

Determining pollinator behavior differences bumblebees and flies.

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Abstract

Pollinator behavior is integral to understanding community network interactions. These interactions can serve as a proxy for community health. This study aims to compare the behavior between bumblebee pollinators and fly pollinators. This will take place around the area of Gothic, CO, at an elevation of 2900m. Bumblebees and flies are both common pollinators in the region, and studying their behavior would give us insight into how these species interact within a community.

Introduction

Understanding the interactions between plant-pollinator communities is a crucial part of determining what effects climate change has on an ecosystem. Alpine ecosystems are being rapidly affected due to climate change (Seddon et al. 2016) and their flowering phenology is affected strongly by snowmelt date (Inouye 2008). This study would help define the effects of changes in plant phenology and pollinator emergence on a community.

In 2023, we have had a considerably larger amount of snowfall than the past two years. This means that during the time of data collection there are going to be potentially many more flowering plants than previous years, and it will be easier to achieve representative samples within plots. The late snow also means that flowers are blooming later and may synchronize better with pollinators who have been out of sync with plant phenology in recent years (Bernal 2022). Pollinator networks are relatively robust and can conserve their structure even if the species composition changes (Bourke & Alarcon 2011). However, a study done by Brosi et al. (2017) showed that removing pollinators within a network can result in pollinator niche overlap and decreased specialization resulting in less plants visited.

Studies have been done about pollinator species richness and diversity in the Elk Mountains of Colorado, but usually it is with respect to specific plants or plant traits (Bergonzoli et al. 2022, Macdonald 2009). This is due to looking at specialized traits of either the pollinator or the plant, instead of studying the behavior of a community.

The purpose of this study is to document the flower preferences and visitation patterns of both bumble bees and flies in the region. Gothic, CO, is nearly 3000m above sea level; bumblebees, moths, and flies are commonly found at high altitudes (Inouye 2020). This study aims to observe a difference between visitation patterns of bumblebees and flies. Bumblebees are generalist pollinators that can interact with a wide variety of plants. Syrphid flies, Batesian mimics of wasps and bees, are commonly found around our research sites. They have been found to regularly pollinate orchids (Pansarin 2008, Li et al. 2012), as well as Rubiaceae flowers (Xie et al. 2013). Overall, both play an important role in the community, however I hypothesized that bumblebees would pollinate a more diverse selection of flora and flies would be more frequent visitors.

Methods

The experiment was conducted in collaboration with Dr. Berry Brosi and his team. For my research, I utilized the Brosi Lab's "Avery Picnic" research site. At each site there are eight 20x1m transects divided into ten 2x1m plots. Four of the transects are for network observations and four transects are for insect sweep. Plots were visited 1-2 times per week starting from June 26, 2023, July 24, 2023. Plots were observed for pollinator visits for 90 seconds on each side of a plot, for a total of 3 minutes per sampling date. Pollinator visits only counted if a pollinator lands on the reproductive organ of a flowering plant. Once a visit was confirmed, insect pollinators were netted and placed in a vial to be identified, while also identifying the type of flowering plant that was visited. Once the insect was captured, ethyl acetate was used to euthanize them *in situ*. After the fieldwork for the day was completed, the vials of pollinators were taken back and identified to family, or to genus or species when possible. The data analysis used the total number of visits per insect group and the diversity of plants visited was calculated using a Shannon Diversity Index. The groups of insects I analyzed were "Bumblebees", "Other Bees", and "Flies." Originally the project was going to focus on only bumblebees and flies, but we decided to include all bees because we caught very few bumblebees. This was most likely due to the late snowmelt and dry monsoon season for shifting normal phenology for both plants and pollinators.

Results

By utilizing a Chi-square test and a student's t-test, respectively, we observed a significant difference in total abundance of flies and all bees (Chi-square=159.578, df=1, $p < 0.001$; *Figure 1*). Flies also provided a greater mean number of visits per plant species than all bees ($t = -2.193$, df=23, $p = 0.039$; *Figure 2*). Flies vastly outnumber bees at this site in both pure abundance and in visitation.

The diversity of plants visited was calculated using the Shannon Diversity Index (*Figure 3*). A Single Factor ANOVA and a Tukey HSD post-hoc test were used to compare the diversity of plants visited by flies, bumblebees and other bees. (*Table 1*, *Table 2*). There was a significant difference between bumblebees and flies in the diversity of plants they visit ($p = 0.0105$). Bumblebees and other bees had a marginally different diversity of plant visitation ($p = 0.075$). Flies had a much higher diversity (mean diversity=1.985, SE=0.289) of plant visits than bumblebees (mean diversity=0.187, SE=0.187), which goes against my original hypothesis. Overall, bumblebees almost exclusively visited *Helianthella quinquenervis* at this site, while the most visited flower for both other bees and flies was *Potentilla pulcherrima*.

Discussion

Both bees and flies are important pollinators but in different ways. Flies visit more often than bees, however bees carry much more pollen than flies. We also found that bumblebees and flies differ in the species of flowers they prefer to pollinate. Flies acted as generalists, pollinating a wide variety of plants while bumblebees acted as specialists and preferred to land on a few specific flowers. Both flies and bees can act as generalists, but with flies and other bees mostly visiting the generalist pollinated plants, that leaves bumblebees to forage within a more specialized niche. Since bumblebees are better equipped to pollinate specialist plants, like *Delphinium barbeyi*, they take up that niche and let flies and other bees pollinate the easier, open generalist plants.

Although flies had a larger presence, we observed bees held much more pollen utilizing their corbiculae. Bumblebees could very well be more efficient at transferring pollen, but further study is required.

It is important to note that this data was from a single site in the summer of 2023. The structure of plant-pollinator networks can remain stable even if the species within change (Burkle & Alarcon 2011). It is very possible for bees and flies to take up different roles within these networks at different sites, especially if the sites are at different elevations. Even within the same site, which species acts as a specialist or generalist can change over time (Brosi 2016). Although the species are subject to change, making sure these networks keep their structure is an important part of making sure communities stay intact.

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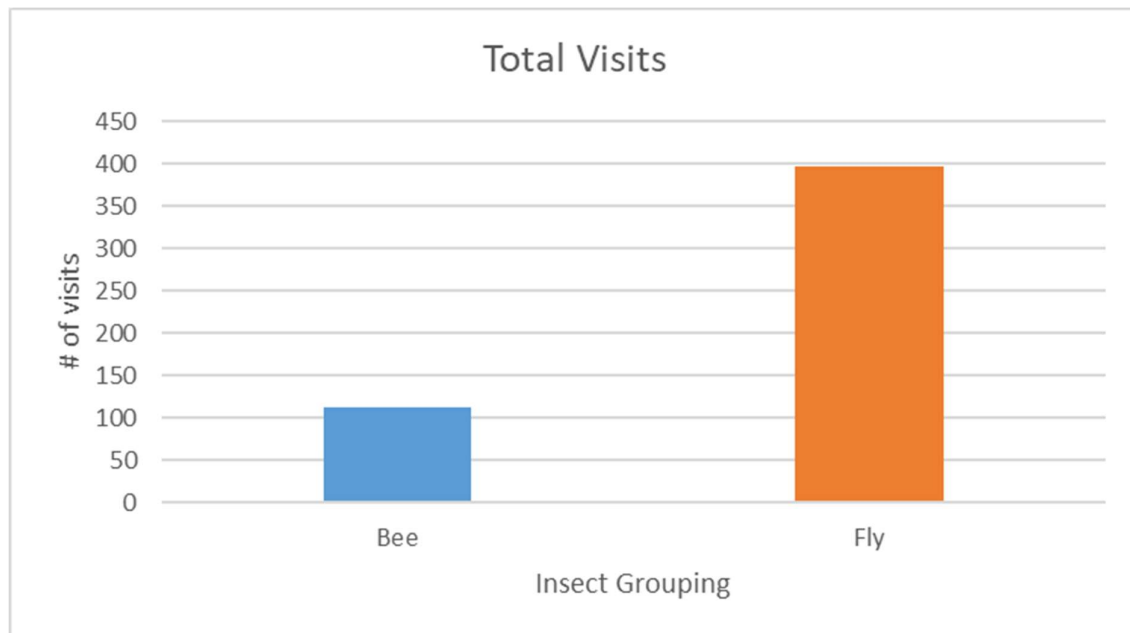


Figure 1: Total number of visits over the summer season of bees and flies. ($p < 0.001$).

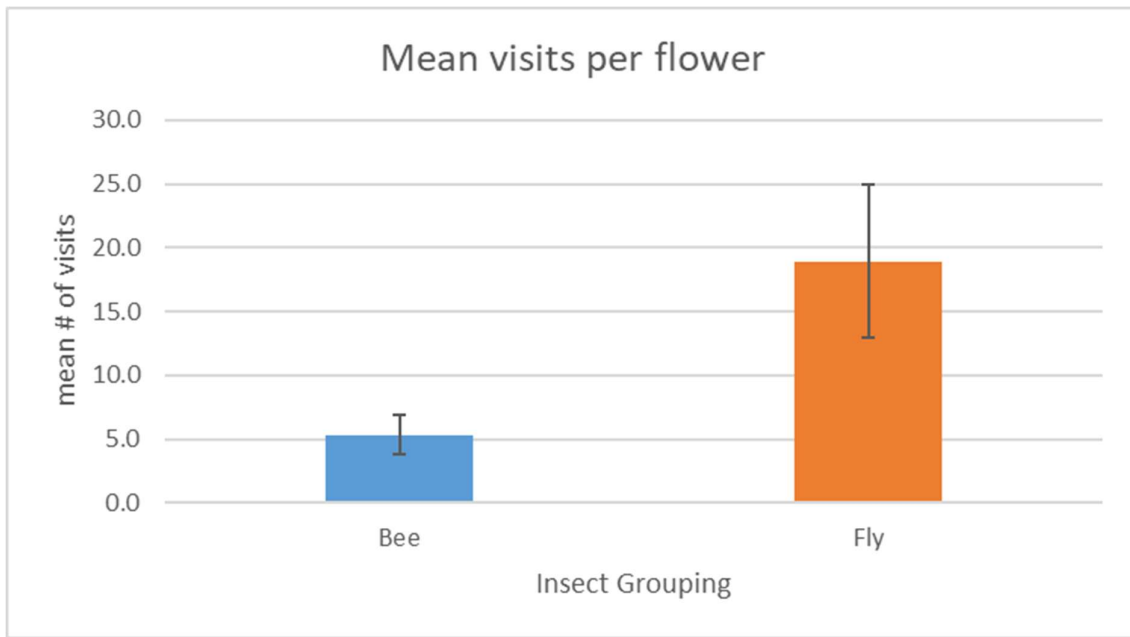


Figure 2: Mean visits per flower by bees and flies calculated by dividing total number of visitors per insect group by number of species visited. The error bars represent standard error. ($p < 0.05$)

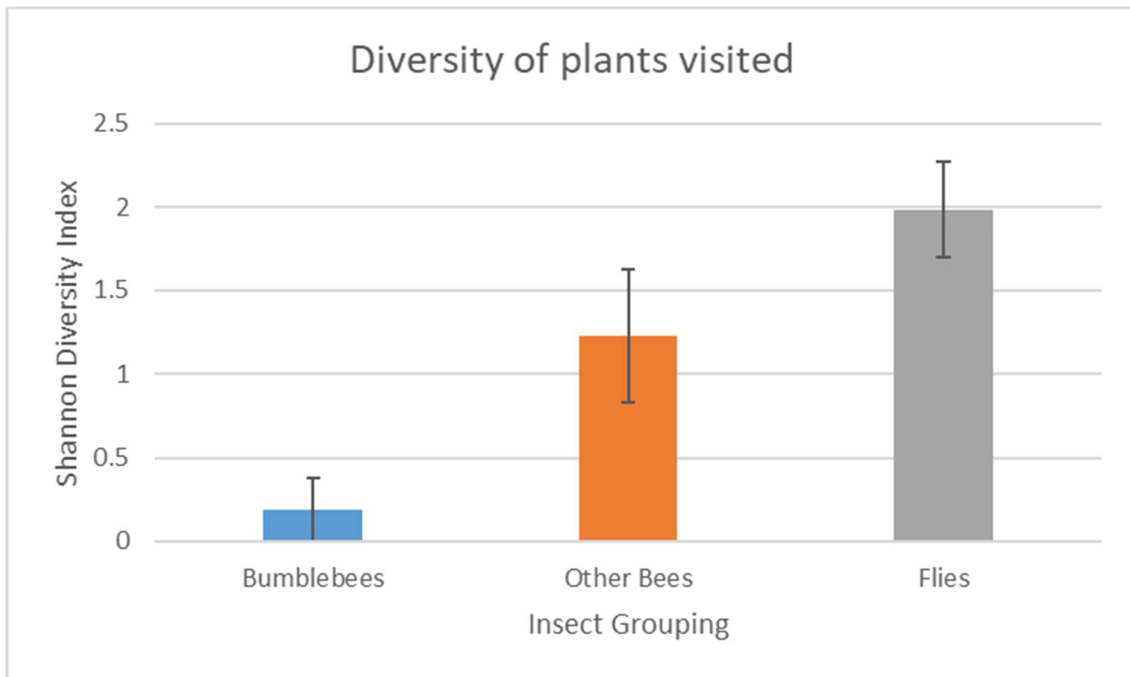


Figure 3: Shannon Diversity Index of Bumblebees, Other Bees and Flies. The error bars represent standard error.

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	6.46887	2	3.234435	7.431994	0.010523*	4.102821
Within Groups	4.352042	10	0.435204			
Total	10.82091	12				

Table 1: ANOVA results for variation within the diversity of plants visited. There was a significant difference found between groups ($p < 0.05$).

Treatments pair	Tukey HSD Q statistic	p-value
Bumblebees vs. Other Bees	3.525	0.0747531
Bumblebees vs. Flies	5.2758	0.009898*
Other Bees vs. Flies	2.2231	0.3012859

Table 2: These are the Tukey HSD results to determine which groups are statistically different. The “Bumblebees vs. flies” group was the only group to have a significant p-value ($p < 0.05$), however “Bumblebees vs. Other Bees” was marginally significant ($p \sim 0.07$).

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