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Ambrosia beetle (Coleoptera: Curculionidae: Scolytinae) responses to ice storm damage in mesic, mixed deciduous forests in southeast Ohio, United States

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Ambrosia Beetle (Coleoptera: Curculionidae: Scolytinae) Activity and Species Composition After an Ice Storm Event in Mesic, Mixed Deciduous Forests in Southeast Ohio, United States

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Abstract

In the eastern United States abiotic forest disturbances are common and cause extensive tree damage. Freshly broken trees and tree branches attract bark and ambrosia beetles (Coleoptera: Curculionidae: Scolytinae and Platypodinae) that utilize inner bark and xylem of damaged branches and trees to fill requisite habitat needs. An ice storm in February 2003 on the Wayne National Forest presented an opportunity to study the local ambrosia beetle species composition and population level responses to this storm event. Ethanol baited Lindgren traps were deployed from 2003–2006 starting in the summer after the storm. Eight native and introduced Scolytine ambrosia beetle species were trapped in large numbers (>500 total) with a large ephemeral increase in the second summer post storm. In addition, another 36 species of Scolytinae bark beetles were trapped in low numbers throughout the four trapping periods.

Key Words: abiotic disturbance, downed wood material, resource pulse, flight response

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Forest damage due to abiotic weather events, including hurricanes, tornadoes, ice storms, straight-line winds, and hail is common in the eastern United States. Ice storms cause ice to build up on trees and thick deposits of ice can cause extensive tree breakage. The amount of tree damage due to ice buildup is influenced by intrinsic tree characteristics, including species, age, crown shape, crown position, wood tensile strength, and tree density (Croxton 1939, Smith and Shortle 2003, Brommit et al. 2004). Large amounts of physical damage to trees can weaken them through reductions in crown size, attract ambrosia beetles and wood borer insects, and create wounds that may allow fungal pathogens routes to infect trees.

A widespread ice storm occurred on 15–17 February 2003, in areas of Ohio, West Virginia, Kentucky, and Virginia (Hazel and Turcotte 2003, Turcotte et al. 2012). This storm included rain, snow, and ice with 30–60 cm of snow and additional ice accumulation in southeastern Ohio and central West Virginia. The Ironton Ranger District of the Wayne National Forest in southeast Ohio was heavily impacted and selected for a study of ambrosia beetle response to this event.

The beetle sub-family Scolytinae includes several feeding guilds known as bark, twig, and ambrosia beetles (Coleoptera: Curculionidae: Scolytinae and Platypodinae). Species in this sub-family typically attack and utilize trees that are extremely stressed or recently dead (Smith and Hulcr 2015), but many species have the potential to cause damage in healthy trees due to associations with pathogenic fungi and changes in abiotic, such as rainfall and temperature, and biotic conditions, such as host age and vigor (Wood 1982, Breshears et al. 2005, Raffa et al. 2008).

Ambrosia beetles typically form a symbiotic relationship with less virulent fungi that they utilize as a food source (Batra 1666, 1967; Beaver 1989; Six 2003). The spores of these fungal food sources are transported to the new host tree in a specialized anatomical structure on the beetle exoskeleton called the mycangium (Francke-Grosmann 1956, 1963, 1967; Batra 1963) which support preferential growth of primary ambrosia fungi, fungi on which the adults and larvae feed, over non-ambrosial fungi (Batra 1966). Fungi introduced through ambrosia beetle vectors are usually not pathogenic to host trees; however, there is a recent exception. The redbay ambrosia beetle (*Xyleborus glabratus* Eichhoff), is an invasive, exotic insect first introduced to North America in Georgia in 2002 (Rabaglia et al. 2006). Soon after its introduction, it was found to vector a fungus that is extremely pathogenic to redbay trees and other Lauracea species (Fraedrich et al. 2008).

Another ambrosia beetle pest, *Xyleborinus saxesenii* (Ratzeburg), was among the first non-native scolytines introduced into North America >100 yr. ago probably from Europe. This species is now found from coast to coast in North America. It is one of the most damaging and occasionally aggressive species in the Xyleborini tribe of ambrosia beetles in North America (Rabaglia et al. 2006). The species, however, is only reported as aggressively attacking in large numbers when tree hosts are in poor health (Rabaglia et al. 2006). Specifically, *X. saxesenii* damage has been reported in stressed peach trees, *Prunus persica* (Kovach and Gorsuch 1985), dying pondspice, *Litsia aestivalis* (Fraedrich et al. 2011), and avocado trees, *Persea americana*, affected by laurel wilt (Carrillo et al. 2012).

With large quantities of tree and branch breakage, the 2003 ice storm provided a study site and an opportunity to characterize the ambrosia beetle community species diversity in southeast Ohio. Our goal was to describe the ambrosia beetles present in this area and describe the impact of a pulse of ice-storm caused tree damage on the population dynamics of the ambrosia beetles found in baited traps.

Materials and Methods

During the growing season following the 2003 ice storm and from mid-Spring to early Fall the following three years (2004-2006), black plastic multiple funnel Lindgren funnel traps (Lindgren 1983) baited with ultra-high release ethanol lures (Synergy Semiochemicals Corp., Delta, BC, Canada) were deployed in 10 areas on the Ironton Ranger District of the Wayne National Forest that had tree damage caused by the ice storm. Six traps were placed in oak-dominated mixed hardwood stands, three were in conifer stands, and one was in a pine/hardwood stand. Traps were hung at a height of approximately 2 m above ground from 1.27 cm L-shaped galvanized steel conduit poles [Wheatland Electrical Metallic Tubing (EMT), UPC 8669202001 (Wheatland Tube Co. Sharon, Pennsylvania)] slid over 1.27 cm rebar stakes driven 25–30 cm into the ground (Seybold et al. 2012) in early April to late May (25 May 2003, 17 June 2004, 30 May 2005, and 10 May 2006) and collected every other week until mid-September to mid-November (13 Nov. 2003, 9 Nov. 2004, 12 Oct. 2005, and 14 Sep. 2006). Collection cups in the traps were filled with non-toxic antifreeze (Prestone Low Tox® antifreeze/coolant) to kill trapped insects. The collected insects were transferred to alcohol in labelled Whirlpak® plastic bags (Whirl-pak, Nasco Inc. Fort Atkinson, Wisconsin) and transported to the Carnegie Museum of Natural History (CMNH), Pittsburgh, PA. All Scolytinae were removed from each sample, sorted to morpho-species, and stored in ethanol within labeled glass vials. All Scolytines in each sample were identified to species and tallied by taxonomists on USDA, FS, Morgantown, WV, staff. Vouchers of each species were stored at CMNH.

Results

Throughout the entire four-year study period, a total of 51,996 individuals from 44 species of Scolytinae beetles were identified. Overwhelmingly, one species, *X. saxesenii*, accounted for most of the catch, 71% (36,925 individuals). Of all the *X. saxesenii* caught, 86% were caught in the second year of trapping (2004) (Fig. 1). Another seven species were represented by at least 500 individuals

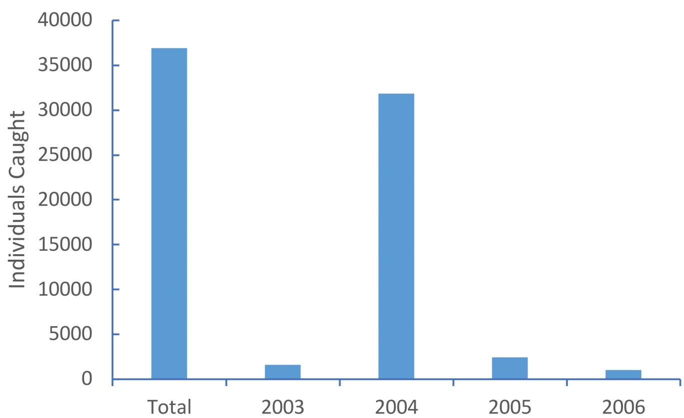

Figure 1. Total number of *Xyleborinus saxesenii* caught throughout the entire collection period for each of the collection years.

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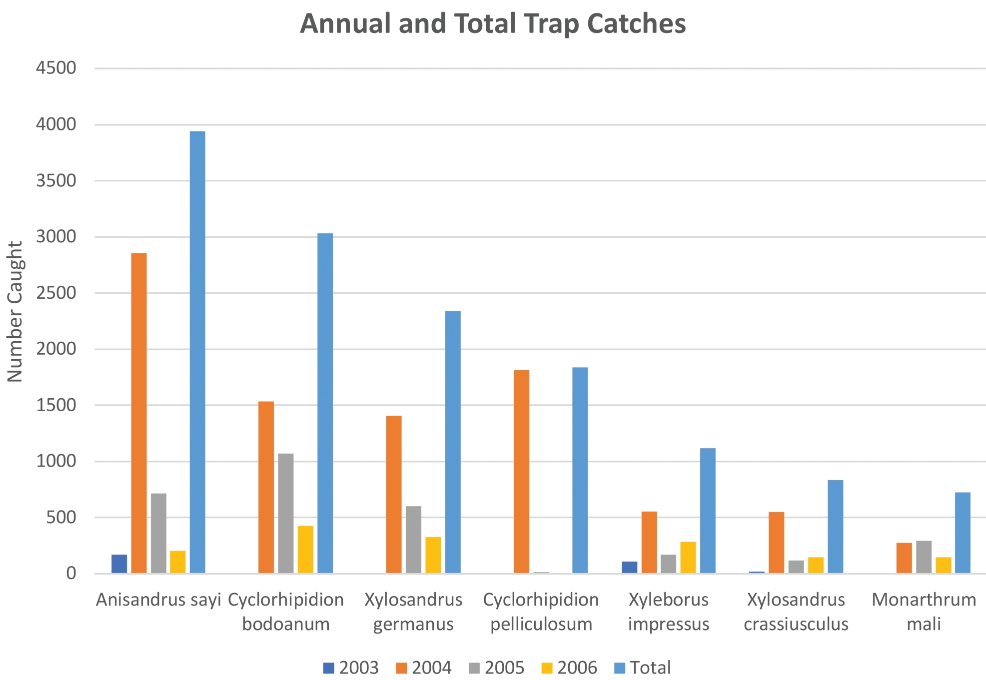

Figure 2. Trap catch totals for each of the seven additional ambrosia beetles for which at least 500 individuals were caught in one of the trapping years.

throughout the four years of trapping: *Anisandrus sayi* Hopkins, *Cyclorhipidion bodoanum (Reitter), Cyclorhipidion pelliculosum (Eichhoff), Xyleborus impressus* Eichhoff, *Xylosandrus crassiusculus* (Motschulsky), *Xylosandrus germanus* Blandford and *Monarthrum mali* (Fitch) (Fig. 2). All the eight most frequently collected species were ambrosia beetles (in the mycetophagous feeding group). These species made up 97.6% of the entire trap catch (50,755 of 51,996 individuals). Initially, all these experienced a large increase in trap catches during the second year of trapping (2004) when compared to the first year in which the ice storm occurred (2003). Subsequently, they all experienced a dramatic decrease in catches in years three and four which brought them back to pre-ice storm population densities. For all (44) species trapped, 75% of all individuals were caught in 2004, and of the eight most frequently caught ambrosia beetles, 81% were caught in 2004. Five of these eight ambrosia beetles are introduced species (*X. saxesenii, X. crassiusculus, X. germanus, C. bodoanum, C. pelliculosum*). The additional 36 species captured were all in the subfamily Scolytinae with mostly ambrosia beetles and some bark beetles (Table 1).

Discussion

Reasons for the differences in total number of individuals among species, and the large majority of specimens being *X. saxesenii*, should be interpreted with caution and likely need more study. *Xyleborinus saxesenii* is highly attracted to ethanol-based baits and often accumulates in ethanol-baited traps in numbers greater than other ambrosia beetles (Steininger et al. 2015). This high attractiveness of *X. saxesenii* to ethanol-based lures and the lack of knowledge on relative differences in attractiveness by the different genera and species to the ultra-high release ethanol lure used in this study precludes our making a judgement about the true population size differences among the seven commonly caught ambrosia beetles in this study. It is clear, however, that in the second growing season post ice storm populations of seven ambrosia beetles greatly increased.

These population increases are not surprising and are likely due to large increase in suitable habitat, with broken branches and tree damage creating ideal habitat. Fresh broken branches have the required moisture content (important for the growth of ambrosial gardens) and emit volatile chemicals that are highly attractive to ambrosia beetles

Table 1. Other species within family Curculionidae, subfamily, Scolytinae that were caught in small numbers from 2003 through 2006 within the ice storm study area, Wayne National Forest, Ohio.

<10 Caught	10–250 Caught
Hylastinus obscurus (Marsham, 1803)	*Gnathotrichus materiarius* (Fitch, 1858)
Pityogenes hopkinsi Swain 1915	*Ambrosiodmus obliquus* (LeConte, 1878)
Pseudothysanoes lecontei Blackman	*Ambrosiodmus tachygraphus* (Zimmermann, 1868)
Ambrosiodmus rubricollis (Eichhoff, 1875)	*Xyleborus atratus* Eichhoff, 1875
Corthylus punctatissimus (Zimmermann, 1868)	*Hylastes tenuis* Eichhoff, 1868
Lymantor decipiens (LeConte, 1878)	*Cnesinus strigicollis* LeConte, 1868
Pseudopityophthorus pruinosus (Eichhoff)	*Euwallacea validus* (Eichhoff, 1875)
Xyleborus intrusus Blandford, 1898	*Xyleborus ferrugineus* (Fabricius, 1801)
Hylesinus pruinosus Eichhoff	*Xyleborus xylographus* (Say, 1826)
Ips pini (Say)	*Dryoxylon onoharaensum* (Murayama 1933)
Phloeotribus liminaris (Harris 1852)	*Chramesus hicoriae* LeConte, 1868
Xyleborus viduus (Eichhoff)	*Monarthrum fasciatum* (Say, 1826)
Pityophthorus species	*Hypothenemus spp.*
Xyleborus affinis Eichhoff (1868)	
Corthylus columbianus Hopkins 1894	
Hylastes porculus Erichson, 1836	
Ips grandicollis (Eichhoff)	
Orthotomicus caelatus (Eichhoff, 1868)	
Scolytus multistriatus (Marsham)	
Xyleborus celsus Eichhoff, 1868	
Dryocoetes granicollis LeConte, 1876	
Pseudopityophthorus species	
Xyloterinus politus (Say, 1826)	

(Hulcr and Skelton 2023). In addition, many species will attack and utilize cut wood and are known pests in log decks (Lindgren et al. 1982). As broken branches age, however, they dry and are eventually no longer suitable for growth of ambrosial gardens. These factors likely explain the pattern of increase and then decrease in beetle populations as the amount of available habitat created by this storm acted as a defined single pulse. As this pulse of wood moved through the natural wood decay process, it decomposed to no longer create suitable habitat to sustain the higher populations.

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