A Brief Evaluation of Elateridae Assemblages in Conjunction with the Hardwood Ecosystem Experiment

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Indroduction

America's hardwood forests are some of the country's most important natural resources. Aside from providing the vast majority of timber used in construction and furnishing, as well as over $17 billion in revenue to the state of Indiana alone, they also play a significant ecological role[(2)]. They provide and ideal habitat for many organism across all kingdoms and phyla. Knowing this, an important question that must be asked is how do current sylvacultural management systems affect the ecological balance of America's hardwood forests in the short-term and the long-term?

The Hardwood Ecosystem Ecosystem Experiment is a hundred year experiment currently taking place in Morgan-Monroe and Yellowwood State Forests that is intended to provide some answers to that question. Research has been ongoing since 2006 and focuses on a broad range of taxa, from birds and reptiles to plants and insects[(5)]. Current insect work focuses on two groups of xylophagous and saproxylic beetles; Cerambycidae (longhorned beetles) and Buprestidae (metallic woodboring beetles)[(2)]. These families are identified in Holland et. al. as groups that are generally considered to have an important impact on the forestry industry, both ecologically and economically[(2)]. Work is currently being done in an attempt to observe community assemblage shifts in these beetles in response to three different types of woodland management regimes. Present research shows that species assemblages in these communities of beetles have been influenced by forest management regimes, with the greatest effect showing in even-age forests[(2)].

Though Cerambycid and Buprestid beetles are seemingly the two most important insect groups in relation to forest management, what about other taxa of beetles, such as those that are not nearly all xylophagous and saproxylic? Do they follow similar patterns of assemblage shifts that are current being seen in Cerambycids and Buprestids? One group of interest in particular is the Elaterids, or click beetles. These beetles have a varied life history and are known to develop in the soil as well as in deadwood. Many are also considered to be agricultural pests or predators[(1)]. Knowing this, I hypothesized that species richness and assemblages of Elaterid beetles are influenced by varying degrees silvacultural management practices, and that they will likely follow similar patterns in species richness and assemblage shifts as the other two groups.

Study Area

This project was in conjunction with the Hardwood Ecosystem Experiment (HEE) that is currently occurring in Morgan-Monroe and Yellowwood State Forests[(5)]. The HEE consists of 9 1km wide study units randomly spread across the property[(5)]. There were three treatments, each

replicated three times[5]. Even-aged treatments were either clearcut or shelterwood, Uneven-aged treatments were left with small openings after a certain percentage of timber had been removed, and the control treatments received no management regimes[5].

Materials and Methods

Sampling was done in the form of multiple trap arrays. Four trap arrays were placed at random locations in each unit, resulting in 36 trap arrays.

3 Treatments x 3 Replicates x 4 arrays/unit = 36 trap arrays

Each trap array contained four traps, one each of the following: Lindgren funnel trap (12 funnel model; Pherotech, Delta, Canada), panel trap (Alpha Scents, Portland, OR), intersecting pane window trap, and linear purple sticky trap[2]. Traps were checked every three weeks and the collected specimens were labeled with unit ID number and the date and taken back to the lab. Due to the timing of this project, samples analyzed came from the 2010 collecting season, two years after initial harvest treatments.

Specimens of Elaterids were pulled from 12 units, four trap arrays from each of the three treatments. Specimens were then pinned, labeled and identified, with all data being entered into an excel spreadsheet.

Data analysis was performed using a variety of statistical tests. We performed a One-Way Analysis of Variance (ANOVA) on the species richness data to determine if there was significant variation within the species richness data collected from the three treatments. We also performed an Analysis of Similarities (ANOSIM) using Bray-Curtis dissimilarity measures between communities at different sites to test for differences in the communities of Elateridae at sites of different treatments. To visualize this, we performed a Non-Metric Multidimensional Scaling (NMDS) Plot based on the ANOSIM results. Based on the results of this analysis, we then performed a Similarity Percentages Analysis (SIMPER) to interpret the contribution of particular species to the differences in assemblages. When analyzing the results of the SIMPER analysis, we focused on only those treatments showing significant or near significant shifts shown in the ANOSIM/NMDS. Any species that had a contribution percentage of 5% or higher was considered to be a significant (driving) species in the assemblage and therefore a likely a significant player in the response seen to a particular treatment.

Results

We discovered 117 specimens of 30 different species of beetles in all 12 units. Total species richness was highest in the even-aged treatment (25), followed by the control treatment (22), then the uneven-aged treatment. (16). There was not a significant variance ($p=0.52$) in the species richness between the three forest management regimes, even though species richness and

individual species counts were higher in both the control and even-aged forests. The ANOSIM showed similar statistically insignificant results, though there was a potential that an assemblage shift could be occurring between the control and even-aged treatment ($p=0.065$). The NMDS plat echoed this discovery. Because of this, we performed the SIMPER analysis and discovered that between the control and even-aged groups, there were seven species of Elaterids deemed significant (CP> 5%), mostly in the genera *Melanotus* and *Hemicrepidius*. These are both mainly soil developing species that feed on roots[3].

Discussion

While no significant finds occurred, there is still a possibility that forest management practices affect the assemblages of Elaterid beetles. We were working with a rather small sample size of both units and specimens, due to the labor required to identify many of the species in this family. Because of this, we opened our data up to a much higher potential of phenomena occurring by chance, as seen by the high p-values and large error bars on the species richness ANOVA. With that said, it is also very possible that there is little to no significant variation in species richness between the three treatment types due to the fact that the family Elateridae has a diverse assemblage of species with a variety of life histories and therefore may not be as easily affected by such habitat manipulation[4].

Our ANOSIM results, though not technically significant, showed that there is a divergence developing between the control (solid woodland) treatment and the even-aged (clearcut) treatment. Again of note, the sample size was small, which is does have an effect on the statistics, especially nonparametric statistics. However, it is worth noting that there is a decent possibility that there truly is an assemblage shift occurring between these two treatments and should therefore be further researched.

Of note, these results are leading in an opposite direction that what has been observed in Cerambycids an Buprestids. While it is the uneven-aged treatment showing the greatest divergence in those two taxa, it is the even-aged treatment showing the greatest divergence in the Elaterids. The reason for this likely lies within the species composition and biology of these groups. The Buprestids and Cerambycids are, as mentioned previously, almost completely xylophagous and saproxylic and therefore are tied much more closely to hardwoods[2]. Elaterids as a whole do not rely primarily on hardwood to develop and also consist of a large number of soil-developing species, include species in the two genera that showed up as the most influential species on the SIMPER, *Melanotus* and *Hemicrepidius*[3]. These two genera are also common pests of roots of field crops and turfgrass[1].

Because of this we can hypothesize that the assemblage shifts between the control and the even-aged treatment are driven by soil developing, root feeding elaterid species that are moving into the clearcut area as a result of the forest cover being removed and secondary succession beginning.

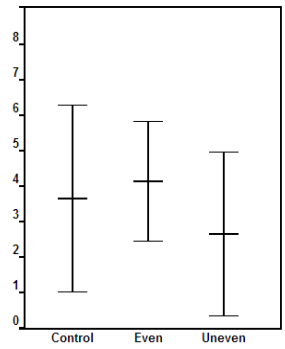
Future Directions

Because there is some promise that there is actually a dynamic between Elaterids and forest management regimes, it would be of interest to further pursue this project to obtain a better understanding of exactly what is taking place. Primarily more samples over a range of dates would strengthen the study from a statistical standpoint and potentially open new doors of other interactions. Monitoring the assemblage shifts of Elaterids, especially with respect to the even-aged treatment would allow us to track any future assemblage changes as succession occurs.

Figures

Site	Treatment	Richness	Specimens	Richness Average	Richness Std. Deviation
1205	control	7	18	3.666666667	2.658320272
1215	control	5	11		
1401	control	1	1		
1415	control	2	4		
1506	control	6	10		
1517	control	1	1		
1312	even	3	8	4.166666667	1.722401424
1326	even	4	7		
1622	even	4	5		
1624	even	7	16		
1917	even	5	8		
1919	even	2	2		
1105	uneven	0	0	2.666666667	2.338090389
1121	uneven	4	8		
1705	uneven	3	3		
1714	uneven	6	12		
1809	uneven	0	0		
1821	uneven	3	3		
Totals:		63	117		

Fig.1 – Table of data showing treatment type and richness



source	df	SS	MS	F	P-value
treatments	2	7.000	3.500	0.6774	0.5228
error	15	77.500	5.167		
total	17	84.500			

Fig.2 – Bar graph and table showing ANOVA results of test performed on species richness data

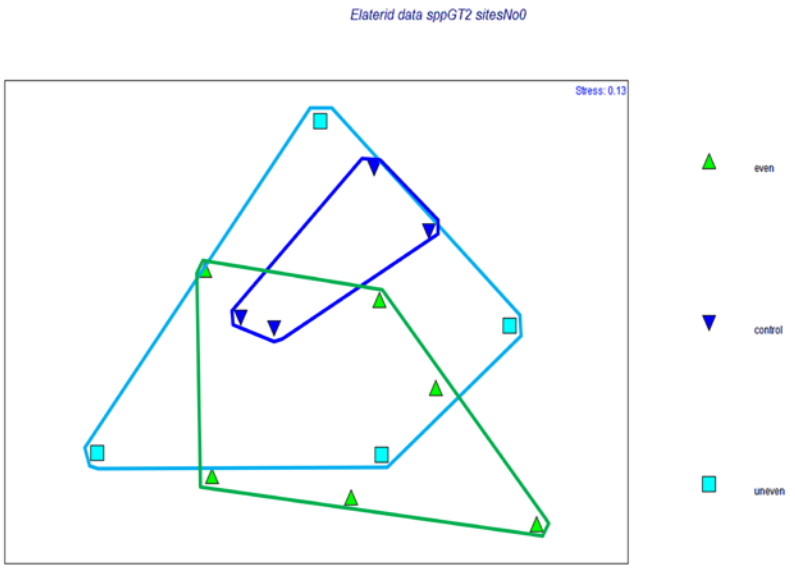


Fig.3 – NMDS plot showing divergence of the even-age treatment and control.

Groups Control & Even-aged

Average dissimilarity = 90.84

	Group Control	Group Even-aged				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Melanotus Sp. #4	1.83	0.67	9.54	1.04	10.50	10.50
Hemicrepidius memnonius	0.00	1.33	8.97	0.88	9.88	20.38
Melanotus Sp. #3	1.00	1.00	7.75	0.73	8.53	28.91
Hemicrepidius brevicollis	0.00	0.50	7.20	0.78	7.93	36.84
Melanotus similis	0.83	0.33	5.95	0.85	6.55	43.39
Athous cuculatus	0.17	0.67	5.19	0.70	5.71	49.10
Limonius quercinus	1.33	0.00	4.71	0.68	5.19	54.29
Unknown Sp. #4	0.50	0.00	4.18	0.66	4.60	58.89
Melanotus pertinax	0.00	1.33	3.42	0.43	3.77	62.65
Hemirhipus fascularis	0.00	0.17	3.25	0.38	3.58	66.23
Lacon discoidea	0.33	0.17	3.19	0.60	3.51	69.74
Megapenthes limbalis	0.17	0.00	3.03	0.40	3.34	73.08
Unknown Sp. #1	0.17	0.00	3.03	0.40	3.34	76.42
Athous brightwelli	0.50	0.00	2.96	0.65	3.26	79.68
Parallelostethus antennuatus	0.00	0.33	2.36	0.42	2.60	82.27
Melanotus Sp. #2	0.00	0.17	2.07	0.41	2.28	84.56
Alous oculatus	0.00	0.17	2.00	0.41	2.21	86.76
Ctenicera sulcicollis	0.00	0.17	1.88	0.41	2.07	88.83
Melanotus Sp. #1	0.00	0.17	1.67	0.42	1.84	90.66

Fig.4 – SIMPER table of control & even-aged treatment showing top contributing species

Acknowledgements

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Works Cited

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