Insect Visitors and Potential Pollinators of Lingonberries, *Vaccinium vitis-idaea* subsp. *minus*, in Sub-arctic Alaska

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Abstract

Flowers of lingonberries were observed at four locations in the Tanana Valley floodplain, Alaska in June and early July 2001. Insect visitors were captured, identified and examined for pollen loads. Visitors included the non-native *Apis mellifera*, and *B. occidentalis*, and the native insects: *Psithyrus* sp., *Dolichovespera arenaria*, *D. norvegicoides*, *Andrena* sp., *Bombus sandersonii*, *B. flavifrons flavifrons*, *B. frigidus*, *B. sylvicola*, *Dialectus* sp. (Halictidae), *Melangyna* sp., ten specimens of *Syrphus* sp. and other Syrphidae and two moths (Geometridae:Lepidoptera). All visitors except two specimens of Syrphidae and the Geometridae carried lingonberry pollen. Insects with the greatest lingonberry pollen (> 1000 pollen tetrads per insect) were *Apis mellifera*, *Bombus occidentalis*, *B. sylvicola*, *B. flavifrons flavifrons*, *Andrena* sp. and *Dialectus* sp. (Halictidae). Three hives of honey bees, *Apis mellifera*, and two of bumble bees, *Bombus occidentalis*, were established in four woodland locations in the Tanana River floodplain. Flowering stems were tagged along two to four transects per hive extending up to 150 m from the hive at each location to learn if honey bees or bumble bees aid in pollination. There was no correlation between fruit set, fruit diameter and weight, filled seeds per fruit and distance from the hive for all transects. This may indicate honey bee and bumble bee colonies do not improve fruit production in wild stands even though they were observed visiting flowers and carrying pollen. It is more likely that the transects occurred in areas with highly variable exposure, cover and flowering abundance, and this diversity masked any effect of the hives.

INTRODUCTION

Lingonberries (*Vaccinium vitis-idaea* L. subsp. *minus* (Lodd.) Hult.) second only to blueberries as the most popular wild berry in Alaska, are harvested for personal use and for a small cottage industry marketing jams, jellies, teas, syrups and other products. Wild berry production fluctuates annually, possibly due to frost or rain during anthesis (Lehmushovi, 1977), disease and insect pests (Torrey, 1914), animal or bird predation (Oldemeyer and Seemel, 1976), and poor pollination (Hall and Beil, 1970; Lehmushovi, 1977; Holloway, 1981; Jacquemart and Thompson, 1996; Gustavsson, 1999). Although insects are important in lingonberry pollination (Warming, 1908; Torrey, 1914; Lovell, 1948; Ritchie, 1955; Haslerud, 1974; Pojar, 1974; Jacquemart, 1993; Jacquemart and Thompson, 1996), native pollinators of lingonberries have not been identified in Alaska.

The management of native pollinators is one method of increasing fruit yield and promoting a consistent supply of berries. In addition, hives of honey bees and more recently bumble bees, have been used to supplement native pollinators in fields of American cranberries (*Vaccinium macrocarpon* Aiton) and blueberries (*V. corymbosum* L., *V. angustifolium* Aiton, *V. myrtilloides* Michaux) (i.e. Brewer, 1968; Lomond and Larson, 1983; Aras et al., 1996; Sampson and Spier, 2001). Similar studies have not been reported for lingonberries. The purpose of this project was to identify potential native pollinators of lingonberries growing in wild stands in Alaska and determine the impact of introduced bumble bees and honey bees on fruit yield.

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MATERIALS AND METHODS

Flowers of lingonberries were observed and video taped at five locations in the Tanana River floodplain, Alaska from 15 June to 3 July 2001. Three sites were located near Fairbanks (64°50'45"N, 147° 43'15"W), one at Eielson (64°44'45"N, 147° 12'16"W) and one at Delta Junction (64°02'15"N, 145°44'00"W) (Tables 1,3). Sites were chosen for their abundance of lingonberries, road accessibility, and isolation from recreational harvesters. Observations were made for a minimum of 3 hr daily throughout anthesis at the Fairbanks and Eielson sites alternating morning and afternoon periods among locations. Observations at the Delta Junction site occurred twice weekly during anthesis. Flowers and insect visitors were videotaped daily at one of the five locations throughout the flowering season including three 24-hr tapings at Eielson and Fairbanks. The cameras were erected at least 0.5 m away from flowering plants and focused on an individual raceme. The video tapes were used to identify insect visitors with limited human presence and to document when visitations occurred throughout the long subarctic daylight hours.

Insect visitors were captured at all five locations, identified and examined for pollen loads using methods of Kearns and Inouye (1993). Insects were washed in 70% ethanol to dislodge pollen. The pollen from lingonberry and all other plants blooming concurrently was mounted on a microscope slide coated with glycerin jelly and lingonberry tetrads were counted within a randomly selected 1cm^2 sample area.

Three commercial hives of bumble bees (*Bombus occidentalis*) and two of honey bees (Carniolan strain) were placed at four locations (Table 3) in mixed white spruce-hardwood forests in the Tanana River Valley (Table 3). Linear transects, 15 m to 150 m in length were established starting at the hive with two to four transects per location. Flower buds were flagged at specific intervals ranging from 0.6 m to 15 m. The length of the transect and spacing between flags varied among sites depending on the size of the lingonberry population (Table 3). Three randomly selected racemes were examined at each sampling point along the transects. All flowers per raceme were counted during anthesis, and the number of fruit, fruit weight, diameter and filled seed number per fruit were recorded. Fruit set as a percentage of flower number and seed number per fruit were correlated with distance from the hive. Data were analyzed by analysis of variance, regression analysis and curve fitting to identify any relationship between distance from hive and fruit set.

RESULTS

Sixteen insect types were identified as potential pollinators (Table 1). Species with more than 1000 pollen tetrads per insect included two introduced species: honey bee, *Apis mellifera* and bumble bee, *Bombus occidentalis.* Native pollinators included the bumble bees *Bombus sylvicola* and *B. flavifrons flavifrons* as well as andrenid bees, *Andrena* sp., and halictid bees, possibly *Dialictus* sp. Most insects foraged lingonberry flowers between 0500 HR and 1800 HR (Table 2). The foraging time of the most important potential pollinators was 0800 – 1800 HR.

No relationship was found between percent fruit set and distance from honey bee or bumble bee hives at any wild stand. Fruit set varied significantly along the transects regardless of orientation or site (Table 3). Average fruit weight and percent filled seeds per fruit did not show any relationship with hive distance.

DISCUSSION

The greatest lingonberry pollen loads were recovered from several *Bombus* species, *Andrena* sp. and *Apis mellifera* indicating that both native and introduced insects may be useful in managing wild lingonberry stands. These data are consistent with lingonberry research from other regions that show the importance of insects for pollination and fruit development (Torrey, 1914; Haslerud, 1974; Pojar, 1974; Jacquemart, 1993; Jacquemart and Thompson, 1996). Despite the nearly 24-hr daylengths in Alaska in late June, insects foraged lingonberry flowers during the period that would be considered daylight hours at lower latitudes. Foraging may be related to air temperature more than light.

The hive placement experiments were based on the assumption that fruit set might improve with greater proximity to the hive. No such relationship was shown by the data. On the contrary, variability in fruit set was high along all transects. The fruiting pattern was typical of wild stands where fruit set may vary from no fruit to 100% of flower production (Holloway, 1981) Several factors could explain the results. The assumption that proximity to the hive is correlated with pollination intensity could be incorrect. Lingonberry flowers were visited by bumble bees and honey bees at all sites as well as natural pollinators, and transects may have been too short to show relationships. Vegetation, tree cover and lingonberry abundance were not uniform along the transects. More flowers occurred in exposed, sunny sample areas than forested areas, possibly promoting higher visitation at exposed sites. Although the introduced honey bees and bumble bees were observed visiting the flowers, we did not demonstrate that introducing hives to wild stands had any influence on fruit set, filled seed number or fruit weight. The influence of honey bees may be more effective in uniform cultivated stands than in highly variable wild stands.

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Tables

Table 1. Insects visitors on lingonberry, *Vaccinium vitis-idaea*, and the amount of recovered lingonberry pollen tetrads per insect.

Location	Insect visitor	Pollen tetrads per cm^2
Closed hardwood/white spruce floodplain forest adjacent to cleared farm fields, 160 m elevation (Eielson)	Andrenid bee, *Andrena* sp.	>2000
	Andrenid bee, *Andrena* sp.	798
	Bumble bee, *Bombus flavifrons flavifrons*	>1000
	Halictid bee, *Dialectus* sp.	137
	Halictid bee, *Dialectus* sp.	1034
	Honey bee, *Apis mellifera*	217
	Honey bee, *Apis mellifera*	4
	Honey bee, *Apis mellifera*	>2000
	Syrphid fly, *Syrphus* sp.	7
	Trichosoma sp.	0
	Cuckoo bumble bee, Psithyrus sp.	4
	Yellowjacket, *Dolichovespula arenaria*	18
Paper birch/aspen hardwood upland forest 300 m elevation (Fairbanks-1)	Bumble bee, *Bombus occidentalis*	>3000
	Bumble bee, *Bombus frigidus*	1
	Bumble bee, *Bombus sandersoni*	775
	Bumble bee, *Bombus flavifrons flavifrons*	285
	Geometer moth, Lepidoptera, Geometridae	0
	Syrphid fly, *Syrphus* sp.	64
Closed white & black spruce/ hardwood upland forest 366 m elevation (Delta Junction)	Bumble bee, *Bombus occidentalis*	1606
	Black moth, *Rheumaptera* sp.	0
	Bumble bee, *Bombus flavifrons flavifrons*	2
	Yellowjacket, *Dolichovespula norvegicoides*	5
	Yellowjacket, *Dolichovespula norvegicoides*	36
	Andrenid bee *Andrena* sp.	3
	Syrphid fly, *Syrphus* sp.	7
	Hover fly, *Melangyna* sp.	0
Alpine tundra, 869 m Elevation (Fairbanks-3)	Bumble bee, *Bombus sylvicola*	1549

Table 2. Time of day for insect visitations to lingonberry flowers at four locations in the Tanana River floodplain, Alaska sampled from 15 June to 3 July, 2001

Time of day	Insect visitors	
0000 – 0200	None	
0200 – 0400	None	
0400 – 0600	None	
0600 – 0800	Yellowjacket, *Dolichovespula* sp.	
0800 – 1000	Andrenid bee, *Andrena* sp. Bumble bee, *Bombus flavifrons flavifrons* Bumble bee, *Bombus* sp.	Honey bee, *Apis mellifera* Syrphid fly, *Syrphus* sp.
1000 – 1200	Andrenid bee, *Andrena* sp. Bumble bee, *Bombus flavifrons flavifrons* Bumble bee, *Bombus* sp. Bumble bee, *Bombus occidentalis* Cimbicid moth, Cimbicidae: Lepidoptera	Geometer Moth, Geometridae: Lepidoptera Halictid bee, *Dialectus* sp. Honey bee, *Apis mellifera* Yellowjacket, *Dolichovespula arenaria*
1200 – 1400	Andrenid bee, *Andrena* sp. Bumble bee, *Bombus occidentalis* Halictid bee, *Dialictus* sp.	Bumble bee, *Psithyrus* sp. Mosquito, *Ochlerotatus* sp. Syrphid fly, *Syrphus* sp.
1400 – 1600	Andrenid bee, *Andrena* sp. Bumble bee, *Bombus occidentalis* Halictid bee, *Dialictus* sp. Syrphid fly, *Syrphus*, sp.	Honey bee, *Apis mellifera* Yellowjacket, *Dolichovespula arenaria*
1600 – 1800	Bumble bee, *Bombus* sp. Geometer moth, Geometridae:Lepidoptera Syrphid fly, *Syrphus* sp.	
1800 – 2000	Halictid bee, *Dialictus* sp.	
2000 – 2200	None	
2200 – 2400	None	

Table 3. Range of fruit set, weight, and percent filled seeds for lingonberry flowers tagged along transects 15 m to 150 m in length starting from hives of honey bees or bumble bees. Data for transects were not significant (P≤.05) for all categories.

Hive type and location	Fruit production (% of flowers)	Fruit weight (g)	Filled seeds per fruit (%)
Honey bees			
Delta Junction[1]	28.4 – 95.2	0.09 – 0.27	27.2 – 63.8
Eielson[2]	11.6 – 81.3	0.38 – 1.76	32.2 – 86.1
Bumble bees			
Fairbanks-1[3]	0.0 – 100.0	0.00 – 0.20	0.0 – 12.2
Fairbanks-2[4]	0.0 – 0.5	0.12 – 0.69	17.6 – 77.4

[1] Closed white and black spruce/hardwood/spruce upland forest, 366 m elevation, 2 transects per 2 hives each 150 m in length, n=20

[2] Closed hardwood/white spruce floodplain forest adjacent to agricultural fields, 160 m elevation, 2 transects each 60 m in length, n = 20.

[3] Paper birch/ aspen upland forest, 300 m elevation, 2 transects, 60 m in length, n=20

[4] Mixed hardwood/white spruce upland forest, 500 m elevation, 4 transects each 61 m in length, n=80.

Revisions:
The following insect identifications were revised following additional taxonomic analysis:
Table 1. *Bombus sandersoni*; revised identification = Bombus frigidus F. Smith
Tables 1 & 2: *Psithyrus* sp. = *Psithyrus fernaldae* Franklin