Understanding Ground Dwelling Pest and Natural Enemy Populations in Urban Gardens

Savanna Ploessl

Department of Entomology – Purdue University – West Lafayette, IN 47907

Abstract Urban agriculture in the form of urban gardening is becoming increasingly popular in response to the COVID-19 pandemic. Identifying the community composition of insect populations in urban environments is a current priority for Urban Ag IPM. Our foundational study documented arthropod diversity and feeding guilds present in ground dwelling populations within urban gardens across Tippecanoe and Montgomery County in Indiana. Our results suggest a correlation between increased plant diversity and increased arthropod diversity resulting in the presence of beneficial predators increasing. We can use the information found in this study to begin to understand how urban gardens influence arthropod communities and develop resources specific to urban needs.

Introduction

Over the past decades, urban gardens have become increasingly prominent (Tornaghi, 2014). In cities and suburbs, urban agriculture helps alleviate localized food insecurity through cultivating green spaces in these urban settings (USDA, 2022). Urban agriculture often takes the form of backyard and community gardening, but it can also include rooftop, roadside fringe, and vacant lot gardening. Urban agriculture improves food access, connects members of the community with the practice of producing food and, especially in community gardening, brings people together (USDA, 2022). More landscapes are being converted to this urban agroecosystem, and Urban growers in Indiana have identified insect pest identification as their number one challenge according to needs assessments by Shoaf and Ingwell. Our lack of knowledge of insect communities in urban gardens limits our capacity to provide tailored recommendations for pest management to urban growers. Therefore, identifying the community composition of arthropod populations in urban environments is a current priority for urban agriculture integrated pest management. Understanding what populations of natural enemies and herbivorous insects are in these urban gardens can fill the gap around arthropod and invertebrate food web dynamics in these urban agriculture systems. In order to fill the knowledge gap, we examined 10 urban gardens across Indiana over the course of June, July, and August in 2021. Plant diversity, type of ground cover, and landscape matrices were recorded at each site. The gardens were surveyed during each month to identify arthropod diversity and feeding guilds present in ground dwelling populations.

Materials and Methods

Urban Garden Sites

Five urban garden sites were located in each of Montgomery and Tippecanoe Counties. We located all sites with the help Purdue Extension ANR Educators in each county. Garden sizes ranged from roughly 610 to 10,000 square feet. Upon the initial visit to each garden information was taken on the production practices and landscape matrix (Table 1). During each visit to the garden site plant diversity was measured and categorized into plant families (Figure 1).

Sampling for Arthropods

Pitfall traps were placed randomly throughout the gardens on-site for 48 hours each month. The number of pitfall traps at each site were scaled to the square footage of the gardens: ranging from four to eight traps. Pitfall traps were comprised of plastic pots placed in the ground with a plastic cup filled with Propylene glycol placed inside. A plastic funnel was also placed within the pot to guide the arthropod into the cup. Roof paneling was placed above the trap in order to prevent rain from flooding the trap during the 48-hour collection period (Pictures 1-3). Arthropods were stored in Propylene glycol and then identified to family, common name, and feeding guild.

Diversity Calculations

The Shannon Diversity Index (H), which is a mathematical measure of species diversity was used to calculated to compare the diversity of invertebrates at each site and county. The formula used to calculate this index is $H = -\Sigma p_i * ln(p_i)$. A higher H value correlates to a higher diversity for the overall county or the individual site (Table 2). This index is an information statistic index that assumes all species are represented in a sample and that they are randomly sampled (NIST, 2016).

Results

Pitfall Trap Identifications

After processing the pitfall traps, 76 unique families were identified, and 4668 arthropods were identified in total, representing eight different feeding guilds (Table 3). The eight feeding guilds identified were omnivores, detritivores, predators, herbivore, fungivores, parasites, parasitoids, and pollinators (Figure 2). The three most abundant feeding guilds were detritivores, omnivores, and predators. The three most abundant omnivores identified were ants, crickets, and stone centipedes. The three two most abundant detritivores identified were pill bugs, hump-backed flies, and house flies. The three most abundant predators identified were wolf spiders, beetle mites, and rove beetles. Beetle mites exhibit a symbiotic relationship with many beetles, including carrion and carabid beetles, so their significant prevalence is intriguing. They travel on beetles and feed on the eggs and newly formed maggot of flies that compete for food with beetle larvae. Therefore, even though there were not high numbers of carrion and carabid beetles caught across the sites, these beetle mites could act as an indicator of their presence.

Shannon Index (H)

Montgomery County was calculated to have a higher H value and higher diversity at 2.22 than Tippecanoe County at 1.91. The site with the highest calculated H value and highest diversity was Christ Lutheran at 2.26 and the site with the lowest H value was North 12th (Table 2).

Discussion

Our study revealed that the most abundant feeding guilds identified were detritivores, omnivores, and predators. Detritivores, on average, were the most abundant guild present throughout the garden sites. The footbridge garden site had the highest percentage of detritivores present at 72.75% (Figure 2). Footbridge had one of the lowest diversity ratings in arthropods identified at

1.45 (Table 2) which could be influenced by the large percentage of detritivores identified at the site making up almost 75% of all arthropods present. The low diversity rating and the high percentage of detritivores could be influenced by the lack of overall diversity in plant species present at the site and the straw mulch production practice.

Omnivores, on average, were the second most abundant guild present throughout the garden sites. The North 12th garden site had the highest percentage of omnivores present at 67.51% (Figure 2). North 12th had the lowest diversity rating in arthropods identified at 1.16 (Table 2) which could be influenced by the large percentage of detritivores and omnivore present at the site and underrepresentation of other guilds. The high percentage of omnivores could be explained by the specific plant families identified at the site with the largest percentages being Malvaceae, Solanaceae, and Cucurbitaceae (Figure 1) since omnivores are more likely than other most abundant guilds to be influenced by the plant diversity. The high numbers of ants identified at this site could be explained by the cucurbit and solanaceous plants which are attractive to aphids, identified as herbivorous pests at this site, and the ants are attracted to the aphids present.

Predators, on average, were the third most abundant guild present throughout the garden sites. The C.C.G garden site had the highest percentage of predators present at 20.29% (Figure 2). C.C.G had an above average at diversity rating in arthropods identified at 2.09 (Table 2) which could be influenced by the soil bare ground production practice, woodland landscape matrix, and high diversity in plant species at the site (Table 1 & Figure 1). C.C.G was a highly diverse site for plant families which drew in more diverse arthropods for predators to feed on. These results are supportive of the idea that there is a correlation between increased plant diversity and increased arthropod diversity resulting in the presence of beneficial predators increasing.

Conclusion

Working in urban garden systems with local landowners and growers can present unique challenges, but this work is crucial to develop integrated pest management strategies tailored to urban growing. Our study identified the most abundant arthropods and feeding guilds throughout urban gardens. We can use the information found in this study to begin to understand how urban gardens influence arthropod communities and develop resources specific to urban needs.

Table 1

Site	Production Practice	Landscape Matrix
Perry	Bare ground Tilled Cornfield	Tilled Cornfield
Grady	Wooden Raised Beds/Soil Bare ground	Mowed Lawn
Christ Lutheran	Soil Bare ground	Mowed Lawn
C.C.G.	Soil Bare ground	Woodland
Nicholson	Soil Bare ground	Mowed Lawn
M.G.D.P.	Soil Bare ground	Mixed Garden
Bethany	Straw Mulch	Mowed Lawn
North 12th	Straw Mulch	Mowed Lawn
Lincoln	Straw Mulch	Mowed Lawn
Footbridge	Straw Mulch	Mixed Garden

Table 2

SHANNON INDEX (H)	
Location	H
Montgomery Co.	**2.22**
Grady	1.99
Perry	1.52
Christ Lutheran	2.26
C.C.G.	2.09
Nicholson	1.99
Tippecanoe Co.	**1.91**
M.G.D.P.	2.07
Bethany	2.11
North 12th	1.16
Lincoln	1.99
Footbridge	1.45

Table 3

Family	Guild	Grdy	Prry	C Lthm	C.C.G	Nichlsn	M.G.D.P	Bthny	N 12th	Lncln	Ftbrdg
Agelenidae	predator		1								
Anthicidae	omnivore		2					1		1	
Aphididae	herbivore	5	1		3	1	1			1	
Araneidae	predator	1					8				
Argidae	pollinator				1						
Armadilliidae	detritivore	54		53	34	155	260	34	78	97	514
Boopiidae	parasite	3									
Cantharidae	pollinator						1				
Carabidae	predator	3	3	11	2	3		1	14	1	15
Ceratopogonidae	detritivore					5					
Chironomidae	detritivore							5			
Chrysomelidae	herbivore	1	11	6	11	15					
Cicadellidae	herbivore	2	1	1	3						
Coccinellidae	predator		1								
Coreidae	herbivore		1								
Cryptophagidae	fungivore		2								
Culicidae	omnivore	2		1	1						
Curculionidae	herbivore		1		1						
Cydnidae	herbivore						2				
Cynipidae	herbivore	2					3			2	
Diapriidae	parasitoid		5					2			
Dolichopodidae	predator				1	4					1
Drosophilidae	herbivore			2							
Dryinidae	parasitoid		1								
Dyseridae	predator									2	2
Ectobiidae	detritivore					1					
Elateridae	omnivore	2	3			2	5	1	1	1	4
Erebidae	herbivore	2			2						
Fanniidae	detritivore				2					1	
Forficulidae	detritivore					1					
Formicidae	omnivore	79	57	64	106	64	163	95	331	85	129
Gryllidae	omnivore	6	3	2	11	22	19	26	5	14	19
Ichneumonidae	parasitoid				1						
Julida	detritivore				8						
Lampyridae	omnivore		1	1							
Latridiidae	detritivore				2						2
Lepidopteran Pupae	herbivore		1								
Lithobiidae	omnivore	1	1		7	2	19	8	8	4	10
Lucanidae	herbivore					1					
Lycosidae	predator	9	58	21	5	6	5	1		2	
Merothripidae	herbivore	1									
Muscidae	detritivore		1	6			5	1	2	2	

Mycetophilidae	herbivore		1		4		1				1
Nitidulidae	detritivore	1	5	4		1	1			2	
Noctuidae	herbivore		1								
Oribatida	predator	1	8		59	4	50	6		51	13
Pentatomidae	herbivore			2		2	2				
Phalangiidae	omnivore		1		1	2	1	1			
Phoridae	detritivore	6	6	8	4	4	1	5	3		
Platygastroidea	parasitoid		2					3			
Polydesmidae	detritivore						2				4
Pompilidae	omnivore			1							
Pseudoscorpion	predator				2		1	1			
Ptiliidae	fungivore				2						
Rhagionidae	predator			1							
Rhapidophoridae	omnivore		1			3					
Rhinophoridae	detritivore						1				
Rhyparochromidae	herbivore				1		1				
Scarabaeidae	detritivore						1		1		1
Scelionidae	parasitoid		11				6				
Sciaridae	herbivore	4	7		5	9	6	15	3	12	5
Scutigeridae	predator							1	6	2	2
Silvanidae	herbivore						1				1
Simuliidae	omnivore	1									
Slug	fungivore	5					11	3	1	2	8
Sparassidae	predator							1			
Sphaeroceridae	detritivore	1									
Sphecidae	pollinator		1								
Springtail	detritivore	61	363	63	160	53	124	53	68	55	125
Staphylinidae	predator	5	8	14	15	7	19	6	2	4	11
Tabanidae	omnivore			1							
Tachinidae	parasitoid	1									
Tetragnathidae	predator								1		
Tetranychidae	parasite		1								
Thomisidae	predator					1					2
Worm	detritivore	2					2	2	2	3	4

Figure 1

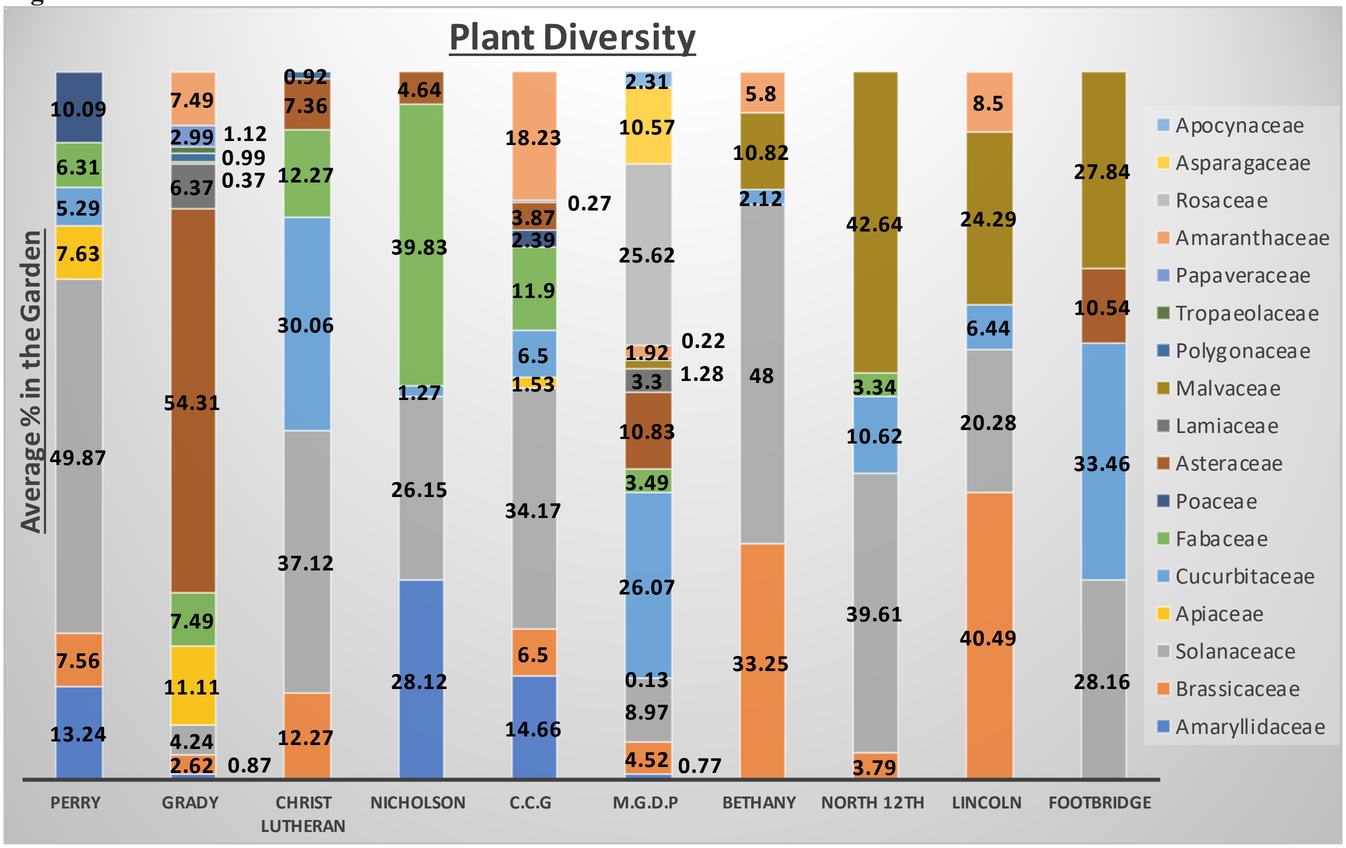
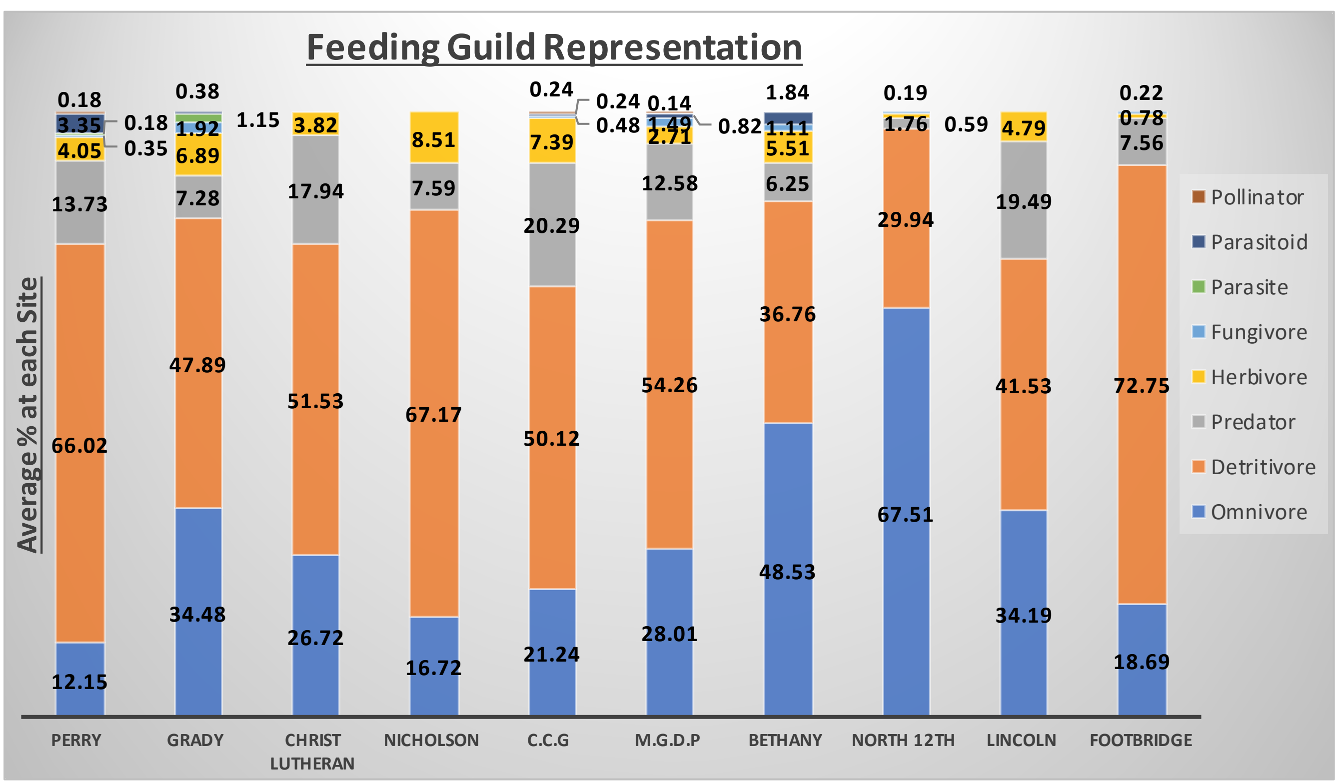


Figure 2



Picture 1

Picture 2

Picture 3

References

NIST. (2016, October 7). *Shannon Diversity Index*. Statistical Engineering Division Data plot. Retrieved April 25, 2022, from https://www.itl.nist.gov/div898/software/dataplot/refman2/auxillar/shannon.htm

Tornaghi, C. (2014). Critical Geography of Urban Agriculture. *Progress in Human Geography*, *38*(4), 551–567. https://doi.org/10.1177/0309132513512542

USDA. (2022, February 1). *USDA announces inaugural Federal Advisory Committee on Urban Agriculture*. U.S. Department of Agriculture. Retrieved April 25, 2022, from https://www.usda.gov/media/press-releases/2022/02/01/usda-announces-inaugural-federal-advisory-committee-urban