DEPARTMENT OF ENTOMOLOGY

Body size of ground beetles (Coleoptera: Carabidae) decreases with urbanization

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INTRODUCTION

Urbanization

- Urbanization influences biodiversity and shapes functional traits of local biota (1,2,3).
- Traits such as body size, shape, or symmetry can all be effected by environmental changes caused by urbanization (4).
- Loss of human populations in cities due to socioeconomic factors results in the demolition of residential structures.
- This leads to increased greenspaces (vacant lots) within cities that can be converted into a variety of habitats such as urban farms, and wildflower prairies.

Equilibrium Theory of Island Biogeography

- The Equilibrium Theory of Island Biogeography (ETIB) can be applied to cities where rural areas act as mainlands and urban greenspaces are islands (4,5,6).
- ETIB predicts lower species richness with increases distance from mainland and decreased area of islands (5) (Fig 1).

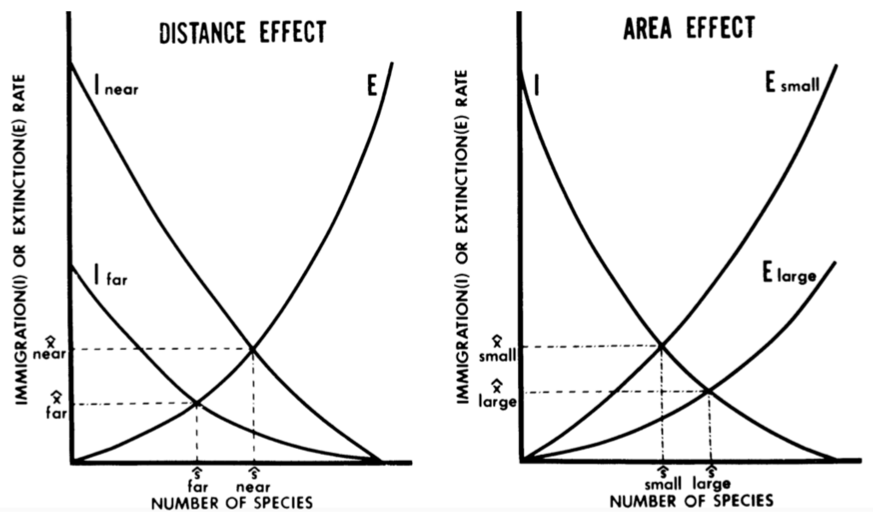

Figure 1. (Left) Distance effect; a near island has larger equilibrium number of species (*S*)and turnover rate (*X*). (Right) Area effect; a large island has larger *S* and smaller *X*. Simberloff 1974.

Reproductive success and body size

- Dispersal of arthropods like ground beetles is influenced by body size as smaller individuals are more commonly macropterous.
- Areas of high disturbance have been shown to drive the prevalence of smaller arthropods (7,8).
- This suggests that smaller species will be more likely to colonize urban islands, following a similar trend to species richness (smaller body size with increased distance from mainland and decreased area of islands).
- Body size impacts fitness via female fecundity and male mating success both of which typically increase with increased beetle size (9,10,11,12,13).
- Applying a functional trait based approach to ETIB can elucidate the effects urbanization has on beetle assemblages, functional traits, and reproductive success.

Hypothesis and Predications

- H: Urbanization poses reproductive barriers to ground beetles resulting in a decrease in overall body size within cities.
- P1: Larger beetles are expected to be more abundant in metro parks and rural farms.
- P2: Smaller beetles are expected to be more prevalent in vacant lots, pocket prairies, and urban farms.

Importance

- Ground beetles are bioindicators and biological control agents (14,15).
- Understanding how urbanization effects populations and reproductive success can guide conservations efforts in order to restore ecosystem services.

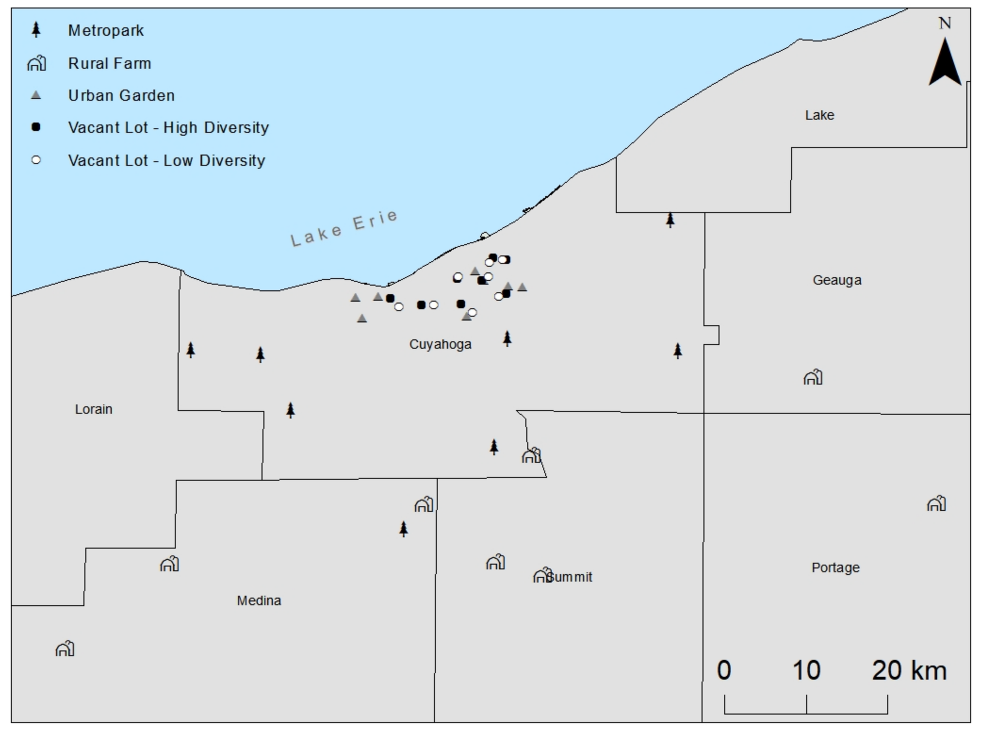

Figure 2. Map of 40 collection sites from Cleveland, Ohio and surrounding rural areas. © Emily Sypolt 2018

METHODS

Beetle sampling

in June 2018 ground beetles were collected from 40 greenspaces in Cleveland, OH, USA and surrounding rural areas (Fig. 2) using unbaited pitfall traps (Fig. 3 left) in five treatments:

1) vacant lots mown monthly (Fig. 3 middle)
2) urban pocket prairies seeded with wildflowers (Fig. 3 right)
3) urban farms (Fig. 4 left)
4) rural agroecosystems (Fig. 4 middle)
5) metro park forests (Fig. 4 right)

Figure 3. (Left) 1L deployed pitfall trap placed just below soil surface. (Middle) Control vacant lot mown monthly. (Right) Pocket prairies seeded with wildflowers.

Figure 4. (Left) Urban farm, (Middle) rural agroecosystem, (Right) metro park forest.

Measurements

We measured the body size (mm) of four ground beetle species: *Scarites vicinus* (Fig. 5 left), *Chlaenius tricolor* (Fig. 5 right), *Poecilus chalcites* (Fig. 6 left), and *P. lucublandus* (Fig. 6 right).

Statistical Analyses

A Kruskal-Wallis non parametric test was used to investigate body size of ground beetles among the five treatments.

Figure 5. (Left) *Scarites vicinus.* (Right) *Chlaenius tricolor* © 2014 roar

Figure 6. (Left) *Poecilus chalcites* (Right) *P. lucublandus* © 2012 Anthony Rodgers

RESULTS

Species size and distribution

- Body size of beetles was greater in rural agroecosystems and metro parks (Fig.7; χ^2 = 8.8, *P* = 0.032) than urban vacant lots and prairies.
- All species measured were capable of flight with fully developed wings.
- Clear habitat associations were observed for the most abundant species.
- *S. vicinus* and *P. lucublandus,* the largest of the species (Table 1), were only found in rural treatments along with *P. chalcites*, a slightly smaller species (Table 2).
- The smallest of the abundant species, *C. tricolor* (Table 1) was predominantly found in urban greenspaces though it was not completely excluded from rural environments (Table 2).
- No one species of beetle was found in abundance at the urban farms (Table 2).

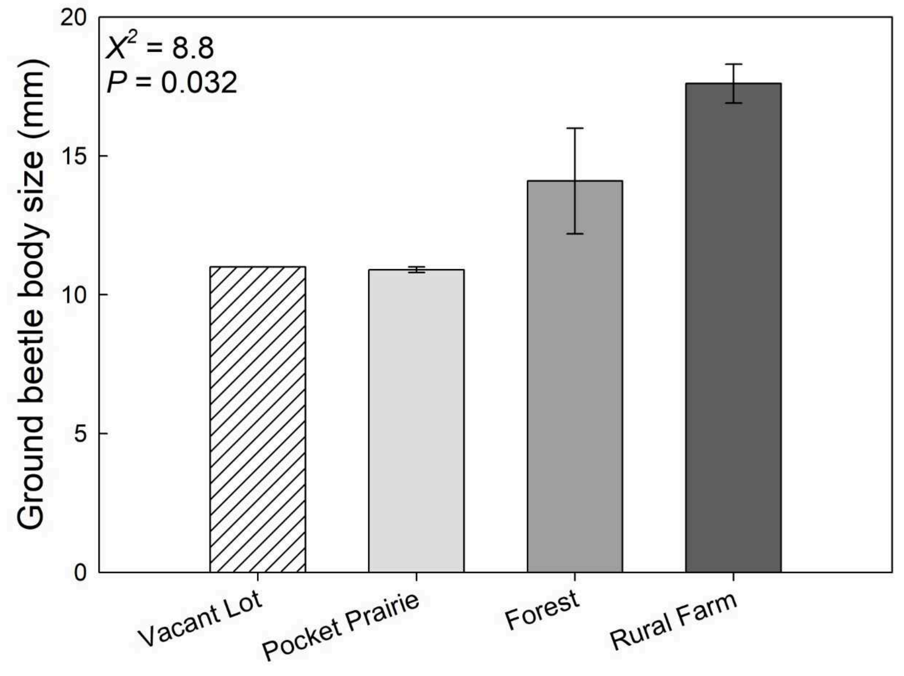

Figure 7. Average beetle size across all four species for each treatment except urban farms where no one species was found in abundance.

Table 1. The body size range and average body size of each beetle species.

Species	Body size range (mm)	Avg Body Size
Scarites vicinus	19.5-24.0	21.7
Poecilus lucublandus	11.2-13.7	12.7
Poecilus chalcites	10.4-12.7	11.4
Chlaenius tricolor	10.3-12.0	11

Table 2. Number of individuals of each species per treatment including vacant lots (VL), pocket prairies (PP), metro park forests (MP-F), rural farms (RF), and urban farms (UF).

Species	VL	PP	MP-F	RF	UF
Scarites vicinus	0	0	3	37	0
Poecilus lucublandus	0	0	27	4	0
Poecilus chalcites	0	0	0	22	0
Chlaenius tricolor	1	21	1	4	0

CONCLUSIONS

- Beetle populations are not ubiquitous among urban and rural greenspaces despite all being capable of flight.
- Urban islands are not easily inhabited by larger beetles while rural environments may be the source of populations within the cities.
- This coincides with ETIB fortifying the assumption that built up areas of urban spaces are barriers of entry to larger arthropods.
- Increasing connectivity between rural and urban areas as well as increased size of urban greenspaces could potentially help eliminate these barriers.

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