*Spring 2021*
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# Quantitative Sampling of Ant Populations as a Measure of Biodiversity in Rowan County Woodlands

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## ABSTRACT

Biodiversity is an important metric used for conservation efforts and ecological assessments. Biodiversity is defined as the measure of taxonomic diversity within an area. Several groups of organisms have been used as surrogates to assess overall biodiversity for an area, for example plants, mammals, birds, beetles, etc. Ants represent another surrogate taxon for assessing biodiversity because ants are found in many types of habitats, fulfill a variety of ecological roles, are diverse, and are numerous. Leaf-litter samples were collected from three wooded sites in Rowan County: Eagle Lake, Stoney Cove, and Rodburn Hollow between the months of August and October in both 2019 and 2020. Ants were extracted from the leaf-litter using Berlese funnels which are used to extract arthropods from soil. The ant specimens were organized, identified, counted, and labeled to analyze the biodiversity among the different ant habitats collected. A total of 6,283 ants, and 18 genera were collected across the samples. Additionally, there are several useful indices for ant alpha and beta diversity evaluation including, Shannon and Simpson indices. The Shannon index is used to find diversity of a species or genera within a certain environment. The Simpson index is used to find proportional abundance within a given area. Alpha diversity is the diversity at one site and beta diversity is the difference in diversities between sites. The values calculated from these indices can be used to assess ant biodiversity within Rowan County.

## INTRODUCTION

Biodiversity can be defined as the biological variety and variability of life in a particular ecosystem. Surveying ant populations can be very telling of the overall biodiversity and ecological health of an ecosystem. An efficient method of doing so is to focus on a single diverse taxonomic group, known as an indicator taxon.

Ants are an ideal candidate to use as an indicator taxon because they are diverse, easily collected, and found abundantly in nearly every terrestrial habitat (Agosti, Majer, Alonso, Schultz 1983). Ants are a better indicator taxon than other insects because they typically have a stationary nest with restricted foraging areas. Many other insect species move frequently between ecosystems in search of nesting sites, food, or mates. Therefore, ants are a more constant presence across an ecosystem, allowing them to be sampled reliably. Ants also function at many levels within an ecosystem, making them important ecologically. They can function as herbivores, mutualists, predators and prey, or as detrivores (organisms that feed on decaying matter).

In this particular study, we used the ants of Rowan County as an indicator taxon to measure the biodiversity of the Rowan County Woodlands. The goal of this study was to identify which genera of ants and their abundance come from these two areas and in what quantity. The data was analyzed to find correlations between the abundance of each genus and the location where they were collected.


Fig. 1 - Representation of the ants collected during our experiments, obtained from bugguide.net

## MATERIALS AND METHODS

Three samples each were collected from Eagle Lake, Stoney Cove, and Rodburn Hollow in the Fall 2019 and Fall 2020. Considering ants are very diverse within leaf litter, we chose to use a sifting method. Sifting leaf litter required the collection of the top layer of debris from the forest floor by hand (Fig. 2A) which was then placed into the sifter. The sifter consists of a nylon shoot in which near the top is a screen that is attached to a handle. At the top of the sifter is a wire ring attached to a handle (Fig. 2B). The sifter is shaken vigorously ants, insects, spiders, and other fine debris fall into the shoot (Fig. 2B). Once there is 8-10 pounds of siftate it is then placed into a collection bag and brought into the laboratory.

Fig. 2A-B. Various stages of leaf litter sorting and collection

Berlese funnels (Fig. 3A-B) were utilized for separation after collection of living organisms from other debris. A Berlese funnel consists of a base cone which has a wire or metal screen near the top which is then covered by cheese cloth. At the bottom of the funnel is a collection jar with alcohol. The loose debris is placed onto the cheese cloth. The lid of the Berlese funnel has a 100 W incandescent bulb. Once the lid is placed over the base the heat and light of the bulb drive the ants and other organisms deeper through the debris, finally falling through the screen into the collection jar. After each day for the next week the alcohol jars were replaced, and the collected organisms were sorted.

Fig. 3A-B. Berlese Funnel external and internal structure

Once a vial of unsorted ants was obtained, the ants were sorted to morphospecies using a dissecting microscope (Fig. 4). Each morphospecies was placed into its own watch glass in alcohol. Once sorted each morphospecies was identified to genus using *Ants of North America Guide* (Fisher and Cover, 2007). Each watch glass of identified morphospecies was then counted, labeled, and stored in a vial of alcohol.

Fig. 4 Microscopic examination, sorting, and counting

## RESULTS

Table 1: Total Specimens Collected Sorted by Genus by Site

| Genus | Rodburn Hollow | Stoney Cove | Eagle Lake | Total |
|---|---|---|---|---|
| *Amblyopone* | 7 | 7 | 7 | 21 |
| *Aphaenogaster* | 288 | 73 | 36 | 397 |
| *Brachymyrmex* | 297 | 1436 | 849 | 2582 |
| *Camponotus* | 1 | 2 | 1 | 4 |
| *Dorymyrmex* | 1 | 0 | 0 | 1 |
| *Hypoponera* | 2 | 5 | 16 | 23 |
| *Lasius* | 42 | 0 | 2 | 44 |
| *Myrmecina* | 121 | 89 | 69 | 279 |
| *Myrmica* | 34 | 0 | 0 | 34 |
| *Nesomyrmex* | 0 | 0 | 1 | 1 |
| *Paratrechina* | 373 | 128 | 33 | 534 |
| *Ponera* | 378 | 570 | 613 | 1561 |
| *Prenolepis* | 1 | 0 | 0 | 1 |
| *Solenopsis* | 0 | 0 | 3 | 3 |
| *Strumigenys* | 225 | 361 | 88 | 674 |
| *Tapinoma* | 0 | 0 | 1 | 1 |
| *Temnothorax* | 32 | 5 | 80 | 117 |
| *Tetramorium* | 6 | 0 | 0 | 6 |
| Total | 1808 | 2676 | 1799 | 6283 |

Table 2: Calculated Diversity Indices from Table 1

| Index | Eagle Lake | Rodburn Hollow | Stoney Cove |
|---|---|---|---|
| Simpson: λ | 0.35 | 0.16 | 0.36 |
| Shannon: H' | 1.38 | 1.98 | 1.33 |
| Hill's Numbers: N0 | 14.0 | 15.0 | 10.0 |
| Hill's Numbers: N1 | 3.97 | 7.22 | 3.80 |
| Hill's Numbers: N2 | 2.90 | 6.27 | 2.81 |

## DISCUSSION

Diversity has two components: richness and abundance. Richness includes the total number of species in a given area, which is commonly known as "species richness." If an area yields a large number of different species, it is considered to be very rich. Abundance is the number of individuals of each species in a given sample. An important aspect of abundance is evenness or how abundance is distributed amongst the species. There are many equations that describe diversity in terms of richness and abundance.

Simpson index (Eq. 1) and Shannon index (Eq. 2) have long been commonly used. The Shannon and Simpson indices are both a measure of uncertainty and predictability of an individual ant's species in a sample. Hill's indices incorporate both Simpson and Shannon indices.

$$\lambda = \sum_{i=1}^{S} p_i^2$$

Equation 1: Simpson Formula

$$H' = -\sum_{i=1}^{s^*} (p_i \ln p_i)$$

Equation 2: Shannon Formula

In the Simpson index (Eq. 1) is a measure of probability that varies from 0 to 1. The probability refers to if two individual ants were pulled at random from a population if they belong to the same species. The higher the probability indicates that both individual ants would both be of the same species. This also indicates that the diversity of the community would be low. If the probability is low this indicates that the two individuals do not belong to the same species and the diversity of the community would be high.

The Shannon index (Eq. 2) is the most commonly used index when studying ecology and it measures the degree of uncertainty when predicting species chosen randomly from a collection of species (S) and individuals (N). The uncertainty increases as the species and individual distribution increases and becomes even.

The Hill's equation (Eq. 3) calculates diversity orders and numbers that correlate with some of the most important diversity measurements known. Hill's diversity numbers include the zero order, N0=S (Eq. 4) where S is the total number of species; the first order, where N1=e^H (Eq. 5) where H is the Shannon index; and second order, where N2=1/λ (Eq. 6) where lambda is the Simpson index. The diversity numbers from the Hill's equation measure the number of species present in a sample and their effectiveness. Numbers of species that are effective measure the degree of proportionality distributed throughout all of the species sampled. N0 equals the number of all the species present in the sample and this does not account for abundance. N2 equals the very abundant species. N1 equals the number of abundant species that are present in a sample.

$$NA = \sum_{i=1}^{S} (p_i)^{1/(1-A)}$$

Equation 3: Hill Formula

$$\text{NUMBER 0:} \quad N0 = S$$

Equation 4: Hill's Formula for N0

$$\text{NUMBER 1:} \quad N1 = e^{H'}$$

Equation 5: Hill's Formula for N1

$$\text{NUMBER 2:} \quad N2 = 1/\lambda$$

Equation 6: Hill's Formula for N2

On species richness (Hill's N0) at Stoney Cove 10 genera is only 2/3 as diverse as Eagle Lake or Rodburn Hollow. However, Rodburn Hollow at a Simpson index 0.16 and with the Simpson index of 0.35 (Eagle Lake) and 0.36 (Stoney Cove) indicates that the abundance for each genus is more even in Rodburn Hollow. This is also supported by the Shannon Index. Hill's N1 and N2 both indicate that at Rodburn Hollow there are 6 to 7 genera that are abundant or very abundant. Whereas, at both Eagle Lake and Stoney Cove there are 3 to 4 genera that are abundant or very abundant which indicates a greater unevenness at Eagle Lake and Stoney Cove. At both Eagle Lake and Stoney Cove about half the specimens at each were from a single genus, *Brachymyrmex.* At Rodburn Hollow the most diverse genera, *Ponera* and *Paratrechina* each only compose 1/6 of the specimens. Based on the preliminary for these two field seasons Rodburn Hollow appears to be the most diverse based on these metrics.

## ACKNOWLEDGEMENTS

We would like to thank Morehead State University and the Department of Biology and Chemistry for providing the materials and laboratory space needed to conduct our study.

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