Big city bees: investigating functional traits of native bee communities in Chicago, Illinois

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Introduction

Urbanization is increasing worldwide and threatening native species[1,2]. Native bees are particularly susceptible to the effects of urbanization due to their specific floral resource and nesting requirements, yet the extent of its effects on native bee communities is not well understood[3,4]. A greater understanding, however, can be better known through research using a functional trait and environmental gradient approach[5].

Figure 1. Bees foraging on flowers along the UPN Metra line in Chicago.

Knowledge about native bee functional traits in urban areas is particularly lacking. Functional traits are traits that define a species' ecological role within a community; noteworthy bee functional traits include sociality and body size[6,7]. Studying changes in functional traits between native bee communities along an urbanization gradient may identify certain traits associated with a native bee's ability to persist in urban environments. In this study, we examine certain bee functional traits along Chicago's urban gradient to better understand urbanization's effect on native bee communities.

Objectives

Question:
How do urban and suburban native bee communities differ in functional traits (1) body size (intertegular distance) and (2) sociality in Chicago, Illinois?

Hypotheses:

- Urban sites will have more large-bodied bees than suburban sites, as larger bodied bees can travel further in to find floral resources.
- Urban sites will have more eusocial bees than suburban sites, as eusocial insects are typically more flexible in their resource needs and requirements.

Figure 2. (a) Suburban field site; Indian Hill. **(b)** Urban field site; Clybourn.

Works Cited: [1]McKinney (2002) *BioScience* 52, 883; [2]McKinney (2006) *Biological Conservation* 127, 247; [3]Zanette *et al.* (2005) *Landscape and Urban Planning* 71, 105; [4]Winfree & Cariveau (2011) *Annual Review of Ecology, Evolution, and Systematics* 42, 1; [5]Hernandez *et al.* (2009) *Cities and the Environment* 2, 3; [6]McGill *et al.* (2006) *Trends in Ecology & Evolution* 21, 178; [7]Fortel *et al.* (2014) *PLoS ONE* 9; [8]Matteson *et al*. (2008) *Annals of the Entomological Society of America* 101, 140.

Results & Discussion

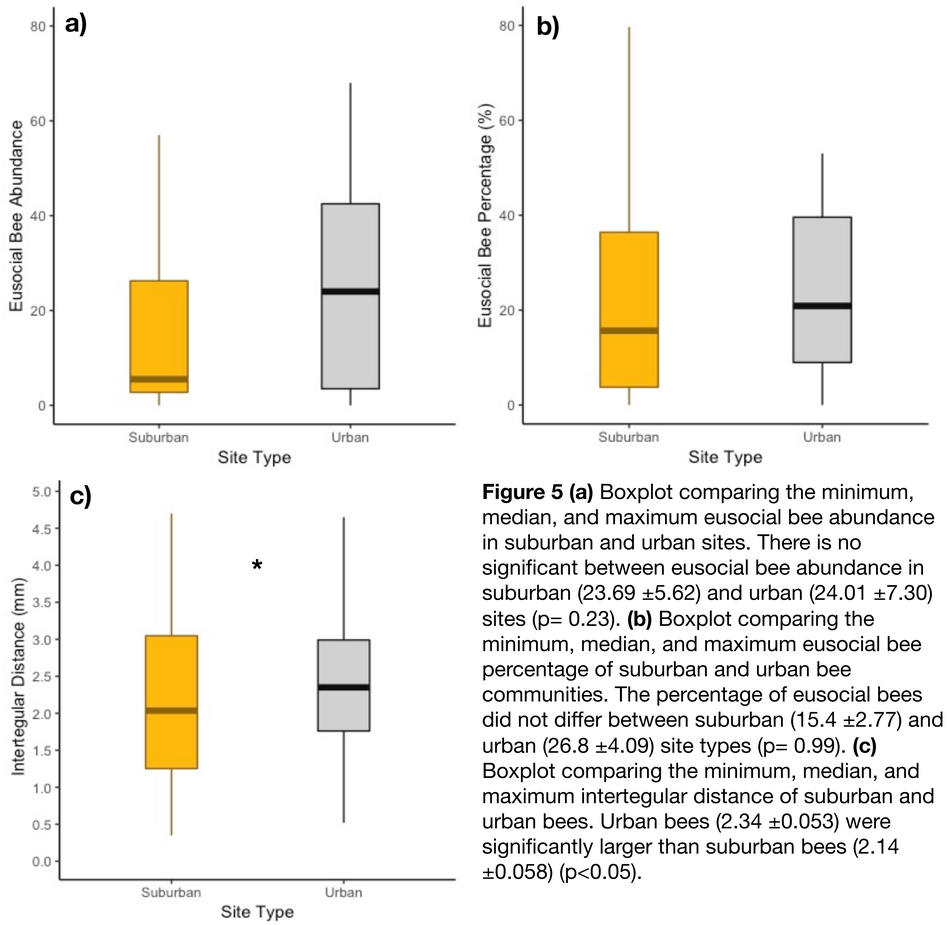

Figure 5 (a) Boxplot comparing the minimum, median, and maximum eusocial bee abundance in suburban and urban sites. There is no significant between eusocial bee abundance in suburban (23.69 ±5.62) and urban (24.01 ±7.30) sites (p= 0.23). **(b)** Boxplot comparing the minimum, median, and maximum eusocial bee percentage of suburban and urban bee communities. The percentage of eusocial bees did not differ between suburban (15.4 ±2.77) and urban (26.8 ±4.09) site types (p= 0.99). **(c)** Boxplot comparing the minimum, median, and maximum intertegular distance of suburban and urban bees. Urban bees (2.34 ±0.053) were significantly larger than suburban bees (2.14 ±0.058) (p<0.05).

In total, we collected 1827 bees, 740 bees from suburban sites and 1087 bees from urban sites. We found no difference between the abundance or percentage of eusocial bees in urban and suburban bee communities (Fig 5a, t-test, df= 19.35, p= 0.23) (Fig 5b, t-test, df= 20.66, p= 0.99). This suggests sociality does not affect a bee's ability to persist in urban environments compared to suburban. This is consistent with other studies that have found no differences in sociality between urban and rural bees[7,8]. In contrast, results showed urban bees (2.34 ±0.053) are, on average, 8.54% larger than suburban bees (2.14 ±0.058) (Fig. 5c, t-test, df= 574, p< 0.05). These results suggest that larger bees may have an advantage over smaller bees in urban areas; this may be because large-bodied bees have an increased flight ability, making them more well equipped to navigate a fragmented, urban landscape[8].

In conclusion, there appears to be some differences in bee functional traits within suburban and urban communities. Future work will incorporate information on other bee functional traits, such as nesting preference, diet breadth, and flight season length. All together, these analyses will help us identify traits that allow different bee species to persist along an urbanization gradient.

Future Directions

- Future work will explore differences in species diversity and richness between urban and suburban sites.
- Additional functional traits (tongue length, nesting behavior, and diet breadth) will be assessed in future work.
- Future work will analyze floral and nesting resources at each site.

Methods

Field: Eight sites along Chicago's Union Pacific North Metra railway were sampled and categorized as either "Urban" (over 50% impervious surface) or "Suburban" (less than 50% impervious surface). Bees were collected using two methods: hand netting and bee bowls. Floral resources and percentage of impervious surface were evaluated each site visit.

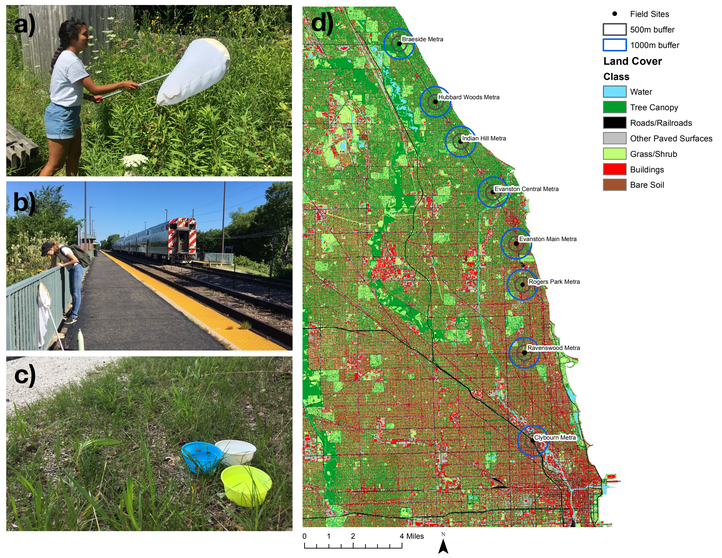

Figure 3 (a) Netting for bees. **(b)** Analysis of floral resources. **(c)** Bee bowls set out to catch ground nesting bees. **(d)** Sites sampled along the UPN Metra line in Chicago.

Lab: Size was estimated by measuring intertegular distance (distance between wing attachment) using a digital caliper for 25 bees randomly selected from each site visit, resulting in 600 total bees measured (300 suburban, 300 urban). To determine abundance and percentage of eusocial bees, we counted the number of *Apis mellifera* and *Bombus* individuals collected at each site.

Figure 4. Difference in intertegular distance between two *Bombus* sp.

Statistical: T-tests were used to analyze the difference between urban and suburban sites for intertegular size and eusocial bee abundance.

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