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POLLEN COLLECTORS AND OTHER INSECT VISITORS TO *PENSTEMON HAYDENII* S. WATS.

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Abstract. Records of insects visiting the flowers of *Penstemon haydenii* (S. Wats.) are supplied. The flower-visitor fauna was different at the two sites censused. Primary pollinators appeared to be four species of megachilid bees which consistently visited the flowers for pollen. While bees exhibited high fidelity to flowers of the genus *Penstemon,* analysis of the pollen carried by females suggests that crossing over between *Penstemon* species on a particular foraging trip may be common. Opportunities for interspecific hybridization almost certainly occur.

Key Words. blowout penstemon, *Penstemon haydenii,* endangered plant, pollination, pollen collection, flower visitors, Apoidea, Nebraska

INTRODUCTION

The preservation of endangered plant species such as blowout penstemon (*Penstemon haydenii* S. Wats.) in the wild ultimately rests on preservation of sufficient habitat to contain all the necessary requisites for that species' continued existence. While the identity of many of those requisites (and their complex interactions) remains hidden, one essential biotic requisite is pollinators. It has been estimated that about 67% of flowering-plant species depend to some extent upon insect intermediaries to transfer viable pollen from anthers to receptive stigmas (Axelrod 1960). Indeed, many species cannot reproduce sexually at all without the aid of certain insect "helpmates."

Despite the beauty of the flowers of many *Penstemon* species, the size of the genus and the opportunities it offers for the study of evolutionary biology, relatively little work has been conducted on pollination. However, pollination mechanisms and pollinators are known to be quite diverse: Birds (Lyon 1976), flies (Straw 1963, Schmidt 1976), and wasps and bees (Crosswhite and Crosswhite 1966) have been recorded as pollinators of different species. Many species of *Penstemon* in the western United States appear to be closely associated with bees of the family Megachilidae, particularly in the genera *Osmia* and *Anthocopa* (*Atoposmia*), and with wasps of the genus *Pseudomasaris* (Masaridae) (Crosswhite and Crosswhite 1966).

Blowout penstemon was shown to be primarily cross-pollinated, but the pollinator affinities of blowout penstemon are largely unknown (Flessner 1988). Aside from reports that several kinds of bees and other insects (all unnamed) visit the flowers for pollen and nectar, no other information appears to be available (Fish and Wildlife Service 1987, Flessner 1988). This is surprising not only because of the plants' endangered status, but also because of the suggestion by Freeman (1981) that blowout penstemon may be a hybrid of its sympatric congeners, narrow penstemon (*Penstemon angustifolius* Nutt. *ex* Pursh) and shell-leaf penstemon (*Penstemon grandiflorus* Nutt.). When Straw (1955, 1956) originally proposed a hybrid origin for another western species, *Penstemon spectabilis* Thurb. *ex* Gray, he suggested that its origin was mediated by the species-specific flower-visiting behavior of certain pollinators.

The objective of this research was to provide a preliminary survey of the insects visiting the flowers of blowout penstemon. Because this species usually exists in small, isolated populations, an additional objective was to determine whether the flower-visitor fauna from eastern and western parts of the species range was similar. Because many insects visit flowers without pollinating them, the actual pollinator fauna would be some subset of these flower-visiting species. Additional studies, currently underway, will separate the pollinators from the non-pollinating parasites.

METHODS

Insects were collected from blowout penstemon plants at one site in both Cherry and Morrill counties in 1987 during peak bloom. The Cherry County site, which contained about 100 plants, was in a typical blowout of about 40 m in diameter, situated near rather large sandhill lakes. The Morrill County site contained about 2,000 plants in an extremely large blowout with no lakes nearby (Weedon, Hardy, and Bowlin, personal communication).

Four two-hour collections were made at the Cherry County site between 30 May and 10 June 1987. Two collections of two-hour duration were made at the Morrill County site on 11 and 13 June 1987. All collecting was completed between 10:00 a.m. and 3:00 p.m. Only insects actually in the blowout penstemon corolla were captured. Most specimens were collected when they exited into an ethanol-filled vial that was being held at the flower entrance. Larger insects, such as butterflies, were captured by placing a sweep net over the flowers being visited.

Insects were sorted to order and sent to experts for specific identification. Aculeate Hymenoptera were determined by T. L. Griswold. Voucher specimens were placed at the USDA-ARS, Bee Biology and Systematics Lab, Logan, Utah.

Pollen was removed from the scopa of each pollen-collecting female bee, treated on a microscope slide with ethanol, and stained with fuchsin glycerin jelly (Beattie 1971). Random transects across each slide were taken under the light microscope at 400X until 500 grains had been examined and identified to genus by comparison with a reference collection. Further separation of these pollen grains was done by size into the three sympatric and synchronic species *Penstemon angustifolius, Penstemon haydenii,* and *Penstemon grandiflorus*. At 400X, 50 pollen grains were measured from each of three flowers, each from a different herbarium specimen, for the first two species, and 50 pollen grains from one flower of the latter species. A nested ANOVA was used to test for differences in grain size between *Penstemon angustifolius* and *Penstemon haydenii. Penstemon grandiflorus* could not be tested because only one flower was sampled. These measurements were used to assign the pollen carried by bees to one of the three species.

RESULTS AND DISCUSSION

The diversity and relative abundance of insects visiting blowout penstemon is shown in Table 1. At both sites, the predominant group of visitors were solitary bees of the family Megachilidae. Four species from this group deserve special attention because they are probably important pollinators of the plant.

Table 1. Diversity and relative abundance of insects visiting blowout penstemon.

Species	Location and Numbers	
	Cherry County	Morrill County
Hymenoptera:		
Halictidae-		
Dialictus pruinosiformis (Crawford)	7[1]	
D. pilosus (Smith)	4	—
D. sp. 1	—	15
D. sp. 2	2	—
Agapostemon splendens (Lep.)	—	1
Andrenidae		
Perdita sp.	1	—
Megachilidae		
Hoplitis pilosifrons (Cresson)	39	5
Osmia cyaneonitens Cockerell	1	70
O. distincta Cresson	63	—
O. integra Cresson	3	11
Anthophoridae		
Emphoropsis sp.	1	1
Apidae		
Bombus fervidus (Fabricius)	—	1
B. n. nevadensis Cresson	—	1
B. pennsylvanicus (Degeer	—	
B. vagans Smith	1	—
Braconidae	—	1
Scoliidae		
Campsomeris pilipes (Sauss.)	—	1
C. plumipes confluenta (Say)	3	—
Vespidae		
Polistes sp.	1	1
Pterocheilus quinquefasciatus Say	1	—
Pompilidae		
Anoplius sp. 1	—	1
A. sp. 2	—	2
Sphecidae		
Ammophila sp. 1	1	—
A. sp. 2	1	—
Podalonia sp. 1	1	—
P. sp. 2	1	—
Priononyx atratus (Lep.)	1	—
Coleoptera:		
Cleridae		
Phyllobaenus pubescens LeConte	1	—
Phalacridae		
Phalacrus politus Melsh.	—	1
Mordellidae		
Mordellistena sp.	1	4
Meloidae		
Epicauta sericans LeConte	—	1
Lytta reticulata Say	1	—
Chrysomelidae		
Chelymorpha cassidea (F.)	1	—
Gastrophysa formosa (Say)	—	1
Curculionidae		
Odontocorynus sp.	1	2
Lepidoptera:		
Hesperiidae		
Atrytonopsis hianna (Scudder)	3	1
Noctuidae	3	2
Pyralidae	1	—
Diptera:		
Chironomidae		
Chironomus sp.	11	
Stratiomyidae		
Odontomyia sp.	2	
Asilidae	2	
Bombyliidae		
Bombylius sp.	2	
Poecilanthrax sp.	1	
Villa sp.	1	
Dolichopodidae	3	
Syrphidae	2	
Conopidae	2	
Muscidae	1	
Sarcophagidae	1	
Tachinidae	1	

[1]County location not available for data in center column.

Hoplitis pilosifrons (Cr.) is a mostly eastern species that ranges from the east coast, west to Alberta, Colorado and Texas. It is known to nest in stems and wood, usually excavating pith from weed stems (Michener 1955). A variety of plants are known to be visited for pollen, including *Penstemon* spp. (Hurd 1979).

Osmia distincta Cr. is another eastern species that ranges from the east coast, west to North Dakota and Colorado. The nesting biology is unknown. It is known to visit several genera of plants, including *Penstemon* but no pollen plant has previously been recorded (Hurd 1979).

Osmia cyaneonitens Ckll. is a rare western species recorded previously only from Colorado and South Dakota. Its nesting biology is also unknown. The type specimen was collected from *Penstemon* sp. at Florissant, Colorado, in 1906 (Hurd 1979).

Osmia integra Cr. is the largest of the four species. It ranges from the Pacific coast, east to Texas and Manitoba. It is known to build mud nests under rocks (Hicks 1926). It has not been previously recorded as a visitor of *Penstemon* (Hurd 1979).

It is of interest to note that no species of bees in the taxon *Anthocopa* (*Atoposmia*) nor the wasp genus *Pseudomasaris* were collected. Many species in these groups are known for their strong preference for *Penstemon* pollen (Parker 1977, Torchio 1974).

The insects visiting blowout penstemon at Morrill were quite different from those at Cherry County, approximately 225 km to the east (Table 1). The Morrill County site was frequented mostly by the western and prairie species *Osmia integra* and *Osmia cyaneonitens*. At Cherry County, the eastern species *Osmia distincta* and *Hoplitis pilosifrons* were most abundant. The two most abundant species, *Osmia distincta* and *Osmia cyaneonitens*, exhibited distributions that were almost mutually exclusive. Questions about interspecific competition between them for pollen and/or nectar need to be answered. More importantly, are there morphological differences in flowers between blowout penstemon populations that would favor different suites of pollinators at different sites?

Collection of *Penstemon* pollen by foragers was common. Of 198 females in the four species of megachilid bees, 88 were found to have been collecting pollen at the time of capture (Table 2). Of these, all but five *Osmia cyaneonitens* and three *Hoplitis pilosifron* carried pollen loads of pure *Penstemon* pollen. The three non-pure *Hoplitis pilosifrons* pollen loads had over 70% *Penstemon* pollen. Thus, these four species of megachilids were extremely constant to flowers within the genus *Penstemon*.

Table 2. *Penstemon haydenii* 1987 pollen carriers.

Bee Species	*Females with Penstemon Pollen*	*Females with ≥ 95% Penstemon pollen*	*Females with ≥ 70% Penstemon pollen*
Osmia integra	3	3	
Osmia distincta	30	30	
Osmia cyaneonitens	44	39	39
Hoplitis pilosifrons	11	8	11

To determine if females were flower-constant to *Penstemon haydenii*, it was first established that pollen grains of *Penstemon angustifolius* and *Penstemon haydenii* differed significantly in size (nested ANOVA, $F = 15.8$, $df = 1, 4$; $P < 0.05$). A normal distribution of pollen-grain sizes for each of the three *Penstemon* species is shown in Figure 1. These estimates were in close agreement with those of Freeman (1981). Grains were assigned to species by greatest probability for a given grain size: Thus, a 24-micron grain was assigned to *Penstemon haydenii* but a 23-micron grain to *Penstemon angustifolius* (Figure 1).

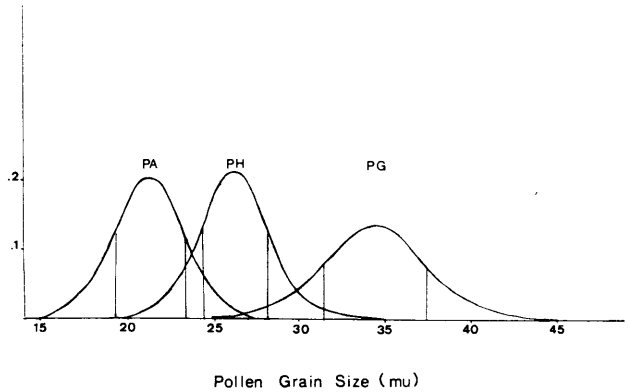

FIG. 1. Normal distributions of pollen-grain sizes for *Penstemon angustifolius* (PA), *Penstemon haydenii* (PH) and *Penstemon grandiflorus* (PG). Vertical lines mark ± 1 standard deviation.

Using this method, bees do not appear to have been so constant to flowers of blowout penstemon during a particular foraging trip. Although over 60% of the pollen in an average pollen load is that of blowout penstemon (Table 3), pollen of the other two species was commonly incorporated as well. This conclusion should be regarded as tentative for three reasons: 1) the number of flowers used to obtain the estimates was small; 2) the nested ANOVA yielded a significant within species term ($F = 46.3$, $df = 4,294$, $P < 0.001$), i.e., a substantial variation in pollen size occurred among flowers within species; and 3) a considerable overlap existed in grain size, particularly between *Penstemon angustifolius* and *Penstemon haydenii* in the 22- to 25-micron range, and between *Penstemon haydenii* and *Penstemon grandiflorus* in the 29- to 31-micron range.

Table 3. Percent of *Penstemon haydenii* pollen carried by pollen carriers.

Species	*Sample size*	*Pollinators carrying P. haydenii pollen*
		%
Osmia integra	3	74.0
Osmia distincta	30	62.6
Osmia cyaneonitins	44	63.3
Hoplitis pilosifrons	11	67.6

Nevertheless, bees seem to have commonly crossed over between species on individual foraging trips. Even allowing that these estimates are somewhat inflated, it is still highly likely that ample opportunities occur for hybridization among these species of Penstemon.

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