Assessing Arthropod Diversity in Forest Ecosystems: Systematic Design vs Stratified Design

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Abstract

Identifying the scales of both environmental and spatial drivers on animal diversity can prove to be difficult when the sampling design does not match up with the interaction of a target's organism with their habitat. Data on arthropod communities sampled in forest floor habitats was compared by both systematic design (grid of pitfall traps) and stratified design (expert-based distribution of pitfall traps) to test if they both led to similar results about diversity and composition. Results show that both assemblages types and taxa differ and are dependent on microhabitat types, concluding that both sampling and selection of habitat features can provide information about the drivers of arthropod diversity in forest ecosystems.

Introduction

Heterogeneity in vegetation composition and structure is an inherent feature of landscapes and an important driver of variation in animal communities (Atauri & de Lucio 2001; Tews et al. 2004). Different attributes of vegetation, be it structural or floristic, determine how different taxa perceive and interact with their habitat, but the importance of the different attributes can vary with spatial scale (Field et al. 2009). Many studies have examined drivers of diversity at large scales (e.g. Bohning-Gaese 1997; Ribera et al. 2003) or between different vegetation types (e.g. Woodcock et al. 2010; Fahr & Kalko 2011). Yet, studies of animal assemblages at fine spatial scales can reveal new ways that attributes of vegetation structure can influence patterns of species diversity and distributions (Koivula et al. 1999; Rypstra et al. 1999). This can be particularly important, as analyses of environmental drivers of animal diversity at one scale may be contingent upon factors operating at much smaller scales (Allen & Hoekstra 1992; Barton et al. 2009).Knowledge of how fine-scale structuring of habitat affects animal assemblages is also important from a biodiversity conservation perspective. Manipulation of key structural features of habitat, such as trees (Stenchly et al. 2011) or woody debris (Castro & Wise 2010; Barton et al. 2011), can provide a tractable approach to the management of habitat to benefit biodiversity. However, this requires an understanding of what habitat structures are associated with the diversity and composition of animal assemblages. For example, it is well established that coarse woody debris and individual trees provide localized hotspots of ecological function in landscapes by retaining soil moisture and nutrient content (McElhinny et al. 2010; Goldin & Hutchinson 2013). Further, these structures provide distinct microhabitats for a variety of taxa (Harmon et al. 1986), yet how they contribute to assemblage turnover across landscapes is only just becoming apparent (Barton et al. 2009, 2010). Here, we apply a sampling strategy to build on the work by (Sereda et al. 2014, Barton et al. 2017), that is quite different from most other studies of finescale arthropod diversity patterns, as it targeted different components of the ground-active fauna Our study allows for the identification of fauna associated with distinct microhabitats at ground level. This allows for a comparative approach to the analysis of arthropod diversity, and can potentially reveal how the spatial and environmental structuring of assemblage diversity and composition at fine scales contributes to large-scale diversity (Barton et al. 2009, 2010)

Research Questions:

1. Do arthropod assemblages differ between microhabitats?
2. Does a stratified design provide us with a better understanding of arthropod habitat ecology than a systematic design?

Methodology

We placed our pitfall traps in Pelham Bay Park and had one systematic designed plot (regular grid of pitfalls) and one stratified designed plot which consisted of three replicates; ground cover, downed wood, leaf litter (base of tree) microhabitats. Sampling event was one week, for a total of two weeks. Nine pitfalls per plot, for a total of 18. Total samples 36. Propylene glycol was used in these traps to avoid evaporation. We classified the specimens as orders. Due to time constraints and the bycatch of carrion beetles that reduce diversity dramatically; low sample size was the result. Therefore, our sample size wasn't actually 36. Nevertheless, we applied bar graphs and rank-abundance curve charts to display our results. This way, we can visualize taxa richness and eveness (abundance similarity).

Results

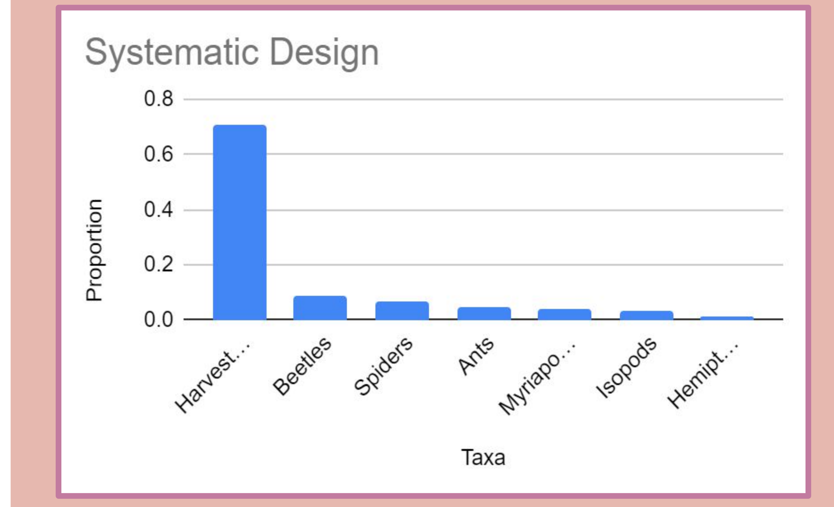

Figure 1. Taxa distribution in a systematic design

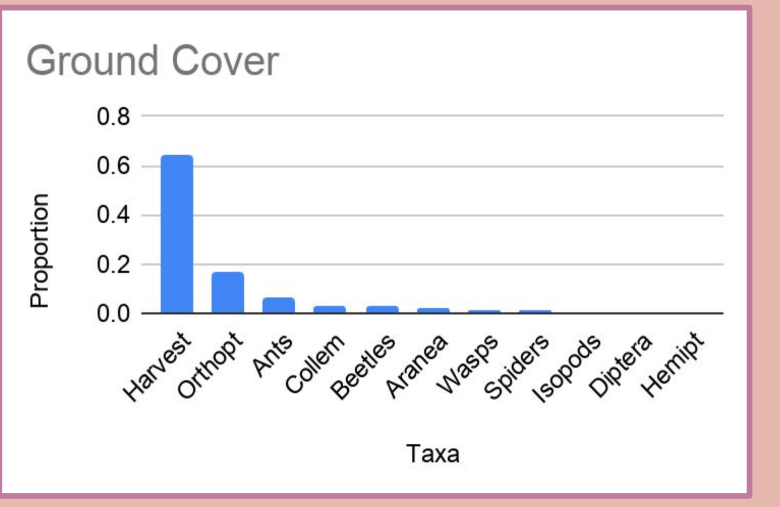

Figure 2. Taxa diversity in Ground Cover (Stratified design)

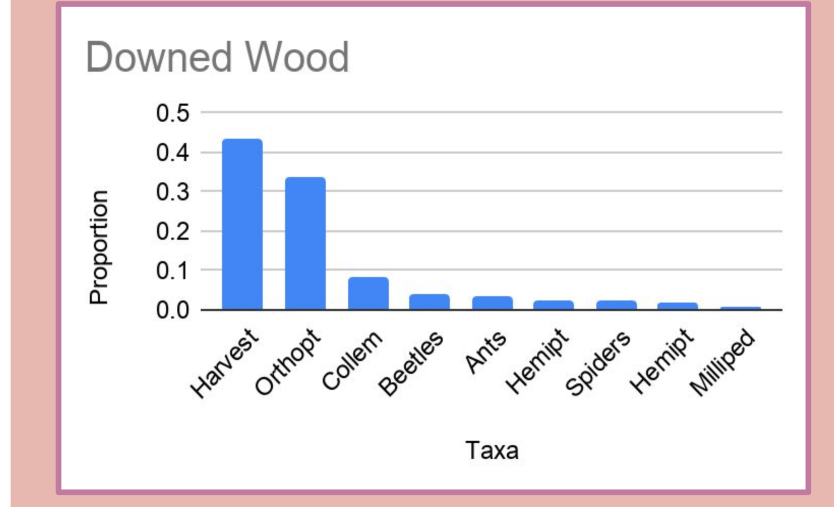

Figure 3. Taxa diversity in Downed Wood (Stratified design)

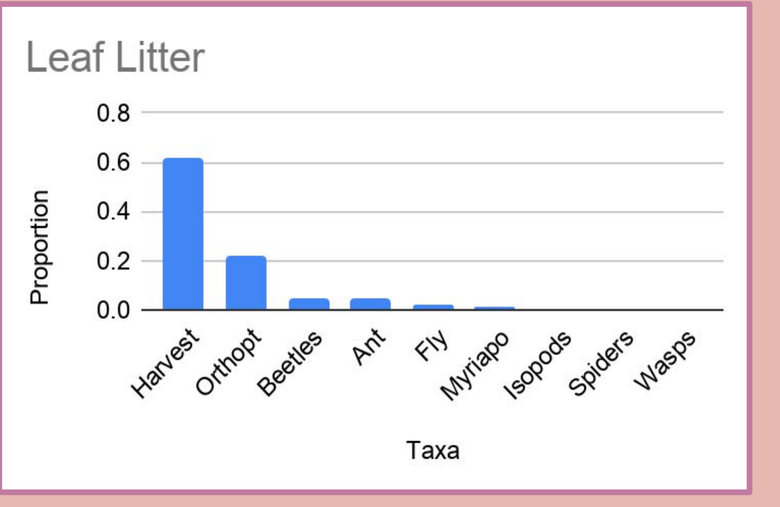

Figure 4. Taxa diversity in leaf litter (base of trees) (Stratified design)

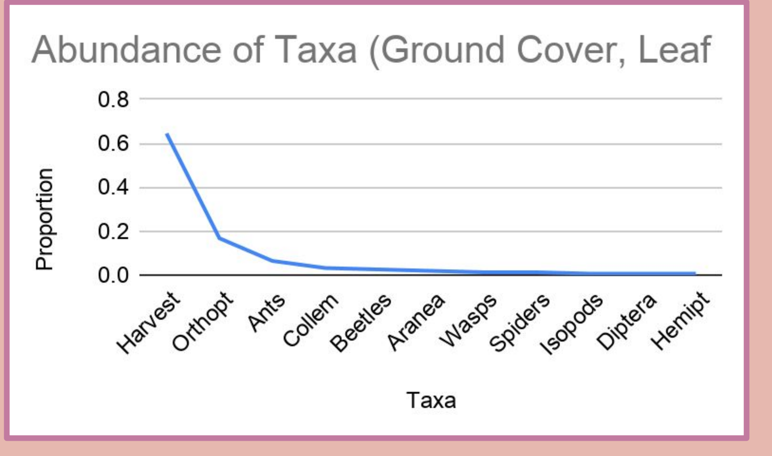

Figure 5. Taxa abundance in Stratified Design

Figure 6. Comparison between Ground Cover, Leaf Litter, and Downed Wood (Stratified Design)

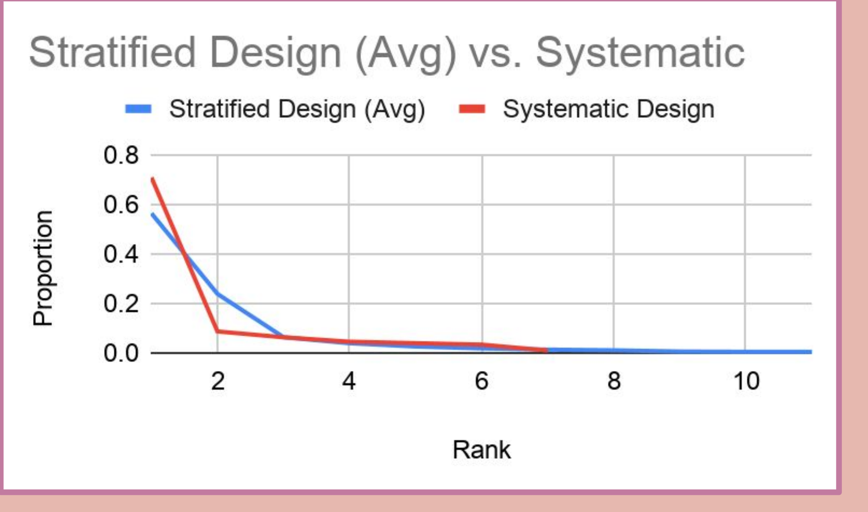

Figure 7. Comparison between Stratified Design and Systematic Design

Discussion

After assessing our data we found that some arthropods preferred specific microhabitats while other arthropods did not show any clear preference. For example, when comparing figures 2 (ground cover), 3 (downed wood), and 4 (leaf litter), harvestmen are present throughout all habitats. Within the harvestmen taxa, a high level of proportion is shown throughout all three figures. While the harvestmen appear to not have any type of clearly indicated preference over what microhabitats they prefer, other assemblages show a slight preference in the different microhabitats.

When looking at figure 3 (downed wood) it is clear to see that orthoptera had a preference for downed wood in comparison to their other proportion level in the other two microhabitats. In Figure 3, the proportion level of the orthoptera surpasses 0.3, looking at the same taxa in Figure 4 (leaf litter) the proportion is around .2 and in figure 2 (ground cover) the orthoptera proportion is below .2. The data from the stratified design indicates that arthropods within the orthropera taxation have a higher preference for downed wood microhabitats. This is also shown with the different assemblages as all 3 figures, such as ants and collembola. While these were our findings, the sampling size was a clear indication of how small and limited our information truly is. With a more consistent data collection it would allow us to notice a more precise pattern of proportions between assemblages, rather than falling towards similar and lower numbers throughout all the microhabitats.

According to our data, our findings show that arthropod assemblages generally differ between each microhabitat. For example, there is more diversity of taxa in the stratified design graphs than the single systematic design graph as shown in Figure 7. While the harvestmen's proportions is prominent in both types of design, stratified design is the only design that gives insight on assemblages like the orthoptera, which are more present in downed wood habitat. Whereas the systematic design does not have any orthoptera present in the data. The systematic design also misses a few other assemblages that are present in the stratified design data. With this information, systematic design would be best used in counting the general population of arthropods at a site, but the stratified design is more suited for finding the correlation between arthropod assemblages and specific microhabitats.

Conclusion

We therefore conclude that being explicit about the type of habitat sampled, whether that habitat is widespread or forms discrete patches, and considering the relevance of the scale of sampling to the study taxon, can provide a more robust way of investigating drivers of compositional variation among arthropod assemblages within landscapes.

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