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Functional Feeding Groups of Aquatic Macroinvertebrates on Natural and Artificial Leaves in Forested Stream Habitats in the Sebago Lake Land Reserve

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Abstract

We investigated preferential insect colonization of natural versus artificial leaves in forested streams to determine the impact of invertebrate-substrate associations on macroinvertebrate community composition and ecosystem nutrient cycling. We created 10 onion bags filled with natural maple leaves and 10 filled with artificial maple leaves, and placed 5 of each in two forested streams, one larger and one smaller, in the Sebago Lake Land Reserve (SLLR) in Standish, Maine. We identified the aquatic macroinvertebrates found on these samples after approximately one month to order-level and used Maine DEP biomonitoring data and functional feeding group taxonomies to classify macroinvertebrates by functional feeding groups. There was a greater difference in Simpson diversity values between habitats than between substrate types and a substantially greater difference in functional feeding group composition between habitats than between substrate types. The patterns in functional feeding group abundance across habitats (specifically the decline in shredder proportions from the smaller stream to the larger stream) match the patterns of the river continuum concept. This indicates an unexpectedly high degree of small-scale ecosystem heterogeneity, with wide potential implications for ecosystem-level macroinvertebrate community structure and nutrient cycling.

Introduction

- This project explored the differences in aquatic macroinvertebrate community composition between organic and plastic substrates of similar size, texture, and position in two different habitats, a Larger, faster-flowing stream and a Smaller, more pool-like stream.
- Macroinvertebrates are divided into four functional feeding groups: shredders, collectors (including gatherers and filterers), predators, and grazers. Shredders are especially important for decomposition, as they physically break up decomposing leaves.
- The literature was inconclusive on invertebrate preferences between artificial and natural leaf substrates (Dobson, 1994; Karádi-Kovács et al., 2015; Marquez et al., 2017), so our expectation was that diversity and/or abundance would be identical between these substrates.
- We expected to find higher macroinvertebrate densities in the faster-flowing Larger stream. This expectation was supported by the research of Brown and Brussock (1991), who found that “virtually all” macroinvertebrate taxa were more abundant in riffles than in pools.

Research Questions

- Are macroinvertebrates attracted to leaves as a food source, a substrate, or both? How does this preference vary by functional feeding group and between habitats, and how does it influence decomposition?
- Our hypothesis was that diversity and abundance would be identical between natural and artificial leaf packs, and that the Larger stream would have greater macroinvertebrate density and diversity than the Smaller stream.

Methods

- Our research took place in forested stream habitats in the Sebago Lake Land Reserve in Standish, Maine, owned by the Portland Water District.
- We created 10 mesh bags filled with natural maple leaves (*Acer* spp.) and 10 filled with artificial plastic “maple leaves.” We placed 5 natural leaf bags and 5 artificial leaf bags in each habitat on October 3, 2018.
- We collected all bags on October 31, 2018. At the lab, we counted all macroinvertebrates and identified them to the best of our ability.
- To obtain functional group values for insects identified only to higher-level taxa, we surveyed macroinvertebrate relative abundance data from MDEP’s stream biomonitoring program (MDEP, n.d.). We then found the species or genera with the highest relative abundance values for taxon and used functional feeding group taxonomies to assign functional feeding groups for all highly abundant lower taxa. We obtained functional feeding groupings from Cushing, 2002, Cummins and Klug, 1979, Mandaville, 2002, Masese et al., 2014, Ramírez and Gutiérrez-Fonseca, 2014, and Proctor et al., 2015.

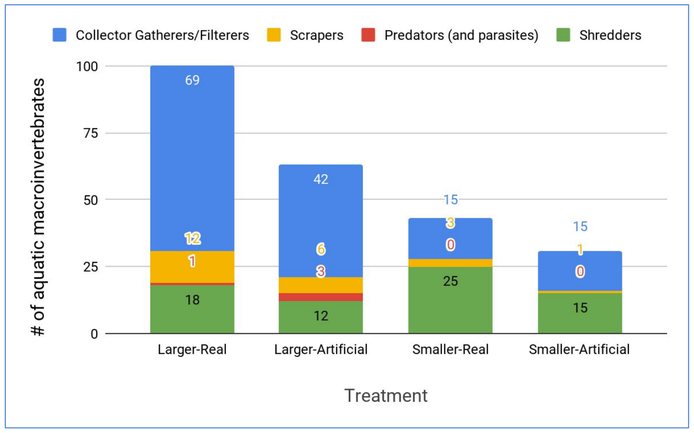

Figure 1: Aquatic macroinvertebrates summed across replicates for our four major treatments (real leaves and artificial leaves in the Larger and Smaller streams) and organized by feeding group.

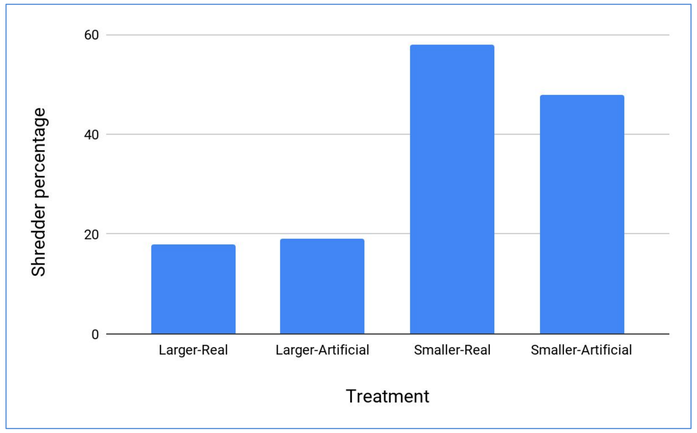

Figure 2: Percentage of macroinvertebrates in the shredder functional feeding group across our four major treatments (real leaves and artificial leaves in the Larger and Smaller streams).

Figure 3: Mayfly larva (family Heptageniidae, generally collectors).

Figure 4: Mayfly larva, top (generally collectors) and caddisfly larva, bottom (generally shredders).

Results

- Invertebrate count was consistently higher in the Larger stream than the Smaller stream and in “real” leaf treatments than “artificial” leaf treatments in the same habitat (Figure 1). However, the difference between habitats was greater than the difference between real and artificial leaves, with artificial leaves in the Larger stream hosting more macroinvertebrates than real leaves in the Smaller stream. This is quite interesting, indicating that from a macroinvertebrate’s “point of view,” these two similar-seeming stream habitats are more different than real leaves and artificial leaves.
- A primary result was the stark difference in shredder percentage between habitats, with the percentage of shredders in Larger stream communities ranging from 18 to 19 and the percentage of shredders in Smaller stream communities ranging from 48 to 58 (Figure 2).
- Shredders play, such as caddisfly larvae (Figure 4) play an outsized role in decomposition due to their feeding habits. The fact that they appeared to be the dominant functional feeding group in the Smaller stream likely means that such streams play important roles in ecosystem decomposition and nutrient cycling.

Discussion and Conclusion

- Differences in macroinvertebrate functional feeding group community composition between similar-seeming stream habitats were substantially greater than between substantially different substrates (Figure 1).
- The patterns of shredder percentage between habitats clearly match those described in the landmark paper “The River Continuum,” with shredder percentage declining sharply from the Smaller stream to the Larger (Figure 2). Vannote et al. (1980) hypothesized that shredders and collectors were codominant in smaller headwater streams due to the abundance of coarse and fine particulate organic matter available, and expected that collectors should increase in importance down the river continuum, becoming a fully dominant functional group, as stream size increased and organic matter particle size decreased. Our results were again a perfect parallel to the River Continuum concept (Figure 1), This degree of small-scale variability in functional feeding type composition between proximate forested streams has wide implications for ecosystem-scale nutrient cycling (Figure 2).
- These results indicate an unexpected degree of forested stream heterogeneity in the SLLR, and appears to indicate that substrate composition is relatively unimportant to aquatic macroinvertebrate colonizers. This could represent a high degree of ecosystem resilience due to diversity of macroinvertebrate functional group communities.

Acknowledgements

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