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Season of Fine Woody Debris Death Affects Colonization of Saproxylic Coleoptera

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Abstract

A study was conducted to explore the effect of season on colonization of dead twigs by beetles in a Louisiana secondary forest. Previous research showed that twigs cut during spring yielded many specimens and species. The present companion study utilized twigs averaging 14 mm in diameter cut from one tree of *Quercus falcata* Michaux (southern red oak) during fall (October) 2008, placed in bundles of 10 each, and left in the forest at three sites. Half the bundles were retrieved during winter (January, four months later) and the other half were retrieved during summer (July, nine months later). Coleoptera were collected from bundles using emergence chambers. Only 39 specimens of adult Coleoptera were collected, representing 12 families, 20 genera, and 21 species. Beetle colonization of oak twigs in Louisiana appears to be affected by the interaction of season and twig "quality" (apparently freshness) with the highest colonization taking place in fresh, dead twigs during spring and an order of magnitude lower colonization in 1) fresh twigs during fall or 2) stale twigs during spring and summer.

Key Words: ecology, beetles, southern red oak, twigs, emergence, phenology

Previous research conducted by the authors and others (Ferro *et al.* 2009) indicated that study of beetles inhabiting fine wood debris (twigs) was a fruitful research topic. In that research, literature on Coleoptera associated with twigs was reviewed, and emergence chambers were used to conduct a survey of beetles associated with fresh cut southern red oak twigs. Subsequent work on Coleoptera associated with twigs includes a review of arthropod vertical stratification (Ulyshen 2011), Coleoptera associated with ash (*Fraxinus* spp.; Oleaceae) twigs (Ulyshen *et al.* 2012), comparison of emergence chambers with other techniques to collect Cerambycidae from fine woody debris (Touroult *et al.* 2010), and effect of diameter of woody debris on assemblages of saproxylic beetles (Brin *et al.* 2011). However, effect of season of twig death on saproxylic beetle colonization of twigs has yet to be studied.

Ferro *et al.* (2009) cut twigs during spring (March), allowed the twigs to be available for colonization (including oviposition) through the summer and fall, placed them into emergence chambers during winter (January), and allowed beetles to emerge until summer (July) (Fig. 1). The current study was designed to complement Ferro *et al.* (2009) and clarify how season of twig death affected beetle colonization. Twigs were cut during fall (October) and two time-trial experiments were performed 1) to document beetle colonization of twigs during fall to winter and 2) to document

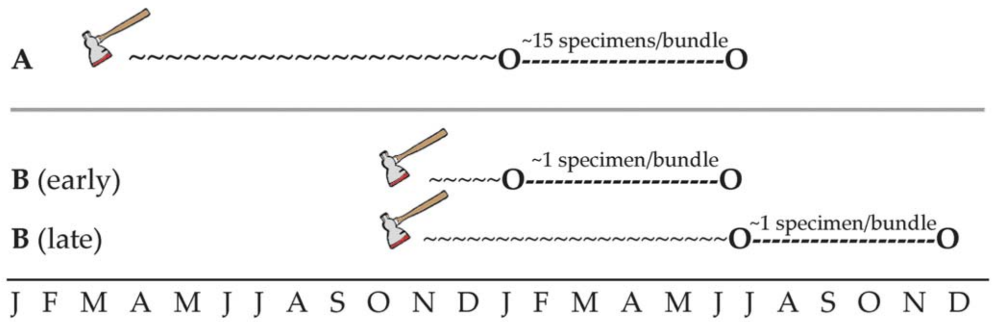

Fig. 1. General timeline: tree death (ax), inoculation time (~~~), and emergence time (O---O) for A: Ferro *et al.* (2009), conducted 2006–2007; and B: this research, conducted 2007–2008.

beetle colonization of twigs during fall to the following summer.

Material and Methods

The study was a replication of Ferro *et al.* (2009) with changes to: 1) number of twig bundles; 2) date of tree cut; and 3) date of placement of twig bundles in emergence chambers. A brief description follows, but see Ferro *et al.* (2009) for more details. The study took place in Feliciana Preserve, West Feliciana Parish, Louisiana (N 30.795°, W 91.254°). A single, healthy, ~30-year-old southern red oak tree, *Quercus falcata* Michaux (Fagaceae), was felled 2 October 2007. A total of 360 twigs, averaging 36 cm (±1 cm) in length and 14 mm (±5 mm) in diameter, were removed from the tree and tied into 36 bundles of 10 twigs each. At each of the three previously used study sites, four twig bundles were placed directly on the ground, four bundles were propped against the trunk of a living tree, and four bundles were hung horizontally approximately 1.5 m above the ground (referred to as ground, propped, and aboveground, respectively).

On 28 January 2008, approximately four months after tree cut, two each of ground, propped, and aboveground bundles from each site, designated "early" bundles (18 total), were placed into emergence chambers until 3 July 2008 (ca. six months later) when emergent specimens were collected (Fig. 1). All other bundles, designated "late" bundles (18 total), were placed into emergence chambers on 3 July 2008 until 6 December 2008 (ca. six months later) when emergent specimens were collected. After collection of emergent specimens, all twig bundles were sealed in a single large emergence chamber for approximately one year to collect any additional emergent specimens.

Adult Coleoptera were pinned or pointed as needed and labeled. Identification to the finest level possible (typically species) was performed with the appropriate taxonomic literature and/or comparison with authoritatively identified reference specimens. Specimens were deposited in the Louisiana State Arthropod Museum, LSU AgCenter, Baton Rouge, Louisiana.

Results

Thirty-nine adult Coleoptera specimens were collected, representing 12 families, 20 genera, and 21 species (Table 1). Nineteen specimens were collected from early bundles, and 20 specimens were collected from late bundles (Table 2). No additional specimens emerged from the aggregated bundles after December 2008. Eight species were collected only from early bundles, 12 species were collected only from late bundles, and one species was collected from both. Eleven specimens and six species were collected from all ground bundles, 17 specimens and eight species from all propped bundles, and 11 specimens and 10 species from all aboveground bundles. Twenty of the 36 twig bundles yielded no specimens. Due to the low number of specimens collected, no statistical analysis was conducted to test for differences among sites, positions, or dates.

Discussion

Small studies and exploratory research conducted with limited resources are rarely ideal. One important factor that was not controlled for in this study was year-effect—Ferro *et al.* (2009) (conducted during 2006–2007) was not concurrent with this study (2007–2008). No literature could be found concerning year-effect on colonization of woody debris by Coleoptera and it appears to be an unexplored topic in need of future research. Certainly factors specific to the years these studies were conducted affected the results. However, based on the large differences seen (absence of

Table 1. Coleoptera emergent from oak twig bundles in Louisiana. Taxa are grouped according to period and treatment position. * = species also collected by Ferro *et al.* (2009).

Family	Species	# individuals emerged: Ground	Propped	Aboveground	Total, Period
Buprestidae	*Mastogenius crenulatus* Knull	4			4, early
Curculionidae	*Pseudopityophthorus asperulus* Blackman*	1			1, early
Melandryidae	*Microtonus sericans* LeConte*	1			1, early
Ptinidae	*Petalium debile* Fall*	1	4		5, early
Carabidae	*Philorhizus atriceps* (LeConte)		2		2, early
Staphylinidae	*Euvira* sp.		1		1, early
Staphylinidae	Homalotini gen. sp.		1		1, early
Curculionidae	*Hypothenemus californicus* Hopkins*	3	3	1	3, early; 4, late
Latridiidae	*Corticaria* sp.*			1	1, early
Staphylinidae	*Euconnus* sp.	1			1, late
Corylophidae	*Clypastraea specularis* (Casey)		4		4, late
Endomychidae	*Micropsephodes lundgreni* Leschen and Carlton		1		1, late
Staphylinidae	*Eumicrota* sp.		1		1, late
Curculionidae	*Acalles minutissimus* (LeConte)			2	2, late
Curculionidae	*Cophes fallax* (LeConte)			1	1, late
Curculionidae	*Cophes oblongus* (LeConte)			1	1, late
Curculionidae	*Pseudothysanoes dislocatus* (Blackman)*			1	1, late
Ciidae	*Octotemnus laevis* Casey			1	1, late
Ciidae	*Orthocis longulus* Dury			1	1, late
Cleridae	*Cymatodera inornata* Say			1	1, late
Tenebrionidae	*Lobopoda punctulata* (Melsheimer)			1	1, late

many species, reduction of specimens), cautious statements can be made. As with all of science, these findings and conclusions will be added to and modified by future studies.

The extremely low number of specimens collected was in stark contrast with the findings of Ferro *et al.* (2009). Twigs that died during fall and were collected the following winter (early) or summer (late) yielded an order of magnitude fewer specimens than twigs that died during spring (Fig. 1). Despite the low number of specimens, 15 species collected during this research were not found by Ferro *et al.* (2009), bringing the total number of Coleoptera species associated with oak twigs in Louisiana to 50.

Early Bundles. The early bundle experiment is a replication of Ferro *et al.* (2009) except that twigs were cut during fall, rather than spring (Fig. 1). The difference in the findings indicates that colonization of fresh cut twigs by the cohort described in Ferro *et al.* (2009) takes place after March but before October, and that twigs that die during fall are colonized by very few beetles before spring. Of the nine species collected from early bundles, five were previously reported from oak twigs by Ferro *et al.* (2009), but four species were only collected from early bundles (Table 1).

Late Bundles. The late bundle experiment documents spring and early summer colonization of twigs that died during the previous fall. With one exception (*Hypothenemus californicus* Hopkins), no species collected from early bundles was collected also from late bundles. The seasonal division may be because individuals of species collected only from early bundles (and therefore early colonists) emerged in spring or early summer before late bundles were place into emergence chambers. Of the 13 species collected from late bundles, two were previously reported from oak

Table 2. Number of specimens and species (in parentheses) collected from twig bundles at three sites during two emergence periods.

Emergence	January - July (early)			July - December (late)			
Site #	1	2	3	1	2	3	Total
Ground	1 (1)	-	7 (4)	3 (2)	-	-	11 (6)
Propped	5 (3)	2 (2)	3 (2)	6 (2)	-	2 (2)	18 (9)
Aboveground	-	-	1 (1)	3 (3)	5 (4)	1 (1)	10 (9)
Total				18 (9)	7 (6)	14 (9)	

twigs by Ferro *et al.* (2009), but 10 species were only collected from late bundles (Table 1).

Season and Twig Quality. Beetle colonization of oak twigs in Louisiana appears to be affected by the interaction of season and twig "quality" (apparently freshness). Highest beetle colonization measured by number of individuals and species occurred in fresh twigs during spring (414 specimens, 35 species from 27 bundles; see Ferro *et al.* 2009), while poor beetle colonization occurred in fresh twigs during fall (19 specimens, nine species from 18 bundles, this study) and stale twigs during spring (20 specimens, 13 species from 18 bundles, this study).

The effect of season on beetle colonization of twigs is almost certainly a reflection of which species are present as breeding adults at the time. These findings indicate that during fall few twig-inhabiting Coleoptera are present as adults or, if present, willing to oviposit. However, it is unknown what percentage of adult beetles collected during this study had actually emerged from the twigs and which were initially placed in the emergence chambers as adults transient on the twig bundles. An understanding of when a given species is available for twig colonization could be gained by reviewing adult specimen capture dates in museum collections.

Attributes of twigs that affect "quality" as determined by twig-inhabiting Coleoptera are difficult to determine. Twig "quality" may be relevant with regard to the twig as a substrate (amount or availability of nutrients, nitrogen, sugars, etc.), the ability of adults to recognize the twig as an appropriate resource (presence or absence of volatiles), moisture content of the twig, presence or absence of fungal growth, other attributes, or a combination thereof.

Conclusions

If a twig dies in the woods during the fall, do the beetles hear it? No.

Implications for Future Research. Explorations into the ecological unknown are fraught with uncertainty. The trend in ecological research, and often a requirement from granting agencies, is the development of statistically rigorous *a priori* hypotheses prior to the start of a study. While absolutely appropriate for systems that are relatively well known, the current study stands as a stark reminder that even seemingly mundane ecological research (beetles in twigs) requires an initial period of (often) qualitative natural history observation before hypothesis testing can even be imagined, much less developed in detail.

Based on the findings of this research, Ferro *et al.* (2009) were lucky to have chosen the seasonal protocol they did. Had they started their research during fall and received results similar to these, it is unlikely the topic would have received further scrutiny. During this research, more than half (20 out of 36) of the twig bundles yielded no specimens. The dismal specimen results serve as a cautionary example for future researchers interested in obtaining statistically relevant data on this topic. Researchers who plan to study suboptimal twig colonization circumstances ("off-season" death, twigs dead more than one year, etc.) should 1) budget for many more twigs and 2) have a portion of the study that includes optimal colonization time to ensure some "positive" results.

Conservation and Management of Saproxylic Organisms. While fine woody debris is generally not associated with species of conservation concern, several relict species of flightless weevils (Curculionidae: Cryptorhynchinae and Molytinae), restricted to ancient European woodlands, are dependent on "small to medium sized twigs" (Buse 2011). Programs designed to create (active cutting) or anticipate (retention of logging residues) the creation of substrate for saproxylic species (of concern or otherwise) should take season into account to maximize returns.

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