface relief, poor drainage due to permafrost, and numerous ponds and lakes. Summer here is short and cool, with the plant growing season limited to about 2½ mon. The vegetation and phytogeography of the northern part of the transect were discussed by Murray (1978). The richness of vascular plants on the coastal plain is low: sedge meadows form the dominant vegetation, with willows and other dicotyledenous plants more abundant on better drained ridges, lake and stream margins, and occasional pingos.

*Institute of Arctic Biology, University of Alaska, Fairbanks, Alaska 99701.

†Department of Biology, Liverpool Polytechnic, Byrom Street, Liverpool L3 3AF, England.

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South of the coastal plain lies the rolling terrain of the northern foothills of the Brooks Range. Tussock tundra dominated by *Eriophorum vaginatum* L. ssp. *spissum* (Fern.) Hult., with a rich assemblage of associated shrubs and herbs, covers vast expanses of the foothills.

The Brooks Range is a young, rugged, east-west oriented mountain range that was recently (and, east of the transect, currently is) glaciated. The crest of the range forms the continental divide, separating the Yukon River drainage from rivers that flow north to the Arctic Ocean. Mountain peaks in the vicinity of the transect reach to about 2000 m. Valley bottoms contain sedge meadows and shrub tundra dominated by willow (*Salix lanata* L. and *S. alaxensis* [Anderss.] Cov.) and dwarf birch (*Betula nana* L. ssp. *exilis* [Sukatsch.] Hult.). The slopes have a dry meadow or heath community dominated by *Dryas octopetala* L. with sparse *Dryas* fellfield on exposed ridges.

The latitudinal tree line which occurs at about 68°N latitude on the south slope of the Brooks Range, at an elevation of about 800 m, is taken as the dividing line between arctic and subarctic Alaska. South of this, islands of tundra vegetation are found at elevations above 800 to 1000 m and in low-lying, permafrost-dominated sites where drainage is impeded.

The transect slopes gradually from the southern Brooks Range to the broad valley of the Yukon River, within which it crosses the Arctic Circle. It traverses the Tanana-Yukon uplands, and ends at Fairbanks, on the flood plain of the Tanana River. Here the interior Alaskan taiga forest is dominated by black and white spruce (*Picea mariana* [Mill] Britt et al., *P. glauca* [Moench] Voss). Psyllids are usually found on dicotyledenous trees, shrubs, and herbs in riparian and successional vegetation.

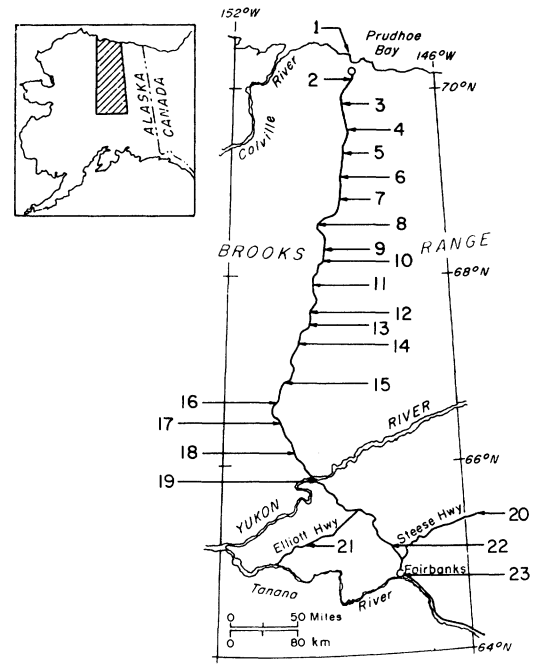

FIGURE 1. Location of the transect across arctic and subarctic Alaska, from Prudhoe Bay to Fairbanks, showing locations of sample collection sites.

METHODS

Collections were made along the transect between Fairbanks and Prudhoe Bay in August of 1976 and 1979, and in June and August of 1977 and 1978. At selected sites spaced along the pipeline road, insects were collected from the vegetation using a sweep net (Table 1, Figure 1). Wherever possible, bushes of willow, dwarf birch, and alder (*Alnus crispa* [Ait.] Pursh) were sampled, as well as the ground vegetation characteristic of the site. Unfortunately, it was not possible to identify and sweep willow species individually in all cases. Although distinct differences occur in the psyllids found on prostrate and erect shrubby willows, there appears to be only weak selectivity within these categories; we have found no psyllid species limited to a single species of *Salix* (Hodkinson, 1978; Hodkinson et al., 1979). The dwarf birches, *Betula nana* L. ssp. *exilis* (Sukatsch.) Hult. and *B. glandulosa* Michx. hybridize and introgress freely, and no attempt was made to separate these forms.

RESULTS

Seventeen psyllid species were collected from *Salix* along the transect (Table 2); four other species known from *Salix* in Alaska (Hodkinson, 1978) were not encountered. The fauna includes one species, *Psylla palmeni*, that is found only in the arctic region of the transect, and three additional species, *P. zaecevi*, *P. toolikensis*, and *Trioza atkasookensis*, that are mainly arctic in distribution. These four species comprise an arctic component of the fauna. One additional species found on the arctic coastal plain, *P. macleani*, is widely distributed along and south of the transect.

Four more species (*T. arctica*, *P. phlebophyllae*, *P. kananaskensis*, and *P. alaskensis*) join the former five in the arctic foothills. *Trioza arctica* is known, so far, only from sites north of the Yukon River, and *Psylla phlebophyllae* reaches its southern limit in subarctic-alpine tundra at Eagle Summit. *Psylla kananaskensis* and *P. alaskensis*, in contrast, were both collected south of the transect in Alaska and are also known from North American sites south of Alaska.

Two new species appear in the central Brooks Range: the widely distributed nearctic species *P. hamata*, and *P. jenseni*, so far known only from the Brooks Range and Eagle Summit. Two species of the arctic foothills, *P. phlebophyllae* and *T. arctica*, were not found in the central Brooks Range, so the total number of species remains at nine.

South of the central Brooks Range, the arctic element of the fauna disappears, the arctic-subarctic element remains, and a new boreo-alpine element gradually appears. This element consists largely of widely distributed nearctic species which also occur in the mountains of Canada and the northern continental United States. Only *T. salicivora*, of this group, also occurs in northern Europe or Asia.

The psyllids collected from other host plants (Table 3) show a more southerly distribution in Alaska, although *Psylla betulaenanae*, *P. ledi*, *P. myrtilli*, *Craspedolepta nebulosa*, and *C. subpunctata* are holarctic in distribution. No psyl-

TABLE 1
Collecting sites along the arctic-subarctic transect in Alaska

Area	Site	Lat. N
Arctic Alaska		
Coastal Plain	1. Cape McIntyre	70°23′
	2. South of Prudhoe Bay	70°07′
	3. Franklin Bluffs	69°43′
	4. Pump Station No. 2	69°28′
Arctic Foothills	5. Sagwan	69°20′
	6. Happy Valley	69°01′
	7. Slope Mountain	68°43′
	8. Toolik Lake	68°38′
Central Brooks Range	9. Atigun River	68°16′
	10. Atigun Camp	68°11′
Southern Brooks Range	11. Treeline	68°00′
	12. Dietrich Camp	67°40′
	13. Sukakpak Mt.	67°37′
Subarctic Alaska		
Yukon Valley	14. Marion Creek	67°20′
	15. Grayling Lake	66°58′
	16. Gobbler Knob-Bonanza Creek	66°43′
	17. Old Man Camp-Finger Mountain	66°07′
	18. No-name Creek	66°07′
	19. Yukon River	65°53′
Tanana-Yukon Uplands	20. Eagle Summit (Steese Highway)	65°29′
	21. Elliott Highway	65°19′
	22. Washington Creek	65°10′
	23. Fairbanks	65°50′

TABLE 2

Distribution of psyllid species on Salix *in arctic and subarctic Alaska*

	Arctic Alaska													Subarctic Alaska													
	Coastal Plain				Arctic Foothills				Central Brooks Range		Southern Brooks Range			Yukon Valley						Tanana-Yukon Uplands				Alaska south of Fairbanks	South of Alaska	
Psyllid species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			Distribution
P. palmeni Löw		X	X	X	X	X	X	X	X																	Holarctic
P. zaecevi Sulc.		X	X	X	X	X	X	X	X		X		X													Holarctic
P. toolikensis Hod.			X		X	X	X	X	X		X															Nearctic
P. macleani Hod.			X		X	X		X	X	X		X		X		X					X	X	X	X		Nearctic
P. phlebophyllae Hod.					X		X													X						Amphi-Beringean
P. kananaskensis Hod.						X				X														X	X	Nearctic
P. alaskensis Ash.								X	X		X				X		X		X		X			X	X	Nearctic
P. hamata Tuthill									X															X	X	Nearctic
P. jenseni Hod.									X											X						Nearctic
P. fibulata Crawf.															X	X	X		X			X	X	X	X	Nearctic
P. sinuata Crawf.																			X		X	X	X	X	X	Nearctic
P. haliaeeti Hod.																				X	X	X		X		Nearctic
P. rufipennis Hod.																					X	X		X	X	Nearctic
P. breviata Patch																									X	Nearctic
P. longiforceps Hod.																								X		Nearctic
P. highwoodensis Hod.																								X	X	Nearctic
P. minor Crawf.																								X	X	Nearctic
Trioza atkasookensis Hod.		X	X	X	X	X	X	X	X							X										Amphi-Beringean
T. arctica Hod.					X										X		X	X								Amphi-Beringean
T. salicivora Reut.													X						X		X	X	X	X	X	Holarctic
T. incerta Tuthill													X								X	X		X	X	Nearctic

TABLE 3

Distribution of psyllid species on host plants other than Salix *in arctic and subarctic Alaska*

	Arctic Alaska													Subarctic Alaska													
	Coastal Plain				Arctic Foothills				Central Brooks Range		Southern Brooks Range			Yukon Valley						Tanana-Yukon Uplands						Alaska south of Fairbanks	South of Alaska	
Host-psyllid	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			Distribution
Betula papyrifera																										
Psylla striata Patch																						X				Nearctic
Betula nana ssp. *exilis*																										
Psylla betulaenanae Oss.					X		X	X	X		X		X	X	X	X	X	X	X	X	X	X		X		Holarctic
Alnus crispa																										
Psylla galeaformis Patch						X	X				X	X	X	X	X		X		X	X	X	X		X	X	Nearctic
P. floccosa Patch																									X	Nearctic
Ledum palustre																										
Psylla ledi Flor.					X												X				X	X		X		Holarctic
Vaccinium uliginosum																										
Psylla myrtilli Wag. ssp. *canadensis* Hod.					X												X			X				X	X	Holarctic
Viburnum edule																										
Psylla rara Tuthill																								X	X	Nearctic
Epilobium angustifolium																										
Craspedolepta alaskensis (Ash.)																								X	X	Nearctic
C. nebulosa (Zett.) ssp. kinkaidi (Ash.)																								X	X	Holarctic
C. subpunctata (Förster)																								X	X	Holarctic
Polygonum-Rumex																										
Aphalara manitobaensis Cald.													X											X	X	Nearctic
A. nigra Cald.											X									X				X		Nearctic
A. nubifera Patch[a]																			X							Nearctic
Sheperdia canadensis																										
Psylla stricklandi Crawf.											X													X	X	Nearctic
Urtica																										
Trioza albifrons Crawf.																								X[b]	X	Nearctic

[a]New to Alaska. Not recorded by Hodkinson (1978).

[b]Recorded by Tuthill (1943); we have not encountered this species.

lids were found on plants other than *Salix* on the coastal plain. Four species (*P. betulaenanae* on *Betula nana*, *P. galeaformis* on *Alnus crispa*, *P. ledi* on *Ledum palustre*, and *P. myrtilli* on *Vaccinium uliginosum*) were found in the arctic foothills, and only *P. betulaenanae* in the central Brooks Range. South of the arctic zone psyllid species are added on a variety of host plants. The largest number of species occurs south of Fairbanks, the end of the transect described here. Each of the species found in arctic Alaska on host plants other than *Salix* is also found south of the transect as well; however, *Aphalara manitobaensis*, *A. nigra*, *P. betulaenanae*, and *P. ledi* possibly reach their southern limit in Alaska, as they have not been recorded from regions farther south.

DISCUSSION

The species richness of psyllids along this arctic-subarctic transect is summarized in Table 4. In all segments of the transect the number of species on *Salix* exceeded the number on all other host plants. *Salix*-feeding psyllids extend well into the arctic; they were essentially as rich in species in the arctic foothills as in any other segment of the transect. The decline in psyllid species on the coastal plain might be attributed to a decline in the availability of host plants; however, willows, dwarf birch, and alder all extend farther north along the transect than do their characteristic psyllid species, so that plants at the northern end of their distribution are free of psyllids. In fact, psyllids are lacking altogether from Cape McIntyre, the northernmost site along this transect, as they are from Barrow, farther west, although both of the sites have *Salix pulchra* and *S. phlebophylla* which are preferred hosts of psyllids elsewhere.

These data on the distribution of psyllid species in Alaska may be compared with published information on the distribution of psyllids in Scandinavia. Fennoscandinavia has been divided into a number of biogeographic provinces (Arnell, 1956), and detailed data on the distribution of psyllids in these provinces is available for Sweden, Finland, and, to a lesser extent, Norway (Ossiannilsson, 1952, 1970, 1972, 1974; Lindberg and Ossiannilsson, 1960; Meinander, 1972). Here, we allocate each province to that 1° interval of latitude in which most of its territory lies, to produce sixteen 1° latitudinal zones between 55° and >70°N latitude. The northern terminus of the Scandinavian transect, at approximately 71°N, is almost identical to that of the Alaskan transect.

The distribution of psyllid species associated with *Salix*, *Betula*, *Alnus*, *Ledum*, and *Vaccinium* in Sweden, Finland, and Norway north of the arctic circle have been plotted within these latitudinal bands (Table 5). Data for southern Norway are excluded because the high mountain plateaus, such as the Hardangervidda, act as arctic islands and obscure any possible latitudinal regularities in faunal distribution.

Twenty-one psyllid species occur on these host plants along the Scandinavian transect, including 13 species on *Salix*. This compares with 17 species on *Salix* and 26 species in total in Alaska north of 64°. Thus, the Alaskan fauna is somewhat richer than that of Scandinavia. Six species occur in both Scandinavia and Alaska. These all occur north of 69° in Scandinavia; all but *Trioza salicivora* occur on

TABLE 4
Number of psyllid species found on Salix *spp. and on other host plants in various regions of arctic and subarctic Alaska*

	Arctic Alaska				Subarctic Alaska			
Host	Coastal Plain	Arctic Foothills	Central Brooks Range	Southern Brooks Range	Yukon Valley	Tanana-Yukon Uplands	Total transect	Alaska south of transect
Salix-feeding	5	9	9	6	7	10	17	13
Other hosts	0	4	1	5	5	6	9	12
Total	5	13	10	11	12	16	26	25

TABLE 5

Distribution of Psyllids on Salix, Betula, Alnus, Vaccinium, *and* Ledum *along a composite north-south transect through Scandinavia*

Host-Psyllid	70 + [a] 1	69-70 2	68-69 3	67-68 4	66-67 5	65-66 6	64-65 7	63-64 8	62-63 9	61-62 10	60-61 11	59-60 12	58-59 13	57-58 14	56-57 15	55-56 16	South of Scandinavia
Salix																	
Psylla zaecevi Sulc.[b]	X	X	X	X													–
P. palmeni Löw[b]	X	X	X	X	X	X	X										–
P. moscovita And.[c]		X	X	X	X		X	X	X	X	X	X			X	X	X
P. elegantula (Zett.)							X										X
P. nigrita (Zett.)				X	X		X			X						X	X
P. pulchra (Zett.)				X			X			X	X	X	X	X	X	X	X
P. brunneipennis Edw.				X							X	X	X			X	X
P. ambigua Först.		X	X	X	X					X	X	X	X	X		X	X
P. parvipennis Löw						X	X	X	X	X	X	X	X		X	X	X
Trioza striola Flor				X	X	X	X	X	X	X	X	X	X	X			X
T. curvatinervis Först.[c]			X		X	X				X	X	X	X				X
T. salicivora Reut.[b]		X	X	X	X	X		X	X	X	X	X					X
T. albiventris Först.											X	X	X			X	X
Betula nana ssp. *nana*																	
Psylla betulaenanae Oss.[b]	X	X	X	X	X	X	X	X	X	X	X		X				–
Betula (other)																	
Psylla hartigi Flor[c]				X	X	X	X	X	X	X	X	X	X	X	X	X	X
P. betulae (L.)			X	X	X	X	X	X	X	X	X	X	X	X		X	X
Alnus spp.																	
Psylla alni (L.)[c]		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P. foersteri Flor					X	X	X	X	X	X	X	X	X	X	X	X	X
P. fusca (Zett.)[c]				X	X	X	X	X	X	X	X	X	X	X			X
Ledum palustre																	
Psylla ledi Flor[b]		X	X		X	X		X		X	X	X	X	X			X
Vaccinium																	
Psylla myrtilli Wag.[b]		X	X		X	X	X	X		X	X	X	X				X
Total	3	9	11	14	15	13	14	13	10	17	17	16	15	9	6	11	18

[a]Latitude °N.

[b]Species occurring in Alaska.

[c]Species having a close relative in the Alaskan fauna.

the arctic coastal plain and/or arctic foothills of northern Alaska. Five of these species are also found on the tundra of northeastern USSR (Hodkinson and MacLean, 1980), and *Psylla palmeni* and *P. zaecevi* from this group are the dominant psyllids of the Taimyr Peninsula (Chernov, 1978). Thus, the fauna of the northernmost sites is dominated by species of holarctic distribution.

There is a tendency for species to reach farther north in Scandinavia, as is seen in *T. salicivora* on *Salix*, *P. betulaenanae* on *Betula*, *P. myrtilli* on *Vaccinium*, and *P. ledi* on *Ledum*. This is also seen in comparing the distribution of closely related species pairs: *P. moscovita* (S) and *P. macleani* (A), and *T. curvatenervis* (S) and *T. incerta* (A), on *Salix*; *P. hartigi* (S) and *P. striata* (A) on *Betula*; *P. alni* (S) and *P. galeaformis* (A), and *P. fusca* (S) and *P. floccosa* (A), on *Alnus*. Tree line is similarly displaced to the north in Scandinavia compared with Alaska.

In general, arctic psyllids have a 1-yr life cycle. Species such as *Psylla galeaformis*, *P. betulaenanae*, *P. myrtilli*, and *P. ledi* all overwinter as eggs which hatch coincident with bud burst, and the nymphs complete their development on the current year's growing shoots. In contrast, all of the *Salix*-feeding *Psylla* studied to date overwinter as adults which oviposit on catkins as soon as they appear. The nymphs usually complete the whole of their development within the catkin (Hodkinson et al., 1979). The *Salix*-feeding *Trioza* species, which seldom reach the high densities seen in *Psylla* species, have a similar life cycle on the leaves rather than in catkins. In all these species, development must be completed within the short growing season, before catkin development is completed or leaf senescence occurs. It appears that the northern limit of the distribution of arctic psyllids is set by the length and temperature of the growing season, as these influence their ability to complete the annual life cycle, rather than by availability of host plants.

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