Restoring native plant and pollinator communities on New York City green roofs

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Abstract

Urban development has dramatically decreased habitat for native plants and other wildlife. One of the native insect groups affected by this change are the bees and wasps (Order: Hymenoptera), which provide valuable ecosystem services like pollination of crops and ornamental plants. These insects are experiencing rapid population declines in urbanizing areas. A major obstacle to restoring pollinator populations in cities is the scarcity of space available that can be managed as habitat. A potential solution to this is to create patches of native vegetation on green roofs. Green roofs consist of live plants, growing media, and a drainage layer on top of a waterproof membrane. Most green roofs are planted with a mixture of non-native succulent plants (mostly from the genus *Sedum*), which are favored for their high survivorship and low maintenance requirements. On roofs with somewhat deeper media, a greater diversity of plants, including native plants typical of local grasslands, can persist. Here, we report on the differences in abundance and diversity of Hymenoptera attracted to native green roofs, *Sedum* green roofs, non-vegetated roofs, and ground-level green spaces. Preliminary data indicate extensive insect use of green roofs, with higher abundances on roofs planted with native species. The next phase of this research will involve comparing how the landscape context provided by different neighborhoods affects the development of the green roof biological communities.

Google Map created by Laura Dickinson

Photos by: Kinne Stires

Photo by: Melanie Smith

Figure 2: From left to right. Map of the locations of Department of Parks and Recreation buildings that will have green roofs. The native plant community at the Ethical Culture Fieldston School. The *Sedum* plant community at the Fieldston School.

Introduction

Green roofs first gained popularity as a way to deal with negative effects of urbanization (Rosenzweig et al. 2006). For example, storm water overflows occur when rain events cause urban sewer systems to release untreated water into surrounding water bodies. Green roofs mitigate this problem by absorbing rainfall and releasing it through evapotranspiration. Green roofs also decrease the ambient temperature on roofs, reducing the urban heat island effect, the phenomenon that urban areas have higher temperatures than surrounding areas.

In recent years, ecologists have begun to consider green roofs as a way to preserve biodiversity (Brenneisen 2006, Oberndorfer et al. 2007) (Figure 1). A study in London found that 10% of insects collected on the roof were "nationally rare or scarce" (Kadas 2006), and a study in Canada found that the bee community on green roofs was similar to that of ground sites, indicating that green roofs offer suitable habitat for Hymenoptera (Colla et al. 2009).

Multiple green roofs with a variety of vegetation types have been planted in recent years in New York City, but there has been no organized study on the diversity of green roof invertebrate communities. Despite this fact, entomologists have looked at Hymenoptera diversity at street level gardens and found high numbers of exotic species (Matteson 2008). However the ornamental flowers and crops planted in these gardens creates a different plant community than the *Sedums* and native plants inhabiting green roofs.

In this study, we address the following research questions:

- What insect communities are found on non-vegetated roofs, and how do these communities vary across New York City?
- Are there differences in the insect communities found on green roofs planted with native plants versus those planted with non-native *Sedum*?

Methods

Insects were sampled on two vegetated and nine non-vegetated roofs throughout New York City in October 2009. The non-vegetated roofs sampled were on recreation centers owned by the New York City Department of Parks and Recreation that will receive green roofs in 2010 (Figure 2). Vegetated roof samples were taken at the Ethical Culture Fieldston School in Riverdale, Bronx. This building had two separate roofs: a lower roof planted with both New York native grassland plant communities and *Sedum*, and an upper roof planted with only *Sedum* (Figure 2).

Several insect collection methods, including malaise traps, aerial nets and pan traps were tested for relative effectiveness in capturing different insect taxa. The results presented here are data collected from pan traps, which are bowls painted with yellow, blue and white ultraviolet paint and filled with soapy water. One to three sets of colored bowls were set out on roofs for 3-5 days. Insect samples from each bowl were collected, stored in ethanol, and sorted to family or order in the lab.

Photos courtesy of: Melanie Smith, University of Alberta and Kinne Stires

Figure 1: Examples of biodiversity collected on New York green roofs: *Bombus griseocollis*, Syrphidae, *Xylocopa virginica*

Results and Discussion

Samples from the three roof habitats at Fieldston yielded between 69 and 97 insects from 5-6 orders. Collembola and Hymenoptera were the most common orders on these roofs. The two roofs planted with *Sedums* each had 6 orders, while the native planted area had 5 (Figure 3). Although the upper roof, planted only with *Sedums*, had the highest number of families,12, the *Sedum* community on the lower roof yielded 11 families and the highest number of individuals (Table 1). The increase in insects in the *Sedum* section of the lower roof could be due to greater diversity in vegetation types or the presence of native species in the vicinity.

Samples from the non-vegetated recreation center roofs yielded between 4 and 56 insects from one to five different orders. Diptera and Hemiptera were the most common orders, representing 79% of the collected insects. Two roofs had fewer than 10 insects, while the other seven all had greater than 25 (Figure 4). There was substantial variation in the number of families across the roofs: Four roofs had 5 or fewer families, while two roofs were inhabited by greater than 13 families. Interestingly, the roof with the highest number of individuals yielded 8 families (Table 2).

The study will continue in the summer of 2010, with standardized collection techniques and an increased number of study sites. The non-vegetated Parks and Recreation roofs that were surveyed in the fall of 2009 will be planted with native plants and will continue to be included in the study. In order to compare them properly with *Sedum* planted roofs of the same age, we are looking for newly planted *Sedum* roofs. Several ground-level sites will also be added to the study and those roofs will be located as close to the green roof as possible. For example, Jackie Robinson recreation center is located in a park that is planted with several native plants. Although the garden is one season older than the roof, it may make a good comparison site to the green roof. The methods will be supplemented with visual surveys of pollinators visiting focal plant species and with sweep netting. The expanded methods should yield more information about specific pollinators and other insects frequenting these roofs.

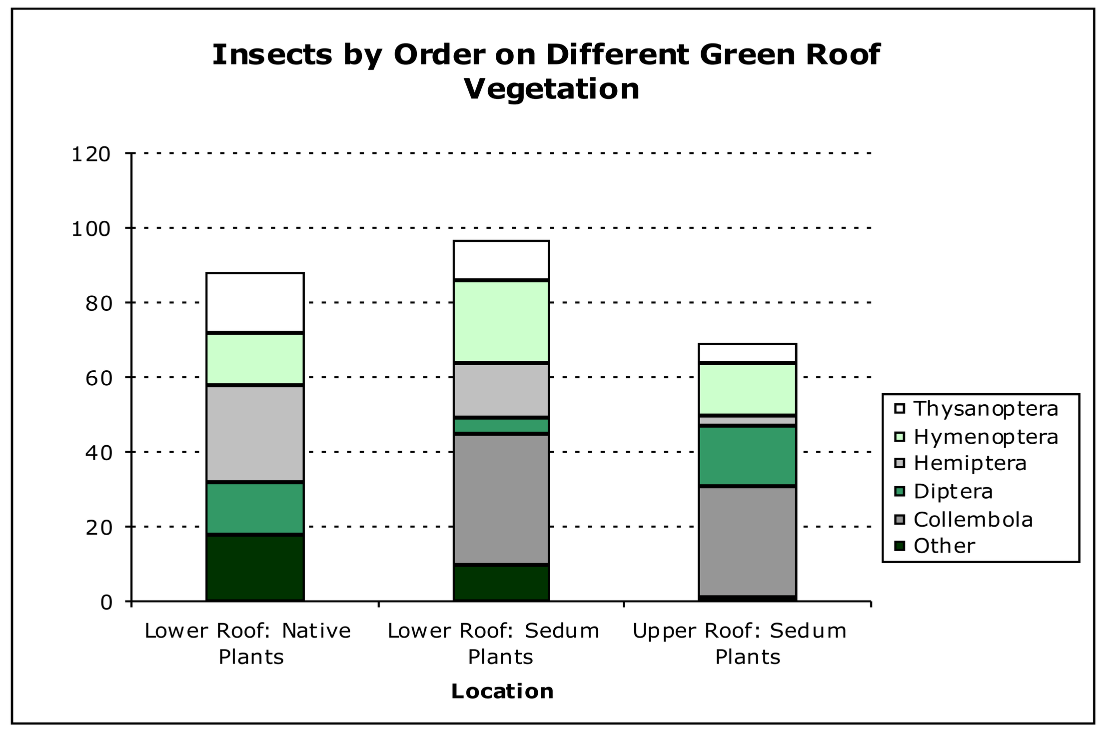

Figure 3: The number of insects, by order, visiting pan traps on roofs with *Sedum* and native plants at the Fieldston School. The diversity expressed in the *Sedum* planted community on the lower roof may be attributed to the greater variety of plants in aggregate on the lower roof.

Orders of Insects:	Lower Roof: Native Plants		Lower Roof: Sedum Plants		Upper Roof: Sedum Plants		Totals	
	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.
Collembola	0	0	UNK	35	UNK	30	UNK	65
Hymenoptera	4	14	4	22	5	14	13	50
Hemiptera	2	26	2	15	1	3	5	44
Diptera	UNK	14	3	4	5	16	8	34
Thysanoptera	1	16	1	11	1	5	3	32
Araneae	UNK	2	UNK	7	0	0	UNK	9
Diplura	0	0	1	1	0	0	1	1
Lepidoptera	1	1	0	0	0	0	1	1
Unknown	UNK	15	UNK	2	UNK	1	UNK	18
Totals	8	88	11	97	12	69	31	254

Table 1: Fieldston school results expressing insect richness in families and individuals. "UNK" represents numbers that could not be estimated when arthropods were not identified.

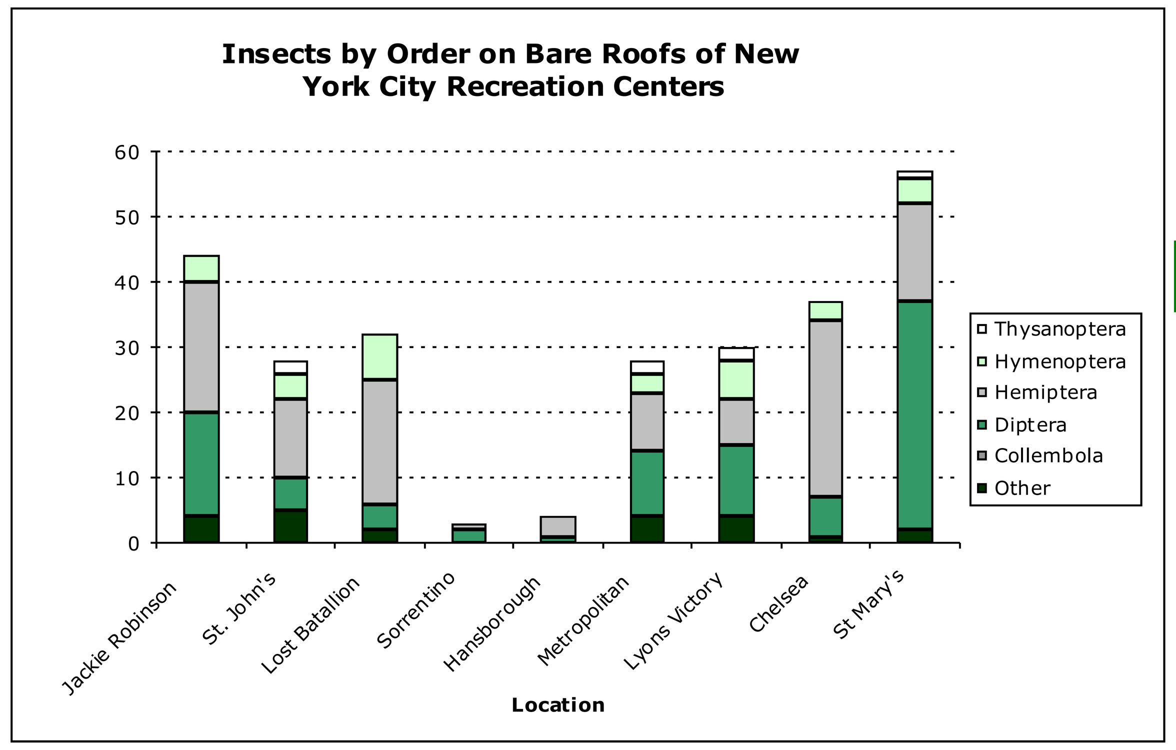

Figure 4: The number of insects, by order, collected from pan traps on non-vegetated roofs on Department of Parks and Recreation buildings.

Orders of Insects:	Jackie Robinson		St. John's		Lost Batallion		Sorrentino		Hansborough		Metropolitan		Lyons Victory		Chelsea		St Mary's		Totals	
	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.	Fam.	Indiv.
Hemiptera	2	20	4	12	2	19	1	1	1	3	1	9	2	7	1	27	1	15	15	113
Diptera	7	16	3	5	3	4	UNK	2	UNK	1	UNK	10	UNK	11	UNK	6	3	35	16	90
Hymenoptera	3	4	3	4	3	7	0	0	0	0	2	3	3	6	1	3	3	4	18	31
Araneae	UNK	2	0	0	UNK	1	0	0	0	0	UNK	1	UNK	2	UNK	1	UNK	1	UNK	8
Thysanoptera	0	0	1	2	0	0	0	0	0	0	1	2	1	2	0	0	1	1	4	7
Coleoptera	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Unknown	1	1	1	2	UNK	1	0	0	0	0	1	1	0	0	0	0	0	0	3	5
Totals	14	44	13	26	8	32	1	3	1	4	5	26	6	28	2	37	8	56	58	256

Table 2: The number of insect families and individual insects sampled from non-vegetated roofs on recreation centers throughout New York City. "UNK" represents numbers that could not be estimated when arthropods were not identified. For example Araneae were not identified to family.

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