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Source: Florida Entomologist, 97(2) : 821-823

Published By: Florida Entomological Society

URL: <https://doi.org/10.1653/024.097.0269>

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NEAR ABSENCE OF *AGRILUS BILINEATUS* FROM AN OAK DECLINE EVENT IN THE OZARK MOUNTAINS OF ARKANSASVANESSA L. MUILENBURG^{1,2*}, LAUREL J. HAAVIK^{1,3}, AND FRED M. STEPHEN¹¹Department of Entomology, University of Arkansas, 319 Agriculture, Fayetteville, AR, 72701, USA²Present address: Department of Biology, Hope College, 35 E 12 St, Holland, MI, 49422, USA³Present address: Great Lakes Forestry Centre, 1219 Queen Street East, Sault Ste. Marie, ON, P6A 2E5, Canada

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From 1999 through 2003, an oak (*Quercus* spp.) decline event affected over one million acres (404,685 ha) of trees within the Ozark Mountains of Arkansas and Missouri (Starkey et al. 2000). Red oak borer, *Enaphalodes rufulus* (Haldeman) (Coleoptera: Cerambycidae), was identified as a secondary mortality agent in this event (Stephen et al. 2001). However, it was unknown if the insect frequently associated with oak decline in Eastern North America, twolined chestnut borer, *Agrilus bilineatus* (Weber) (Coleoptera: Buprestidae) (Dunbar & Stephens 1976), also contributed to tree mortality.

Oak decline is the result of complex interactions between biotic and abiotic factors. In this oak decline event, it has been hypothesized that the prolonged drought from 1998-2000, coupled with mature tree age and poor soil reduced tree vigor, rendering trees more susceptible to colonization by secondary agents, such as *E. rufulus* (Stephen et al. 2001) and *A. bilineatus*.

Agrilus bilineatus is indigenous to eastern North America (Haack & Acciavatti 1992) and has been implicated in numerous oak decline events (reviewed by Millers et al. 1989). It is generally univoltine, with adult flight occurring from Jun through Sep in the northern U.S. (Côté & Allen 1980; Haack & Benjamin 1982). Larvae feed in the cambial region creating distinctive meandering galleries, and adults leave D-shaped holes about 5 mm wide on the bark surface as they exit trees (Haack & Acciavatti 1992). Exit holes first appear in upper branches where the infestation begins, and when trees become severely infested, throughout the main stem (Haack & Benjamin 1982).

The objective of this study was to determine, by monitoring adult flight and by detecting larval galleries and exit holes created by emerging adults, if *A. bilineatus* was an important secondary agent in the recent oak decline in the Ozark Mountains of Arkansas.

Trapping for *A. bilineatus* adults was conducted in 3 geographically separate oak-hickory stands, 20-35 km apart, within the Ozark National Forest in northwest Arkansas. Stands exhibited oak decline and had 31% mean mortality

of *Q. rubra* L. in 2002 (Fierke et al. 2007). Clear panel traps, approximately 60 × 60 cm in size (Fierke & Stephen 2007), were nailed individually on tree boles 6 to 7 m above ground level. Black passive flight-intercept traps, 81 × 30.5 cm in size (IPM Technologies, Portland, Oregon), and light traps (flight-intercept traps with ultraviolet lights attached) were hung individually in trees 15 to 18 m above ground level in the canopy. Trapping occurred from May through Jul. Insects were collected once or twice per week over 3 years (2001, 2003, and 2004). See Table 1 for further information regarding trap numbers, type, and location.

Additionally, trees within the same three general geographic locations where the trapping was completed (UTM: 15N 0429404 3954870; 15N 0412711 3948789; and 15N 0463354 3953264) were destructively sampled. *Quercus* trees exhibiting a range of crown dieback, including 58 *Q. rubra*, 2 *Q. alba* L., and 1 *Q. velutina* Lamb., with a mean trunk diameter at 1.3 m of 29.23 ± 0.78 (SE) cm, were felled and dissected Jan 2003 through Jul 2004, ranging 1 to 5 trees per month. Twenty-five of the sampled trees exhibited 1-33% crown dieback, 21 trees exhibited 34-66% dieback, and 15 trees exhibited 67-99% dieback. Half-meter log samples, cut from the main bole through mid-crown, were examined for adult emergence holes, and outer bark and phloem were removed with a drawknife to examine larval galleries (Fierke et al. 2005). Additionally, branches exhibiting tip dieback but not completely dead, 5 - 25 cm diam, where early *A. bilineatus* infestation would occur, were removed from 9 *Q. rubra* and felled Apr-Jun of 2004. These 9 trees were selected because they exhibited > 34% dieback. This material was kept at approximately 27 °C in plastic 121 L garbage cans to collect emerging insects. Samples were dissected after all insects had emerged.

Fewer than 10 *A. bilineatus* adults were caught by trapping during any of the 3 years (9 in 2001, 4 in 2003, and 3 in 2004, respectively). No *A. bilineatus* larval galleries, exit holes, or adults were observed on dissected oak boles or crown material. However, the presence of other

TABLE 1. TRAPPING FOR *AGRILUS BILINEATUS* IN 2002-2004: TRAP TYPE, NUMBER, AND LOCATIONS WITHIN THE OZARK NATIONAL FOREST OF ARKANSAS, DEPLOYED IN EACH YEAR.

Year	Trap type	No. traps	Coordinate locations (UTM zone 15)
2001	clear panel, flight-intercept	10, 12	0429404 3954870
	flight-intercept	10	3727450 4000178
2003	flight-intercept	5	0412711 3948789
	flight-intercept	5	0430486 3957737
	flight-intercept	5	0429417 3954964
	flight-intercept	5	0432265 3956328
	flight-intercept	5	0429349 3955026
	flight-intercept	5	0429404 3954870
	flight-intercept	5	0463354 3953264
2004	flight-intercept, ultraviolet	1,1	0429417 3954964
	flight-intercept, ultraviolet	1,1	0448102 3955001
	flight-intercept, ultraviolet	1,1	0410596 3958898
	flight-intercept, ultraviolet	1,1	0463354 3953264
	flight-intercept, ultraviolet	1,1	0429349 3955026
	flight-intercept, ultraviolet	1,1	0412711 3948789

32 total traps in 2001; 35 in 2003; and 12 in 2004.

buprestids, most abundantly the apple tree borer, *Chrysobothris femorata* (Olivier) (Coleoptera: Buprestidae), emerged from crown material and was noted but not quantified from one location (15N 0429404 3954870).

Although present, *A. bilineatus* populations were very low and did not seem to be an important factor in this oak decline in the Arkansas Ozarks. On the other hand, *E. rufulus*, which has not been previously implicated as a secondary mortality agent in oak decline was a major contributor to tree mortality in this event (Stephen et al. 2001; Fierke et al. 2005). From June through Aug, in passive flight-intercept traps located at some of the same sites as in this study, Fierke & Stephen (2007) caught > 100 *E. rufulus* in 2001, 2003, and 2005.

Several studies have noted, but did not quantify, the presence of *A. bilineatus* in oak decline throughout the Midwest and South (Millers et al. 1989). Haack & Blank (1991) surveyed incidence of *A. bilineatus* in 4 states: Ohio, Indiana, Illinois, and Arkansas. Inspecting dead oaks, they found evidence of *A. bilineatus* at all sites but the lowest numbers existed in Arkansas.

It is unclear why *E. rufulus* featured prominently in this Arkansas oak decline event, while *A. bilineatus*, the most common borer associated with oak decline in eastern US forests, was present at very low population densities. There may be regional differences in population abundance of the 2 borers. In contrast with numerous instances of *A. bilineatus*-related oak mortality throughout the Appalachians, few exist from the Ozarks (Millers et al. 1989). More information is needed on the population dynamics of these borers to better understand their ecological roles in

forest systems and specifically, their respective contributions to oak decline.

ACKNOWLEDGMENTS

The authors thank L. Chapman, R. Barnhill, M. Fierke, V. Salisbury, B. Kelley, J. Jones, L. Galligan, and J. Bates for help in specimen collection; Dr. J. Barnes for specimen identification; Dr. T. Kring, Dr. C. Sagers, T. Dahl and two anonymous reviewers for reviews and suggestions. Financial support for this research was provided in part through the Arkansas Agricultural Experiment Station, the Arkansas Forestry Research Center, and Special Technology Development Grants funded by the USDA Forest Service, Forest Health Protection, Pineville, Louisiana.

SUMMARY

It was unknown whether twolined chestnut borer, *Agrilus bilineatus* (Coleoptera: Buprestidae), a common secondary agent of tree decline in eastern US oak forests, contributed to tree mortality during a recent (1999-2003) episode of oak decline in the Ozark Mountains. Adult beetle flight was monitored by trapping in 2001, 2003, and 2004 and oak branches and trunks were visually examined for exit holes and dissected to examine larval galleries. Very few *A. bilineatus* adults were found each year by trapping (< 10 as opposed to > 100 red oak borers [*Enaphalodes rufulus*; Coleoptera: Cerambycidae]), and no evidence of *A. bilineatus* was found in 70 dissected tree boles or in upper crown material, although other buprestids (*Chrysobothris femorata*) were noted.

Key Words: cambial region, exit hole, gallery, red oak borer, *Enaphalodes rufulus*, secondary agent

RESUMEN

No se sabía si el barrenador de dos rayos de la castaña, *Agrilus bilineatus* (Coleoptera: Buprestidae), un agente secundario común de la disminución de árboles en los bosques de roble del este de los Estados Unidos, contribuyó a la mortalidad de árboles durante un reciente (1999-2003) episodio de la disminución de roble en las Montañas Ozark. Se monitoreó el vuelo de los escarabajos adultos por capturarlos en 2001, 2003 y 2004 y las ramas y troncos de los robles fueron examinadas visualmente para agujeros de salida y diseccionado para examinar las galerías larvales. Se encontraron muy pocos adultos de *A. bilineatus* capturados cada año (<10 en comparación con > 100 barrenadores del roble rojo [*Enaphalodes rufulus*; Coleoptera: Cerambycidae]), y no se encontró evidencia de *A. bilineatus* en 70 troncos de árboles disecados o en la material de la parte alta de la corona, aunque otros buprestidos (*Chrysobothris femorata*) fueron notados.

Palabras Clave: región cambial, orificio de salida, galería, barrenador de roble rojo, *Enaphalodes rufulus*, agente secundario

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