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Urban and Rural Riparian Forests: Coleoptera Communities and Soil Characteristics

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Introduction

- Urbanization has been shown to have negative impacts on ecosystems and biodiversity leading to increased biological homogenization (1, 2). However, studies indicate that it may not be detrimental to ground beetle richness and abundance (3).
- The riparian forest is a streamside forest that acts as the interface between aquatic and terrestrial ecosystems and provides key ecosystem services. Conservation of these ecosystems can benefit humans and wildlife.
- Riparian forests can support diverse arthropod communities, specifically, Coleoptera (beetles), which are essential for nutrient cycling, decomposition, and soil aeration (4, 5).
- Urban soils have been shown to have high pH which can cause nutrient deficiencies and lowered soil conductivity therefore negatively impacting the health of the ecosystem, vegetation, and arthropod communities present (6).

Questions

- Does Coleoptera abundance, composition, and richness differ between urban and rural riparian forests?
- Do soil characteristics, pH and conductivity differ between urban and rural riparian forests? Is there a trend in differences between upstream and downstream sites?

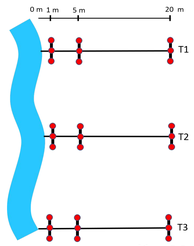
Site Description

- Sites are located in the Greater Binghamton area of the Southern Tier. Binghamton is a medium-sized city with a population of over 250,000.

- Each site was sampled upstream (U) and downstream (D), with the exception of BHCU sampled only upstream.
- FIHD was not sampled at 20m*

Methods

- Samples were collected using a 24-hour wet pitfall trap in 2019
- 3 transects per site with 3 pitfall traps at 3 distances: 1m, 5m, 20m
- Samples stored in 70% ethanol and identified to family level
- In 2020, soil samples were collected (n=9 per site, *FIHD n=6).
- A 2:1 ratio of water to soil was used to measure soil pH and conductivity



Results: Coleoptera Communities

Table 1: This table shows the abundance of families of Coleoptera present and their percent composition overall and at each urban or rural riparian site. The "unidentified" category consists of one unknown family. The families in the highest abundance were: Carabidae, 60.4%, Staphylinidae, 13.3%, and Curculionidae, 10.3%. The Carabidae family was found in consistently high abundance at every site.

Family	Total	Percentage	FHU Urban	FHD Urban	BHC Urban	FIHU Urban	FIHD Urban*	PHRU Rural	PHRD Rural	CRU Rural	CRD Rural
Carabidae	763	60.4	64	69	94	193	53	48	144	66	32
Cantharidae	2	0.2	0	1	0	0	0	0	1	0	0
Coccinellidae	1	0.1	0	0	0	0	0	0	1	0	0
Curculionidae	130	10.3	16	62	3	6	17	15	6	1	4
Elateridae	23	1.8	0	11	4	3	0	3	0	0	2
Eucnemidae	3	0.2	1	2	0	0	0	0	0	0	0
Nitidulidae	78	6.2	13	14	6	7	4	7	17	6	4
Ptilodactylidae	5	0.4	1	2	0	0	0	0	1	0	1
Scarabaeidae	29	2.3	5	9	0	2	6	0	5	0	2
Silphidae	1	0.1	1	0	0	0	0	0	0	0	0
Staphylinidae	168	13.3	12	36	5	6	7	30	37	21	14
Beetle Larvae	39	3.1	4	11	3	2	6	1	8	0	4
Unidentified	21	1.7	1	1	1	1	7	0	6	0	4

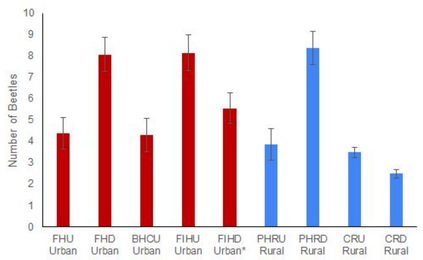


Figure 1: The mean abundance of each sampling site was calculated by averaging the abundance per plot over three months (June - August) and is shown with standard error. Urban sites are shown in red, and rural in blue. Sites FHD Urban, FIHU Urban, and PHRD Rural had the highest mean abundances but overall, the highest mean abundance was found in urban sites.

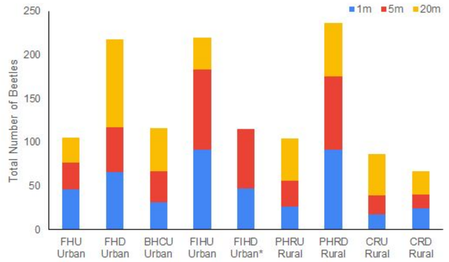


Figure 2: The abundance of Coleoptera at each distance (1m, 5m, 20m) for each site over three months (June - August). Urban mean abundance at 1m: 47.8 ±11.9, 5m: 46.8 ±12.6, and 20m: 53.8 ±16.3. Rural mean abundance at 1m: 34.0 ±14.5, 5m: 33.0 ±13.6, 20m: 39.4 ±8.6. Overall, the urban sites had the highest mean abundance at all distances compared to the rural sites.

Table 2: The Coleoptera abundance in June, July, and August of sampling from each site. June had the highest abundances for every month in every sample site besides FHU Urban, PHRU Rural, and CRD Rural. In July, the abundances of all samples were similar regardless of upstream vs. downstream or urban vs. rural.

Stream	Site	Type	June	July	August	Total
Fuller Hollow Creak	Upstream	Urban	25	48	45	118
Fuller Hollow Creak	Downstream	Urban	113	47	58	218
Bun Hill Creek	Upstream	Urban	49	21	46	116
Finch Hollow Creek	Upstream	Urban	92	45	83	220
Finch Hollow Creek*	Downstream	Urban	48	32	20	100
Prince Hollow Run	Upstream	Rural	29	50	25	104
Prince Hollow Run	Downstream	Rural	108	65	53	226
Chaffe Run	Upstream	Rural	35	27	32	94
Chaffe Run	Downstream	Rural	20	29	18	37

Table 3: Coleoptera family richness is shown by each site during the three sampling months (June - August). The total is the family richness calculated over the three months. FHU and FHD had the highest richness overall. Mean richness was higher for urban sites (8.6 ± 0.76) than rural sites (7.0 ± 1.10).

Stream	Site	Type	June	July	August	Total
Fuller Hollow Creak	Upstream	Urban	4	9	6	10
Fuller Hollow Creak	Downstream	Urban	7	7	9	11
Bun Hill Creek	Upstream	Urban	7	3	4	7
Finch Hollow Creek	Upstream	Urban	6	4	5	8
Finch Hollow Creek*	Downstream	Urban	7	5	7	7
Prince Hollow Run	Upstream	Rural	4	6	3	6
Prince Hollow Run	Downstream	Rural	7	7	8	9
Chaffe Run	Upstream	Rural	4	3	3	4
Chaffe Run	Downstream	Rural	6	8	5	9

Results: Soil Characteristics

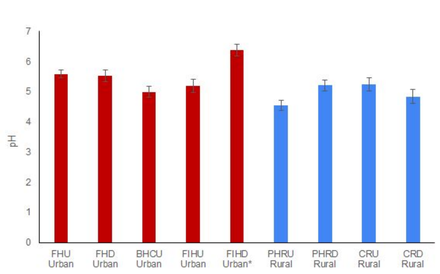


Figure 3: Average pH per site. Mean pH of each site was calculated by averaging the pH per plot per site. Urban sites are shown in red, and rural in blue. Overall, urban sites had a higher pH (5.54 ± 0.24) than rural sites (4.96 ± 0.17).

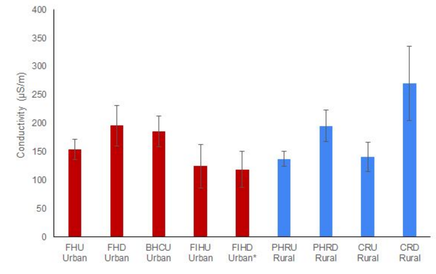


Figure 4: Average conductivity per site. Mean conductivity of each site was calculated by averaging the conductivity per plot by site. Urban sites are shown in red, and rural in blue. Overall, urban sites had a lower conductivity (155.71 ± 3.53 µS/m) than rural sites (186.06 ± 11.40 µS/m).

Discussion

- Overall, there was a trend for higher beetle abundances in urban sites and average abundance was also higher in urban sites across all distances. Urban sites could have provided nutrients, suitable habitat, and diverse vegetation (7, 8).
- Richness over all three months was, on average, higher in urban areas (8.6 ± 0.74, 7.0 ± 1.10). Although similar, this could indicate that urban riparian habitats are able to support diverse beetle populations.
- Carabidae was the most abundant family collected (60.4%); this was expected since these predatory ground dwelling beetles prefer heterogenous, moist environments (3).
- Overall, urban and rural riparian zones had comparable Coleoptera abundances and taxon richness suggesting that urbanization may not be detrimental to beetle communities.
- Average pH and conductivity of the soils were comparable for both urban and rural sites indicating urban riparian soils may maintain buffering capacity and function.

Future Research

- Determine traits and characteristics of beetle families and their preferences for habitat.
- Analyze nutrients (nitrogen and phosphorus) and riparian functions (nutrient cycling) in the riparian soil and adjacent stream in urban and rural sites.
- Compare beetle abundances and richness from 2019 - 2020.

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