

Looking through leftovers: an analysis of bee bowl bycatch

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Abstract

In this lab I analyzed the species composition of arthropods in bee bowl bycatch. The results of an analysis of these different communities show a significant difference in the compositional Orders of arthropods found in both the bowl colors and among the different sites along an elevational gradient. Examining the community composition of arthropods caught as bycatch in bee bowl traps provides an opportunity to collect and analyze data that is useful for asking new questions regarding community composition at different study sites, local interactions among biotic and abiotic factors, seasonal changes in community composition, and for long term studies in the effects of climate change on arthropod communities. To answer these questions more studies like this should be done to examine arthropod communities.

Introduction

Observing bee populations is a necessary part of conservation and bee monitoring. This is often done through a combination of both lethal and non-lethal means (Gezon, 2015, Roulston, 2007, Prendergast, 2020). Active capturing and handling of bees in nets is good for monitoring larger bees such as those in *Bombus* and the larger Megachilidae. However, sampling using only netting can create bias as it is being done actively by a researcher and is not as effective for monitoring smaller species of solitary bees (Roulston, 2007, Prendergast, 2020). Bee bowl traps are a container of soapy water which is brightly colored with ultraviolet colors to attract pollinators. The soap breaks the surface tension of the water, allowing specimens to fall into the water and drown. These traps are good for collecting smaller bees such as those in the Halictidae family and other species of pollinating insects (Roulston, 2007). The arthropods collected in bee traps which are not being examined by a study are called bycatch and are not collected or recorded in any data set. In this experiment, I collected and recorded the bycatch captured in bee bowl sampling to determine the usefulness of this data for analyzing species composition within the study sites and in different colored bee bowls.

Analyzing bycatch has the possibility of utilizing data that may provide information about species that are too uncommon to be approved for their own studies for lethal capture. Due to the importance of bees as pollinators, studies have been approved for these species, while those looking at other insects may face obstacles. Rare arthropod families may require more trapping, or long-term trapping that would require too much time, effort or have too great of an impact on adjacent insect populations to justify their own studies. Studies looking at archaic insect species or studies analyzing general insect presence may not be able to utilize techniques of 'bee bowl' capture used in bee studies due to the possibility of over studying a study site which can cause depletions in insect and pollinator populations if done too frequently. Studies which examine bees are done once every two weeks to ensure that population depletions do not occur. This timeline has been studied and approved as having no observable impact on pollinator populations (Gezon, 2015). Examining bycatch at study sites already approved for bee research would thus provide a valuable wealth of information at a low cost as these organisms will be collected anyway during bee studies, they will just need to be processed and recorded as data and then analyzed by researchers.

Examining bycatch allows broad observations to be made on species composition which can allow researchers to arrive at new questions for future study. Does the insect Order composition change with bowl color? Do these observations change when arthropods are categorized into species or families? How do the species/order composition change with the location of study?

How does it change throughout the year? The collection and analysis of large swaths of data provides an opportunity for future researchers to look back into the records and begin asking new questions. This study observes differences in arthropod order composition within bee bowls of different colors, either blue, yellow, or white, and of the locations from which they were collected along an elevational gradient. I expect bee bowl colors to vary in the kinds of arthropods that become trapped in them as this has been found to be the case in studies examining bees (Leong, 1999, Toler, 2005). I expect there to be variation along elevational gradients as different habitats have different biotic and abiotic factors that would have an impact on the arthropods that can survive and thrive at these locations (Lessard, 2011).

Methods

Data Collection

The bycatch analyzed for this project was taken from 14 of the sites being researched by Rebecca Irwin at the Rocky Mountain biological laboratory located in Gothic Colorado. The sites for this research are being used to study bee populations and species composition along elevational gradients in the Grand Mesa, Uncompahgre on the western slope of the Colorado Rocky Mountains between 3,438 m. and 2,457 m (Figure 1). The sites for this experiment included (Kazenel, 2023)

Mexican Cut Lat: 39.02685 Long: -107.06513,

Elko Lat: 39.01245 Long: -107.05279,

Copper Lat: 38.96896 Long: -106.96801,

Hill Lat: 38.96677 Long: -106.97009,

Little Lat: 38.96732 Long: -106.96885,

Gothic Lat: 38.963088 Long: -106.994866,

Seans Lat: 38.964099 Long: -106.992616

Beaver Lat: 38.961597 Long: -106.993975,

Willey Lat: 38.955971 Long: -106.988482,

Tuttle Lat: 38.954751 Long: -106.988704,

Lypps Lat: 38.74812 Long: -106.83269,

CDOT Lat: 38.78257 Long: -106.87002,

Almont Lat: 38.65622 Long: -106.86203,

Almont Curve Lat: 38.66125 Long: -106.85152.

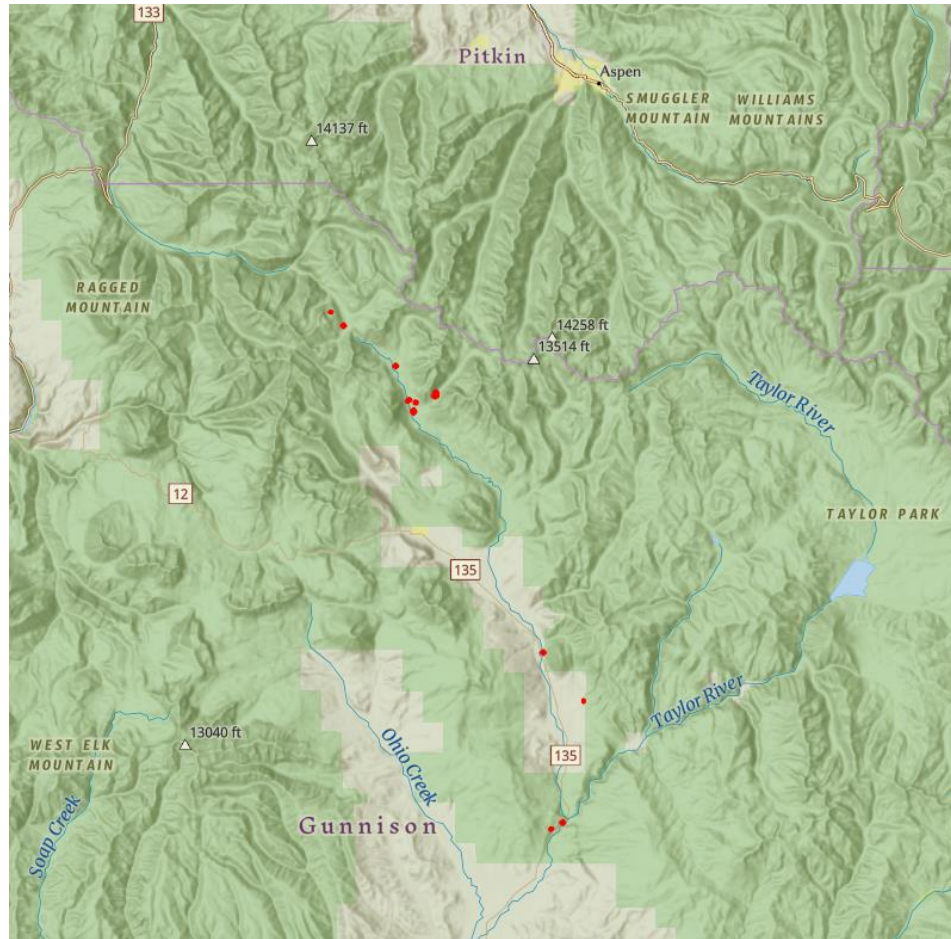


Figure 1: map of 14 sites used for sampling. Sites are being examined for bee phenology data along elevational gradients by Becky Irwin lab.

Arthropods were gathered from bee bowls set up using a standardized bee bowl method. 15 bowls of three colors were set up along a 45 meter transect one meter from one another. Each site had two 45 meter transects and a total of 30 bowls, 10 of each color. Each point on the transect was marked with a blue flag with blue tape, the end of the transect was marked with a wooden stake. 2meter by 2-meter plant plots were dispersed intermittently throughout the transect to record plant data for other projects. Bowls were 3" by 3" and hexagonal in shape and spraypainted either yellow, blue, or white. The bowls were set out at the beginning of the bee survey between 8-11 am and were out for 4 to 6 hours. Non-bee arthropods were collected at the end of the surveys using a fine strainer marked with the respective bowl colors. Once all bowls were collected these strainers were emptied into mason jars marked with tape for each bowl color and the site from which the samples were collected. These jars were then filled with a 70% ethanol to water mixture and refrigerated until they would be analyzed and recorded. Specimens were analyzed within two weeks after collection.

Data Organization and Analysis

Data was organized by families and analyzed by order and then suborder for the order Hymenoptera. The orders Araneae (spiders), Coleoptera (beetles), Diptera (flies), Hemiptera (true bugs), Apocrita (wasps), Formicidae (ants), and Symphyta (sawflies) of the order

Hymenoptera, Lepidoptera (butterflies and moths), and Orthoptera (grasshoppers, crickets and katydids) were observed in bee bowl bycatch. Data analysis by Order was chosen due to the ability to be easily categorized in a short amount of time without the need to consult an expert. Differences in insect communities among bowl color and research sites were examined. Different communities were expected due to the different environmental needs of orders. For example, Diptera and Hymenoptera contain a lot of pollinator species that may prefer certain bowl colors over others and the order Hemiptera is comprised mostly of insects that consume phloem from green plants that are more common in the higher elevations of the Rocky Mountains, as opposed to the lower sagebrush communities.

The Orders of insects were organized and input into R-studio (R Core Team, 2023) (Wickham, 2016). This was to determine the statistical significance of community differences and to organize communities into bar graphs with each bar representing bowl color or location depending on the analysis.

Results:

A chi square test performed on arthropod groups organized by bee bowl color was significant. ($df = 14$, $X^2 = 221.25$, $p < 0.001$, (Figures 2). From this figure we can see a significant difference in the community composition by bowl color. Figure 3 shows the community composition of the various sites from which samples were taken. Some sites like those at Mexican cut, Lypps, CDOT and Almont Curve are dominated by one taxonomic order, either Formicidae or Diptera. At all locations Diptera is present, though not always dominating, while the Orders Orthoptera and Hemiptera were not found at all at some sites. The order of Formicidae dominates many sites but are not present at the Mexican cut where Diptera is dominant.

In all bowls all taxonomic orders were present, but the yellow bowls had a greater number of Apocrita and Diptera while the blue bowls had a larger number of Formicidae on average.

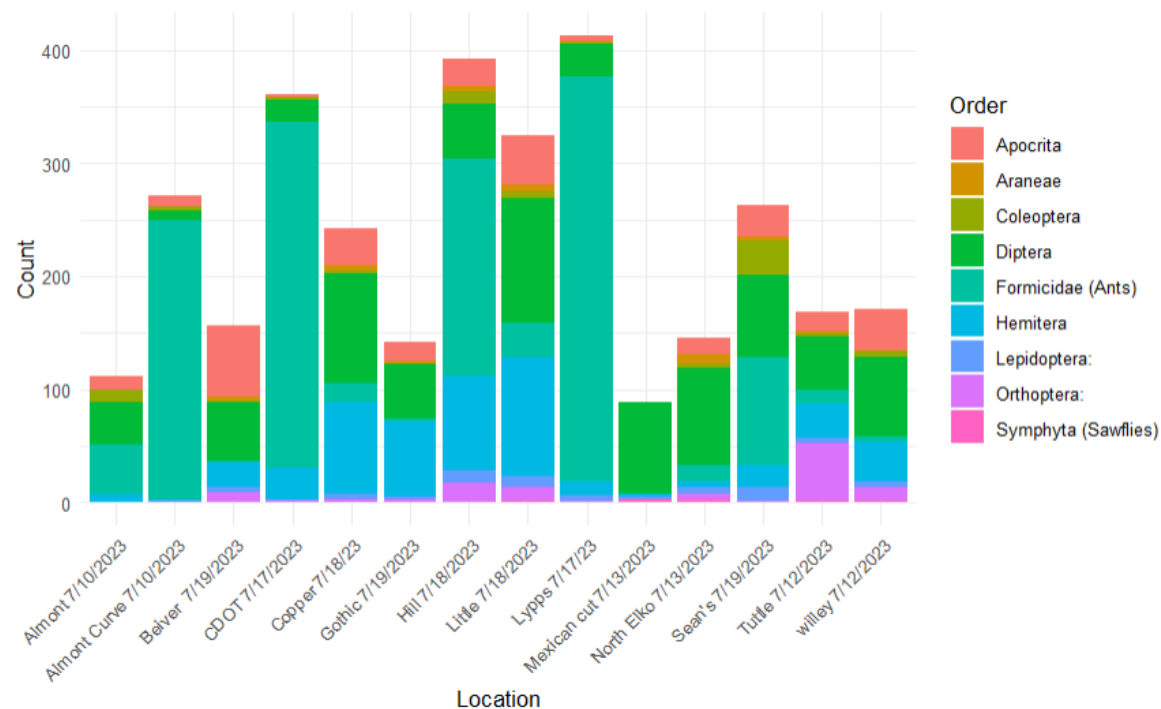


Figure 2: Arthropod communities organized by taxonomic order at research sites throughout the East River valley.

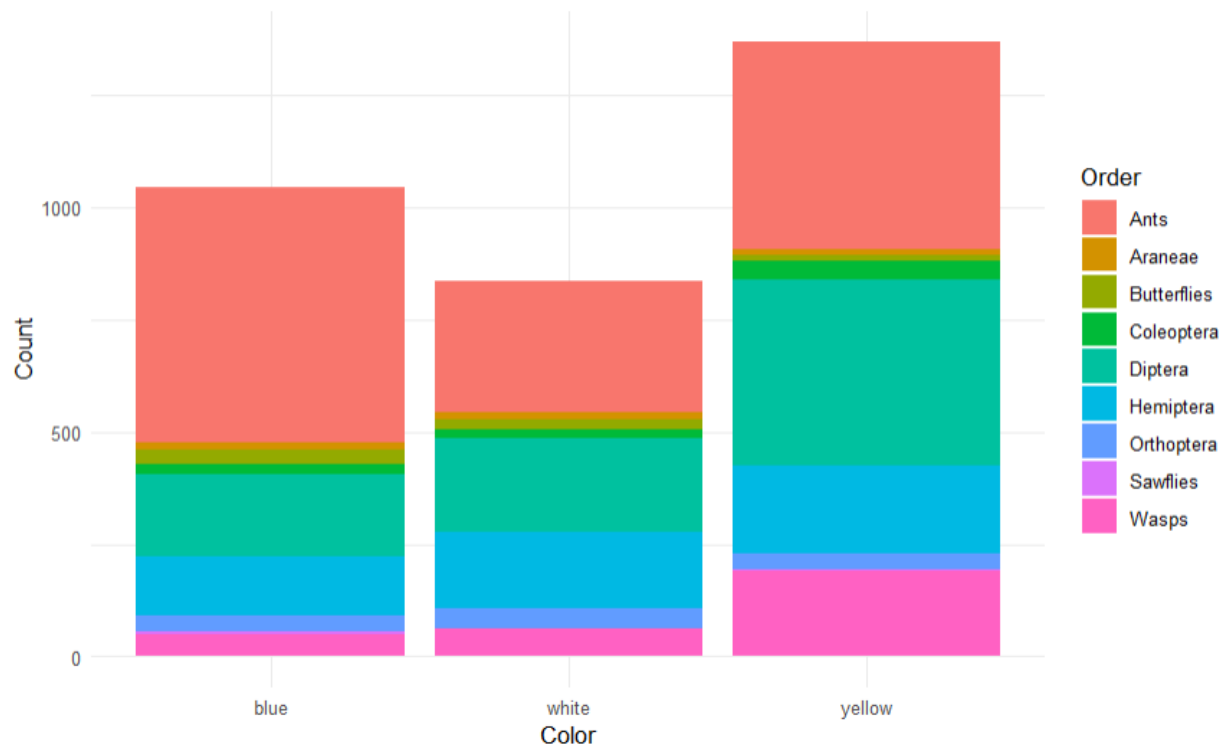


Figure 3: Arthropod communities organized by order in bee bowls of differing colors.

Discussion

The statistical significance in the locations of the sites is expected due to the differences in elevational gradients and habitat composition. These sites were vastly different in their biotic and abiotic factors in terms of temperature, soil composition, and other floral and faunal communities. For example, sites of lower elevation (Almont and Almont Curve) were primarily sage brush communities, which differ greatly from the block sites that occur at higher elevation and are composed primarily of herbaceous meadows. This would intern have an impact on the arthropod orders that would be found at these sites, particularly those with restrictive diet characteristic like Hemitera, which is characterized as an order primarily by distinct mouthparts that allow the insects to feed on phloem and would thus would primarily be found in sites with these food sources. This is different from orders like Diptera, a very diverse order in terms of food they consume, which includes everything from carrion to flower nectar. For orders such as this an analysis of data characterized by species or family might be more useful for relating arthropod communities to a particular landscape.

Differences in communities by color of bee bowls agree with previous studies conducted on pollinators which showed a preference for different bowl colors. It has been found that the color of the bowls influences bee species composition hence why all three colors are used (Leong, 1999, Toler, 2005, Buffington, 2021). It is not surprising that this would also be the case for other pollinator insects. In the graphs it can be observed that there are greater numbers of Diptera and

Apocrita found in the yellow bee bowls compared to the other colors, this makes sense as some wasps and flies are also pollinators and would be expected to behave more cohesively with behaviors observed in bees. It would be interesting to see how different species or even families of these orders differ in their bee bowl color preference. It may also be interesting to examine data collected throughout the year at multiple sites to see how these communities might change throughout the year as seasonal changes in temperature and available food sources in plants change throughout a season. More long-term data collection and analysis could be done to see how these orders might be affected by seasonal changes or changes that occur due to climate change.

Conclusion

For this experiment I collected arthropods in bee bowl bycatch and analyzed the community composition of those captured in the different bee bowl colors and by the site from which they were collected. My results found a significant difference in the community composition of both bee bowl color and sites. These results support my hypothesis that the community of arthropod orders would vary with bee bowl color and by site. More studies should be done on the community composition of bee survey locations throughout the year as these communities could change with the progression of the season. More research should be done into the species identification of samples collected as this can provide a more specific analysis of the community composition that cannot be captured through the analysis of arthropod order.

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