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HOST PLANTS OF *XYLOSANDRUS MUTILATUS* IN MISSISSIPPI

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Abstract

Host range of *Xylosandrus mutilatus* (Blandford) in North America is reported here for the first time. Descriptive data such as number of attacks per host, size of stems at point of attacks, and height of attacks above ground are presented. Hosts observed in Mississippi were *Acer rubrum* L., *Acer saccharum* Marsh., *Acer palmatum* Thunb., *Ostrya virginiana* (Mill.) K. Koch., *Cornus florida* L., *Fagus grandifolia* Ehrh., *Liquidamber styraciflua* L., *Carya* spp., *Liriodendron tulipifera* L., *Melia azedarach* L., *Pinus taeda* L., *Prunus serotina* Ehrh., *Prunus americana* Marsh., *Ulmus alata* Michaux, and *Vitus rotundifolia* Michaux. *Liquidamber styraciflua* had significantly more successful attacks, significantly higher probability of attacks, and significantly higher number of adult beetles per host tree than did *Carya* spp., *A. rubrum*, and *L. tulipifera*. This information is relevant in determining the impact this exotic beetle may have in nurseries, urban areas, and other forestry systems where this beetle becomes established.

Key Words: ambrosia beetle, exotic insect, polyphagous, Xyleborini

Resumen

El rango de hospederos de *Xylosandrus mutilatus* (Blandford) en América del Norte esta reportado aquí por la primera vez. Se presentan datos descriptivos como el número de ataques por hospederos, el tamaño de los tallos en el punto de ataque y la altura por encima del nivel de tierra de los ataques. Los hospederos observados en el estado de Mississippi fueron *Acer rubrum* L., *Acer saccharum* Marsh., *Acer palmatum* Thunb., *Ostrya virginiana* (Mill.) K. Koch., *Cornus florida* L., *Fagus grandifolia* Ehrh., *Liquidamber styraciflua* L., *Carya* spp., *Liriodendron tulipifera* L., *Melia azedarach* L., *Pinus taeda* L., *Prunus serotina* Ehrh., *Prunus americana* Marsh., *Ulmus alata* Michaux y *Vitus rotundifolia* Michaux. *Liquidamber styraciflua* tuvo ataques significativamente mas exitosos, una probabilidad significativamente mas alta de ataques y un número significativamente mayor de adultos de escarabajos por árbol hospedero que *Carya* spp., *A. rubrum* y *L. tulipifera*. Esta información es pertinente en determinar el impacto que pueda tener este escarabajo exótico en invernaderos, áreas urbanas y otros sistemas forestales donde el escarabajo se establece.

Exotic bark and ambrosia beetles are becoming established in increasing numbers in North America due to greater foreign trade and human movement (Rabaglia, unpublished data; Schiefer & Bright 2004). Approximately 4600 arthropod species (2582 species in Hawaii and 2000 in the continental US) have been introduced with approximately 95% of these introduced accidentally in association with plants, soil, or water ballast from ships (Pimentel et al. 2001). Some 360 nonindigenous insects have invaded and become established in U.S. forests with 30% of these causing $2.1 billion in damage per year (Pimentel et al. 2000).

Few bark beetles are considered aggressive species (Paine et al. 1997). Of the 500 species that have been described from North America, only 2% kill trees (Six 2003). Exotic bark and ambrosia beetles introduced into new localities may impact forest ecosystems. Ambrosia beetles fulfill an important role in the forest by initiating and promoting the breakdown of wood (Lindgren 1990).

Xyleborini is one of the largest tribes of insects, and they attack hundreds of species of woody plants worldwide (Norris 1979). Ambrosia beetles are polyphagous and have a wide host range (Beaver 1989). Five of the described species of *Xylosandrus* occur in North America and only *X. zimmermanni* (Hopkins) is native. The remaining *Xylosandrus* species, *X. compactus* (Eichhoff), *X. germanus* (Blandford), *X. crassiusculus* (Motschulsky), and *X. mutilatus* (Blandford), were introduced from the Old World tropics (Wood & Bright 1992; Schiefer & Bright 2004). Some ambrosia beetles can attack healthy vigorous trees and shrubs while others attack only dead or dying hosts (Roeper & French 1981; Dute et al. 2002).

Xylosandrus mutilatus was first discovered in the U.S. in Oktibbeha County, Mississippi in 1999 (Schiefer & Bright 2004). Its present distribution in the USA has been reported (Schiefer & Bright 2004; Cognato et al. 2006; Stone & Nebeker 2007). Native of Asia, *X. mutilatus* is one of the major pests attacking the trunk and branches of Chinese chestnut, *Castanea mollissima* Blume (Tang 2000). The host plants of *X. mutilatus* in Asia have been reported previously (Wood & Bright 1992). Several publications have recorded *X. mutilatus* attacking Aceraceae: *Acer sieboldianum* Miquel, Fagaceae: *Castanea mollissima*, Lauraceae: *Parabenzoin trilobum* (Sieb. & Zucc.) Nakai, and Proteaceae: *Grevillea robusta* A. Cunn. (Sreedharan et al. 1991; Kajimura & Hijii 1992, 1994; Tang 2000).

Studies on the biology and ecology of exotic bark beetles are needed to allow appropriate management recommendations to be made to the public. Schiefer & Bright (2004) stated that the range of host plants of *X. mutilatus* are unknown in North America. The objective of this study was to determine the host range of *X. mutilatus* in Mississippi.

Materials and Methods

Field Design—2004

Xylosandrus mutilatus was offered various potential host plants common to the southeastern United States. Two upland hardwood forests, Tombigbee National Forest, and a privately owned forest (Kimbrough property), were selected in Winston County, Mississippi. The initial field design used bolts (1 m in length) placed horizontally on the ground in three diameter classes (2.54 cm ± 1.27, 5.08 cm ± 1.27, and 10.16 cm ± 1.27). Having observed no *X. mutilatus* attacks on these horizontal hosts from Mar-Aug 2004, we modified the field design. On Aug 16, 2004, single saplings including their canopy (ground-line diameter 2.54 to 5.08 cm) in 9 species were selected and severed at ground-line: loblolly pine (*Pinus taeda* L.), hickory (*Carya* spp.), yellow poplar (*Liriodendron tulipifera* L.), sweetgum (*Liquidambar styraciflua* L.), flowering dogwood (*Cornus florida* L.), red maple (*Acer rubrum* L.), chinaberry (*Melia azedarach* L.), black cherry (*Prunus serotina* Ehrh.), and winged elm (*Ulmus alata* Michaux). At each location, 3 vertical, severed saplings of each species were randomly placed along a continuous transect and spaced approximately 3 m apart. They were leaning 60 to 80 degrees from the ground and supported by other living understory saplings. The severed saplings were inspected at approximately 10-d intervals for 50 consecutive d (Aug 16 to Oct 5, 2004). For each inspection period, attacks were tallied and a small colored dot was placed adjacent to each new attack. An initial attack in this study was recorded when a female created an entrance hole that penetrated the xylem. Different colored markers were used to signify the inspection period during which the attacks had occurred.

At the end of the observation period the following data (mean ± SE) were collected: (1) number of attacks per host plant, (2) diameter of stem at attack, and (3) attack height above ground-line. Proper identification concerning what beetle made the attack was confirmed by the presence of a male or female *X. mutilatus* and/or its unique gallery pattern as illustrated by several authors (Choo et al. 1988; Kajimura & Hijii 1994; Tang 2000).

Field Design—2005

From Apr to Oct 2005, the vertical presentation of severed saplings was replicated three times (Apr 15 to Jun 15, Jun 16 to Aug 16, Aug 17 to Oct 17), and sample size was increased from 3 to 9 saplings per species at each location. *Quercus* spp. replaced chinaberry due to the lack of availability of the latter. Severed saplings were inspected at approximately 10-d intervals for 60 consecutive d. At the end of each inspection period, the same data were obtained as for the fall 2004.

Statistical Analysis

To determine possible host preferences, hickory, red maple, sweetgum, and yellow poplar were chosen and analyzed by the GLIMMIX procedure. Other species had few attacks and were therefore omitted. The mean number of attacks per host, the probability of a sapling for a given host being attacked at least once, and mean number of *X. mutilatus* adults per tree during the 2004 and 2005 fall replications were compared for significant differences among tree species. The data were analyzed with location and inspection periods as random effects by the generalized linear mixed model (PROC GLIMMIX) ($\alpha = 0.05$) in SAS 9.1 version.

Results

Xylosandrus mutilatus attacked saplings in 12 plant families in Mississippi and Alabama (Table 1). Zero attacks occurred on the horizontal bolts. The vertical severed saplings were attacked at both locations during each replication. The percentage of hosts attacked and number of attacks per host were higher during the fall than spring or summer (Table 2). For all replications, the highest numbers of attacks occurred during the first 10 d after severing (Table 2). A higher proportion of successful attacks occurred during both fall replications (Table 3). Unsuccessful attacks had a higher mean stem diameter at point of attack (2.0 cm ± 0.061) than successful attacks (1.81 cm ± 0.045). Successful attacks had a higher mean height at attack (2.171 m ± 0.063) than unsuccessful attacks (1.889 m ± 0.062).

TABLE 1. HOST PLANTS OF *XYLOSANDRUS MUTILATUS* IN MISSISSIPPI AND ALABAMA.

Family	Scientific name	Location	Condition of host
Aceraceae	*Acer rubrum*	Mississippi	Dead
	Acer saccharum[2]	Mississippi	Living
	Acer palmatum[2]	Mississippi	Dead
Betulaceae	*Ostrya virginiana*[2]	Mississippi	Living
Cornaceae	*Cornus florida*[2]	Mississippi	Living
Fagaceae	*Fagus grandifolia*[2]	Mississippi	Dead
	Quercus shumardii[2]	Alabama	Living
Hamamelidaceae[1]	*Liquidambar styraciflua*	Mississippi	Dead
		Alabama	Dead
Juglandaceae	*Carya* spp.	Mississippi	Dead
Magnoliaceae[1]	*Liriodendron tulipifera*	Mississippi	Dead
Meliaceae	*Melia azedarach*	Mississippi	Dead
Pinaceae[1]	*Pinus taeda*	Mississippi	Dead
Rosaceae[1]	*Prunus serotina*	Mississippi	Dead
	Prunus americana[2]	Mississippi	Dead
Ulmaceae[1]	*Ulmus alata*	Mississippi	Dead
Vitaceae[1]	*Vitus rotundifolia*[2]	Mississippi	Dead

[1]Families are new host records for *X. mutilatus*.
[2]Simple observations not within field study.

GLIMMIX Procedure

The mean number of successful attacks per host tree, the probability of a sapling of a given host being attacked at least once, and mean number of *X. mutilatus* adults per host tree during the 2004 and 2005 fall replications among hickory, red maple, sweetgum, and yellow poplar were all significantly different (Table 4). Sweetgum had significantly more successful attacks, significantly higher probability of attack, and significantly higher number of adult beetles per host tree compared with hickory, red maple, and yellow poplar (Table 4). Sweetgum had a total of 114 successful attacks and 65 unsuccessful attacks compared with hickory (19 successful and 26 unsuccessful), red maple (6 successful and 38 unsuccessful) and yellow poplar (4 successful and 2 unsuccessful) during the 2004 and 2005 fall replications.

DISCUSSION

Including the findings in this paper, 20 host plant families have been recorded for *X. mutilatus* worldwide. This is the first report of Hamamelidaceae, Magnoliaceae, Pinaceae, Rosaceae, Ulmaceae, and Vitaceae as host families for *X. mutilatus*.

Several live host plants were observed being attacked. An unhealthy sugar maple (*Acer saccharum* Marsh) possessing crown dieback was attacked. Attacks were located within the dieback, and *X. mutilatus* did not attack any other portion of the tree. Attacked eastern hophornbeam (*Ostrya virginiana* (Mill.) K. Koch.) was observed on a recently herbicide sprayed right-of-way. Attacks occurred on a dying lower branch apparently damaged by the herbicide. A flowering dogwood, observed under attack and planted in a poorly

TABLE 2. NUMBER OF ATTACKED SEVERED SAPLINGS AND TOTAL ATTACKS BY INSPECTION DAY OF *XYLOSANDRUS MUTILATUS*.

Time of year	Number of attacked saplings	Number of attacks[1] by inspection day					
		Day 10	Day 20	Day 30	Day 40	Day 50	Day 60
Fall 2004	17 (N = 52)	86	28	15	9	3	—
Spring 2005	5 (N = 162)	4	3	2	0	1	0
Summer 2005	15 (N = 162)	9	3	3	5	2	0
Fall 2005	37 (N = 162)	130	14	8	1	0	0

[1]An attack was recorded when a female bored into the xylem.
[2]N = total number of saplings presented.

TABLE 3. TOTAL NUMBER AND STATUS OF ATTACKS OF *XYLOSANDRUS MUTILATUS* ON SEVERED SAPLINGS.

Time of year	Successful[1]	Unsuccessful[2]	Total attacks
Fall 2004	76	65	141
Spring 2005	0	10	10
Summer 2005	1	21	22
Fall 2005	82	71	153

[1]Beetles were observed in galleries.
[2]No vertical gallery and/or no live beetles were observed at attack site.

drained area, had approximately 50% leaf drop in Jun 2004. The attacks occurred along the main stem. Potted, healthy *Quercus shumardii* Buckl. approximately 3 m tall located in a nursery in Alabama were attacked (J. W. Brewer, pers. comm.). *Xylosandrus mutilatus* attacked recently stressed and dead understory saplings associated with a prescribed burn. These host plants consisted of sweetgum, hickory spp., winged elm, and wild muscadine grape.

Xylosandrus mutilatus, like most ambrosia beetles, is polyphagous and reproduces in numerous hosts (Beaver 1989; Lindgren 1990; Maeto et al. 1999), and it appears to have low host specificity. The ambrosia beetle's historical environment likely promoted polyphagy (Atkinson & Equihua-Martinez 1986; Beaver 1989). The floristic diversity and high decomposition rates made high host specificity less favorable in the humid tropics and similar climates where ambrosia beetles likely evolved (Atkinson & Equihua-Martinez 1986; Beaver 1989). Atkinson & Equihua-Martinez (1986) suggest that the beetles' fungal symbiosis evolved from competition between the beetles and fungi for the same substrate.

TABLE 4. HOST PREFERENCES OF ATTACKS OF *XYLOSANDRUS MUTILATUS* ON SEVERED SAPLINGS DURING FALL 2004 AND 2005.

Species	Mean number of attacks[1] per tree	Probability of at least one attack[2]	Mean number of adults per tree
Hickory	1.986 bc	27.7 c	1.172 c
Red Maple	1.899 c	62.3 b	0.391 d
Sweetgum	8.033 a	92.6 a	21.726 a
Yellow Poplar	0.259 d	14.0 d	2.018 b

Note: Numbers with the same letter are not significantly different using differences of least square means at ($\alpha = 0.05$).
[1]Beetles were observed in galleries.
[2]A female beetle had bored into the xylem.

The single stem presentation in this study was a smaller landscape disturbance as compared with man-made disturbances such as herbicide spraying and prescribed burning. From personal observations, recently dead and stressed material following a prescribed burn or herbicide application seemed to be preferred during the spring and summer periods. It has been reported that *Xylosandrus crassiusculus* prefers disturbed areas (Maeto et al. 1999).

No successful attacks occurred below 0.5 m, which might suggest a lower limit on attack height for vertically-oriented material. Tang (2000) stated that the attacks occurred at 40 cm or greater above the ground-line and on parts of the branch having a diameter of 1.2 to 2.5 cm. Maeto et al. (1999) reported that more than 70% of *X. crassiusculus* were trapped below 5 m.

In our study, only 3 out of 20 attacks were successful when stem diameter at point of attack was 3 cm or greater. This suggests an upper limit on suitable stem size. Beeson (1930) divided ambrosia beetles into 3 groups in relation to the size of the material the beetles attacked. *Xylosandrus mutilatus* has been classified as a shoot borer, since it may infest material up to 5.08 cm or more in diameter (Browne 1958). Browne (1958) recorded *Xylosandrus* (=*Xyleborus*) *mutilatus* in hosts with diameters of 1.27 to 5.08 cm; however, most attacks occurred in the 2.54 to 3.81 cm diameter classes.

Xylosandrus mutilatus showed a preference towards sweetgum when compared to the other host plants represented in this study. Even though most ambrosia beetles have a wide host range, exceptions to this general rule do occur (Browne 1958). *Xyleborus uniseriatus* Eggers shows a strong preference for the Fagaceae (Browne 1958). Since the introduction of *X. crassiusculus* into North America, this species has shown some preference towards sweetgum (Solomon 1995). Further studies to identify the factors involving recognition, suitability, and acceptance of host material by *X. mutilatus* in natural and man-made disturbances are needed.

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References Cited

Atkinson, T. H., and A. Equihua-Martinez. 1986. Biology of bark and ambrosia beetles (Coleoptera: Scolytidae and Platypodidae) of a tropical rain forest in southeastern Mexico with an annotated checklist of species. Ann. Entomol. Soc. America. 79: 414-423.

Beaver, R. A. 1989. Insect-fungus relationships in the bark and ambrosia beetles, pp. 121-137 *In* N. Wilding, N. M. Collins, P. M. Hammond, and J. F. Webber [eds.], Insect-Fungus Interactions. Academic Press, San Diego. 344 pp.

Beeson, C. F. 1930. The biology of the genus *Xyleborus*, with more new species. Indian For. Rec. 14: 33-96.

Browne, F. G. 1958. Some aspects of host selection among ambrosia beetles in the humid tropics of southeast Asia. Malayan Forester 21: 164-182.

Choo, H. Y., K. S. Woo, and A. Nobuchi. 1988. Classification of Korean bark and ambrosia beetles by their galleries. Korean J. Appl. Entomol. 27: 131-137.

Cognato, A. I., C. E. Bogran, and R. Rabaglia. 2006. An exotic ambrosia beetle, *Xylosandrus mutilatus* (Blandford) (Scolytinae: Xyleborina) found in Texas. Coleop. Bull. 60: 162-163.

Dute, R. R., M. E. Miller, M. A. Davis, F. M. Woods, and K. S. McLean. 2002. Effects of ambrosia beetle attack on *Cercis canadensis*. IAWA J. 23: 143-160.

Kajimura, H., and N. Hijii. 1992. Dynamics of the fungal symbionts in the gallery system and the mycangia of the ambrosia beetle, *Xylosandrus mutilatus* (Blandford) (Coleoptera: Scolytidae) in relation to its life history. Ecol. Res. 7: 107-117.

Kajimura, H., and N. Hijii. 1994. Reproduction and resource utilization of the ambrosia beetle, *Xylosandrus mutilatus*, in field and experimental populations. Entomol. Exp. Appl. 71: 121-132.

Lindgren, B. S. 1990. Ambrosia beetles. J. For. 88: 8-11.

Maeto, K., K., Fukuyama, and L. G. Kirton. 1999. Edge effects on ambrosia beetle assemblages in a lowland rain forest, bordering oil palm plantations, in Peninsular Malaysia. J. Trop. For. Sci. 11: 537-547.

Norris, D. M. 1979. The mutualistic fungi of Xyleborini beetles, pp. 53-63 *In* L. R. Batra [ed.], Insect-Fungus Symbiosis. Allanheld, Osmun, & Co., Montclair, NJ.

Paine, T. D., K. F. Raffa, and T. C. Harrington. 1997. Interactions among scolydid bark beetles, their associated fungi, and live host conifers. Ann. Rev. Entomol. 42: 179-206.

Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and economic costs of nonindigenous species in the United States. BioScience 50: 53-65.

Pimentel, D., S. McNair, J. Janecka, J. Wightman, C. Simmonds, C. O'Connell, E. Wong, L. Russel, J. Zern, T. Aquino, and T. Tsomondo. 2001. Economic and environmental threats of alien plant, animal, and microbe invasions. Agri. Eco. & Environ. 84: 1-20.

Roeper, R. A., and J. R. J. French. 1981. Ambrosia fungi of the western United States and Canada-beetle associations (Coleoptera: Scolytidae), tree hosts, and distributions. Northwest Sci. 55: 305-309.

SAS Institute, Inc. 2002. SAS Online Doc: Version 9.1. Cary, NC, USA.

Schiefer, T. L., and D. E. Bright. 2004. *Xylosandrus mutilatus* (Blandford), an exotic ambrosia beetle (Coleoptera: Curculionidae: Scolytinae: Xyleborini) new to North America. Coleop. Bull. 58: 431-438.

Six, D. L. 2003. Bark beetle-fungus symbioses, pp. 97-114 *In* K. Bourtzis and T. A. Miller [eds.], Insect Symbiosis. CRC Press, New York. 347 pp.

Solomon, J. D. 1995. Guide to Insect Borers of North America Broadleaf Trees and Shrubs. Agric. Handbk. 706. U.S. Department of Agriculture, Forest Service, Washington, DC. 735 pp.

Sreedharan, K., M. M. Balakrishnan, S. D. Samuel, and P. Krishnamoorthy Bhat. 1991. A note of the association of wood boring beetles and fungus with the death of silver oak trees on coffee plantations. J. Coffee Res. 21: 145-148.

Stone, W. D., and T. E. Nebeker. 2007. Distribution and seasonal abundance of *Xylosandrus mutilatus* (Coleoptera: Curculionidae). J. Entomol. Sci. (*in press*).

Tang, W. 2000. Biological characteristics of *Xyleborus mutilatus* and its control. J. Zhejiang For. College. 17: 417-420.

Wood, S. L., and D. E. Bright. 1992. A Catalog of Scolytidae and Platypodidae (Coleoptera), Part 2: Taxonomic index volume A., Great Basin National Memoirs, No. 13. Brigham Young University, Provo, Utah. 833 pp.