

INVERTEBRATE BIODIVERSITY IN NORTHERN HARDWOOD ECOSYSTEMS UNDER VARYING DISTURBANCE REGIMES

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Abstract

During 2003-2005 we are investigating the effects of forest type, forest stand characteristics, beech bark disease (BBD) and mechanical thinning on the biodiversity of ground-dwelling arthropods in northern hardwood stands in Michigan. This study is also examining the relationship between downed woody debris and invertebrate biodiversity within a forest stand. The goal of this research is to help explain the complex relationships and interactions between ground-dwelling arthropods, forest stand characteristics, and disturbances in Michigan's northern hardwood forests. Specific research questions being asked include: (1) What is the relationship between downed woody debris and ground-dwelling arthropod diversity?, (2) What is the relationship between forest type and ground-dwelling arthropod diversity? and (3) What is the effect of BBD and thinning on biodiversity of ground-dwelling arthropods? We are collecting ground-dwelling arthropods using unbaited pitfall traps in 48 northern hardwood stands in Michigan based on forest type, presence/ absence of mechanical thinning, and presence/ absence of BBD. Ground beetles (Coleoptera: Carabidae), camel crickets (Orthoptera: Gryllacrididae) and sowbugs (Crustacea: Isopoda) are identified to the species level and are the focal groups of this study. All other ground-dwelling arthropods are grouped and quantified by taxonomic group. A better understanding of the factors affecting diversity of ground-dwelling arthropods is important for management, conservation and the preservation of biological diversity.

Introduction and Literature Review

Biodiversity of ground-dwelling arthropods is influenced by both abiotic and biotic factors at multiple scales from global latitudinal patterns to local microhabitats within a forest stand. Generalizations can be made about patterns of species distributions and diversity on a continental scale, but each taxonomic group examined will have specialized requirements and slightly different factors influencing its persistence in the environment.

Disturbances, both natural and anthropogenic have been shown to influence arthropod distributions, and certain invertebrate groups have been used to study the impacts of these disturbances and to make recommendations for management of disturbed areas (Davis 2000; Werner and Raffa 2000; Lewis and Whitfield 1999; Rodriguez et al. 1998; Niemela et al. 1993; Pearson and Cassola 1992; Lenski 1982).

Invertebrates dominate many forest ecosystems in terms of species richness and biomass, and influence ecosystem processes such as predation, decomposition, nutrient cycling, and pollination (Werner and Raffa 2000; Price 1997). Many studies have used ground-dwelling arthropods as indicators because of the large sample sizes that can be obtained with relatively unbiased methods, short generation times, low dispersal ability which makes them susceptible to disturbance, and sensitivity to microsite changes (McGeoch 1998; Kremen 1994; Kremen et al. 1993).

Downed woody debris (DWD) serves as an important habitat component for many invertebrate and vertebrate groups (Hunter 1990). Structural diversity provided by DWD has been shown to increase biological diversity in forested stands (McGee et al. 1999). Several studies have been conducted to quantify the amount of DWD present in forest ecosystems (Muller 2003; Hagan and Grove 1999; Goodburn and Lorimer 1998; Guby and Dobbertin 1996). Although the importance of the downed wood resource to plants and animals in these ecosystems is assumed, most studies do not directly examine the relationship between DWD and organism use. Managing for DWD has become recognized as necessary for maintenance of biodiversity; management activities such as thinning can heavily impact amounts of DWD in a forest stand (Hagan and Grove 1999).

Methods

This study examines the factors influencing diversity of ground-dwelling arthropods and is investigating invertebrate biodiversity under varying disturbance regimes in northern hardwood stands in Michigan. Forty-eight northern hardwood stands are used in this study; 24 stands are located in the northern Lower Peninsula (LP) and 24 stands are located in the eastern Upper Peninsula (UP) (Figure 1). Dominant overstory tree species include American beech (*Fagus grandifolia*

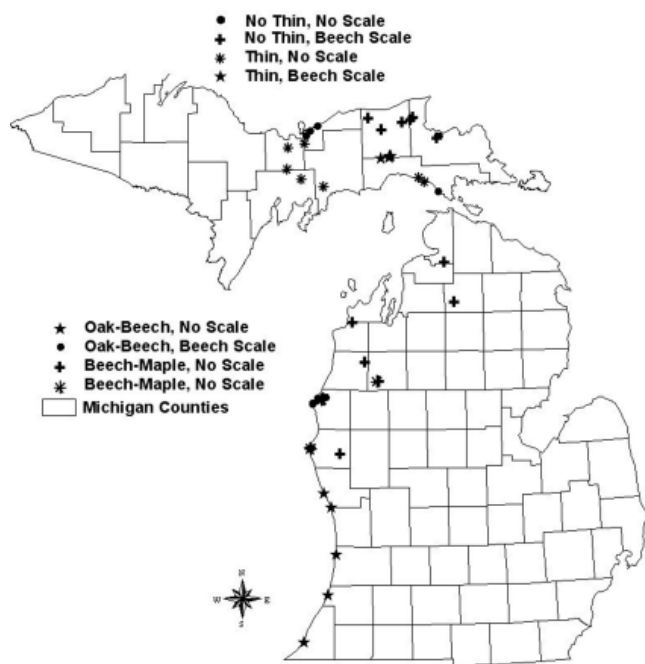


Figure 1.—Location of research stands in the biodiversity study in Michigan.

Ehrh.), sugar maple (*Acer saccharum* Marsh.), northern red oak (*Quercus rubra* L.) and red maple (*Acer rubrum* L.). Treatment types in this study involve a combination of two factors: (1) presence or absence of exotic beech scale and (2) forest type (maple-beech, oak-beech) (LP) or silvicultural treatment (two levels: no silvicultural treatment, selection cut (5 years prior to data collection) (UP)).

Ten unbaited pitfall traps are placed 40 m apart along transects within each stand. Traps are opened for 3 days each month during mid-June, mid-July and mid-August. Collected organisms are counted and grouped by major taxa. The ground beetles (Coleoptera: Carabidae), camel crickets (Orthoptera: Gryllacrididae) and sowbugs (Crustacea: Isopoda) are further identified to the species level. Spiders (Araneae), millipedes (Diplopoda), centipedes (Chilopoda) and land snails and slugs (Gastropoda) are identified to the family level.

For the downed wood study, piles of wood found naturally in a stand are used. Piles are chosen based on four classes of DWD that vary by volume and decay class (Table 1). Pitfall traps are placed as close to the center of the DWD as possible and trap catches are compared among the different classes of DWD. Five replicates of each of the classes are chosen within each stand and eight

Table 1.—Downed woody debris (DWD) sampling classes

DWD class	Quantity/ Quality of DWD
0	Very low volume of DWD (small branches and twigs)
1	One large tree (> 20 cm DBH, >3 m long) in early decay stages
2	One large tree (> 20 cm DBH, > 3 m long) with advanced decay
3	Two large trees (> 20 cm DBH, > 3 m long) in early decay stages
4	Two large trees (> 20 cm DBH, > 3 m long) with advanced decay

stands in the UP were selected for this part of the study. Four of the stands have heavy BBD where mortality of overstory beech has already occurred and four stands are not infested with BBD. Pitfall trap catches will be compared between the different DWD classes to determine if different invertebrate groups and/or species are utilizing different volumes and decay classes of downed wood.

Preliminary Results and Discussion

Significantly more individual arthropods were caught in pitfall traps in August compared to June and July (Figure 2). No significant differences were found between the number of arthropods in plots with and without beech scale. In the Lower Peninsula oak-beech stands without

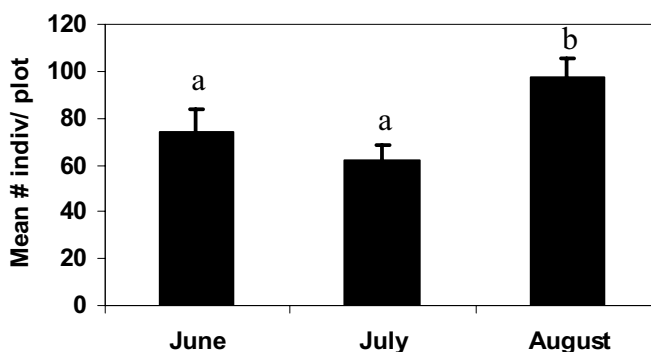


Figure 2.—Mean number of individual arthropods per plot in June, July and August 2003 in Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different among months.

beech scale present had significantly more arthropods compared to oak-beech stands with beech scale and maple-beech stands with and without beech scale (Figure 3). In the Upper Peninsula no significant differences were found between the number of arthropods in thinned or unthinned stands with and without beech scale.

Significantly more carabid beetles were caught in pitfall traps in August compared to June and July (Figure 4). No significant differences were found between the number of carabid beetles in plots with and without scale. In the Lower Peninsula no significant differences were found between numbers of carabid beetles in oak-beech or maple-beech stands with or without beech scale. In the Upper Peninsula significantly more carabid beetles were found in unthinned stands compared to thinned stands (Figure 5).

Conclusion

This research is continuing through 2006. Preliminary results show no effect of BBD or mechanical thinning on number of arthropods caught in pitfall traps. Once individuals are identified to species, we will determine if species shifts occur as a result of habitat changes due to BBD or thinning. Research during summer 2005 will focus on ground beetles, camel crickets and sowbugs at the species level and the relationship between arthropods and downed woody debris.

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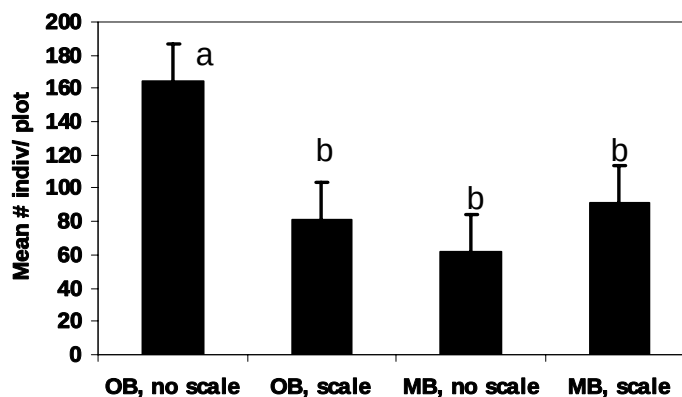


Figure 3.—Mean number of individual arthropods per plot in oak-beech (OB) and maple-beech (MB) stands with and without beech scale present in Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different within each scale rating and forest type.

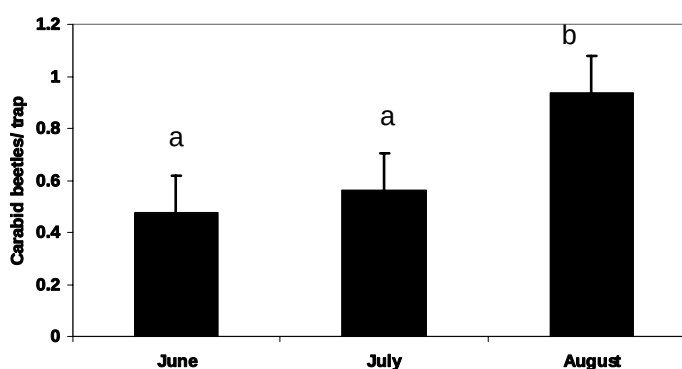


Figure 4.—Mean number of carabid beetles (Coleoptera: Carabidae) per plot in June, July and August 2003 in Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different among months.

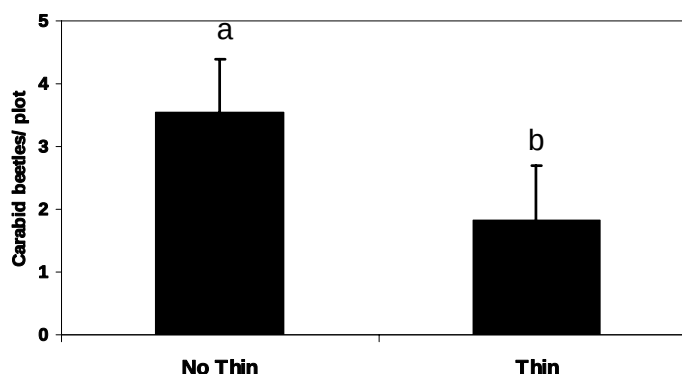


Figure 5.—Mean number of carabid beetles (Coleoptera: Carabidae) per plot in June, July and August 2003 in Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different by treatment.

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Contains invited papers, short contributions, abstracts, and working group summaries from the Beech Bark Disease Symposium in Saranac Lake, NY, June 16-18, 2004.

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