Surveying the Leaf Litter Diversity of Neotropical Parasitoid Hymenoptera

An alternative sampling method for a hyper-diverse group.

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Introduction

On a changing Earth, human-driven ecosystem degradation will test the abiility of conservation planning to identify and target areas of concern. Nowhere is that truer than in the Neotropical forests of South America, where a majority of the world's species dwell. Many of these species are unknown to science and their ecology remains largely mysterious, especially within leaf litter, which harbors nearly twice as many species as the ecosystem above. Some of the least known organisms belong to the the micro-parasitoid fauna of the order Hymenoptera, which have rarely been studied in the context of leaf litter. We believe this speciose group not only provides economic benefits for agriculture and biological control in the U.S., but can also serve as indicators of arthropod diversity in areas of concern around the world. Hyper-diversity, lack of adequate taxonomic knowledge, and the difficulties of studing minute organisms make studying parasatoid Hymenoptera tough and research has largely focused on Neartic and Palearctic species, necessitating a need to survey parasitoid Hymenoptera in South America, where rapid deforestation, for example, is threatening biodiversity hotspots.

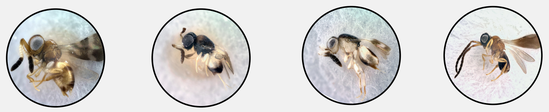
Methods

Parasatoid wasps were separated from samples aquired during **83 collection events** across **4 Neotropical sites** (Guyana highland, Guyana lowland, Peru, and Colombia) from 2005 to 2011 as part of an effort to survey ant (Hymenoptera; Formicidae) diversity in the region. Samples were taken using a modified **Winkler extraction** technique (without pitfall traps) of the "A.L.L. protocol" described in Agosti et al. (2000). Collection events in Guyana deviated slightly from these guidlines and did not sample a 200-m linear transect as in collection events at other sites. Over 1500 specimens were dehydrated, mounted, and labeled. Specimens were sorted to lower taxonomic levels, often with specialists, then sorted into **morphospecies**. Analytics were done using Vegan (R package).

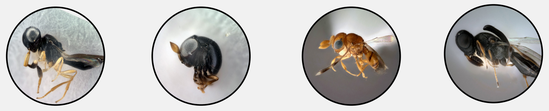
Leaf Litter Sampling Using Winkler Method

Morphospecies examples

Ceraphronidae sp
Most abundant
Most speciose



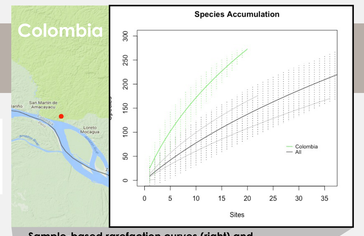
Platygastroidea sp
2nd most abundant
2nd most speciose



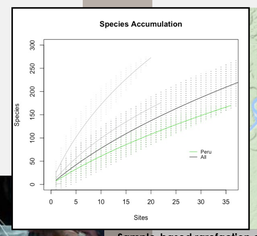
Mymaridae sp

Results

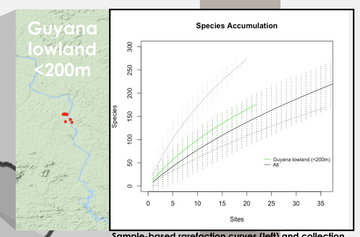
Total parasitoid species = 490
Total specimens = 1550



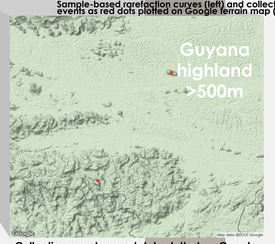
Sample-based rarefaction curves (right) and collection events as red dots plotted on Google terrain map (left).



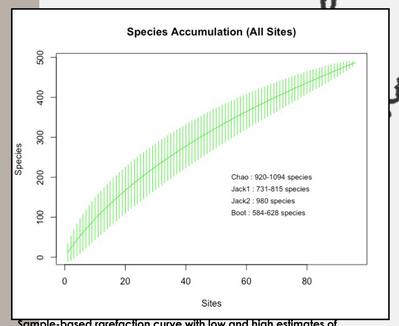
Sample-based rarefaction curves (left) and collection events as red dots plotted on Google terrain map (right).



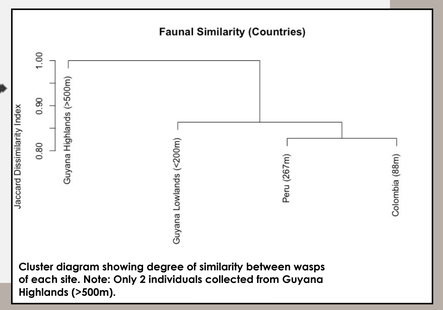
Sample-based rarefaction curves (left) and collection events as red dots plotted on Google terrain map (right).



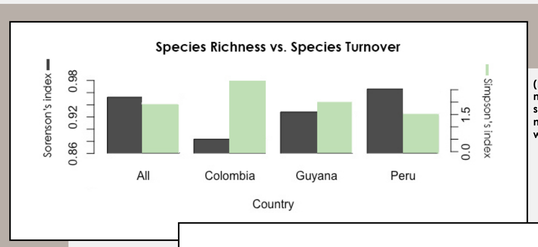
Collection events as red dots plotted on Google terrain map



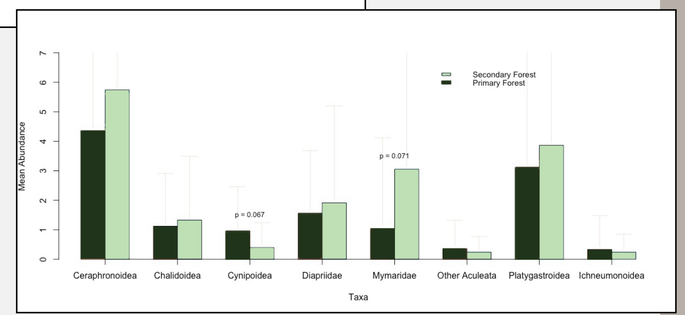
Sample-based rarefaction curve with low and high estimates of species richness



Cluster diagram showing degree of similarity between wasps of each site. Note: Only 2 individuals collected from Guyana Highlands (>500m).



(Left) Simpson's alpha diversity index plotted as the mean species richness for all collection events within site (Grey). Sorenson's beta diversity index plotted mean species turnover for all collection events within site (Green).



(Top) Mean abundance plotted for higher taxa across secondary forest habitat and primary forest habitat. P-values under p = 0.1 reported on plot.

Conclusions

The species accumulation curve for all sites is clearly increasing rapidly without a plateau; this in contrast to curves previously published from this area based on ant abundance data. This indicates that the diversity of parasitoid Hymenoptera within the leaf litter is significantly higher than what our dataset or the corresponding ant data reflects. While Colombia accumulated species the quickest, and had the highest richness score on Simpson's index, it also had the lowest turnover score on the Sorenson's index. The opposite holds true for Peru, which had a species accumulation curve with the flattest slope. This indicates greater homogeneity in Colombian parasatoid fauna and lower homegeneity in Peruvian parasatoid fauna. Taken together, there may be a higher chance of endemism in parasatoids and their hosts in Puru than in Colombia. Based on cluster diagrams of all species, Peru and Colombia had higher faunal similarity than either had with Guyana. This is likely a result of a combination of geological history, as well as proximity, but is not explained by similarities in elevation or habitat as observed on given terrain maps. Only 2 parasitoid species were collected at elevation (>500 m) well above those in Peru, Colombia, and lowland Guyana, indicating an elevational constraint to their distribution. Unlike all other parasitoids, Cynipoidea preferred primary forest to secondary forest, the difference being more significant than differences observed across the remaining groups ($p < 0.1$). Mymaridae showed a stronger and more significant preference ($p < 0.1$) for secondary forest than the other groups. In fact, the shear richness and abundance of Mymaridae was an incredible discovery here, resulting in three genera new to the USNM collection. We speculate that these delicate wasps actually emerged from their host while in the Winkler extractor, as the sifting process is potentially destructive to fragile species.

Future Direction

This dataset begins to unravel the diversity and ecological dynamics of a poorly known but extremely speciose group. Further statistical work will be needed to identify lower level patterns in species abundances and distributions. Ants collected with these specimens are in the process of being databased and will provide an intriguing comparison to determine the relationship between parasatoid Hymenoptera and Formicidae. The data will also allow us to understand the diversity of the order Hymenoptera as a whole, which is often considered to be the most speciose group in the animal kingdom. Specimens sorted here are likely representatives of many new species and few new genera, which will fuel much needed taxonomy in this group.

Acknowledgements

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References

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Agosti D., Majer J., Alonso L.E. and Schultz T.R. (eds) 2000. Ants, Standard Methods for Measuring and Monitoring Biodiversity. Smithsonian Institution Press, Washington, DC. 280 pp.