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FOREST HEALTH

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The Sirex woodwasp, *Sirex noctilio:*

Ecology, Potential Impact, and Management in the Southeastern U.S.

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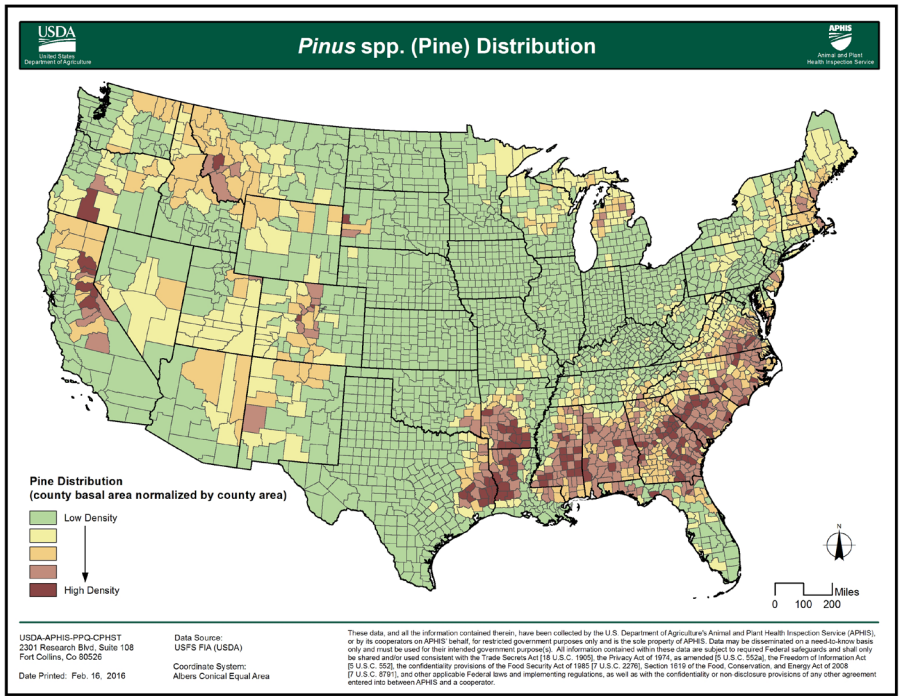

*Figure 1. The high density of likely or confirmed pine (*Pinus *spp.) hosts of the Sirex woodwasp suggests the southeastern U.S. may be heavily impacted should this non-native insect become established in this region.*

Overview and Detection

The Sirex woodwasp (*Sirex noctilio* F.) is a large, non-stinging wasp that colonizes and kills stressed pine trees. This insect, originally from Eurasia, is not considered a pest in its native range. However, it has become a major pest in some countries in the Southern Hemisphere (such as South Africa and Australia), where it was accidentally introduced. It has infested areas with thousands of acres of planted pine in commercial plantations. So far, the Sirex woodwasp has not become a major pest in North America, and is found only in New York, Ohio, Pennsylvania, Michigan, Vermont, and Connecticut, and the Canadian provinces of Ontario and Quebec. However, considering the large amount of favorable habitat that exists in the southeastern U.S. (Fig. 1), great potential for damage from the Sirex woodwasp exists. One reason the Sirex woodwasp has not become a major pest in North America may be the many insects that are competitors or natural enemies. Some of these insects compete for resources (e.g. native woodwasps, bark and ambrosia beetles, and longhorned beetles) while others (e.g.parasitoids) are natural enemies and use Sirex woodwasp larvae as hosts. However, should the Sirex woodwasp arrive in the southeastern U.S., with its abundant pine plantations and areas of natural pine, this insect could easily be a major pest for the region.

Researchers have monitored and tracked Sirex woodwasp populations since its discovery in North America. The most common detection tool is a flight intercept trap (Fig. 2a) baited with a synthetic chemical lure that consists of pine scents (70% α-pinene, 30% β-pinene) or actual pine branches (Fig. 2b). Woodwasps are attracted to the odors given off by the lure or cut pine branches, and as they fly toward the scent they collide with the sides of the trap and drop into the collection cup at the bottom. The collection cup is usually filled with a liquid (e.g. propylene glycol) that acts as both a killing agent and preservative that holds the insects until they are collected. While the traps are somewhat effective, there is still work to be done to improve our trapping methodology and efficiency. Another monitoring technique is the use of a log cut from a live tree. This log, left outside, attracts female Sirex woodwasps, who then lay eggs in the log. The log can then be placed in a cage, and adult woodwasps can be captured and recorded as they emerge from the log.

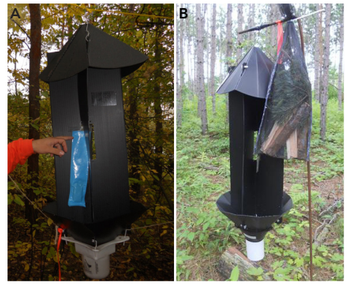

Figure 2. Panel intercept trap (available from Alpha Scents, Inc.: http://www.alphascents.com/traps/traps.html) hung between two pine trees, equipped with a Sirex lure (blue bag, A; available from Contech Enterprises, Inc.: https://www.contech-inc.com/) or bag of fresh pine material (B) and collection cup (white) containing preservative (propylene glycol).

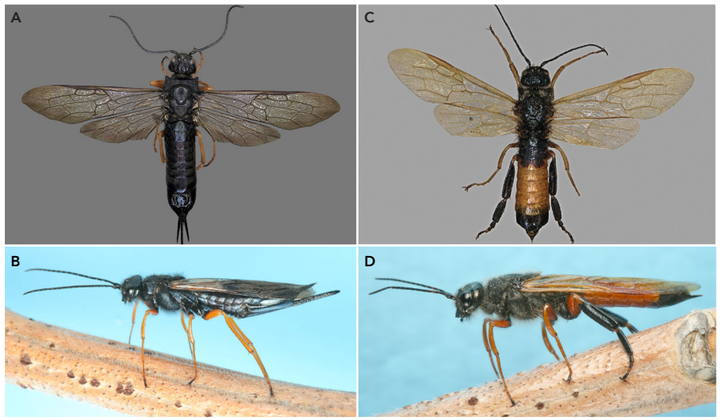

Figure 3. Sirex woodwasp female (A, B) and male (C, D).

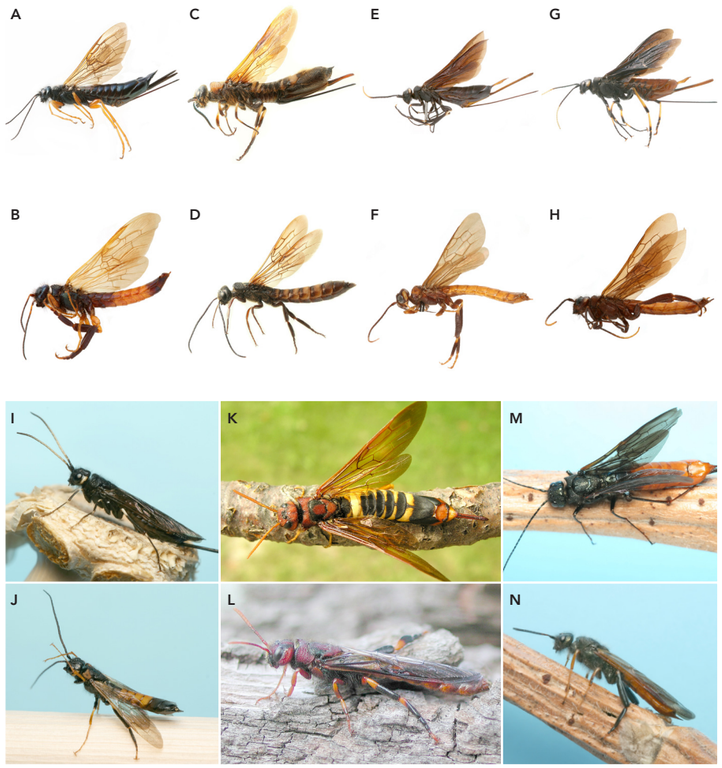

Figure 4. Woodwasps similar in appearance to the Sirex woodwasp, Sirex noctilio: Sirex cyaneus *female (A) and male (B),* Eriotremex formosanus *female (C) and male (D),* Urocerus taxodii *female (E) and male (F),* U. cressoni *female (G) and male (H),* U. albicornis *female (I) and male (J),* Tremex columba *female (K) and male (L), and* S. nigricornis *female (M) and male (N).* Eriotremex formosanus, *like* S. noctilio, *is not native to the U.S.*

Wasp Identifi-

Adults have a black to metallic-blue head, black antennae, and range from ½" – 1½" in length. Adult females have black bodies with orange legs, and adult males are mostly black with an orange band across the abdomen, and black hind legs (Fig. 3). All adults have a pointed spine-like projection (called a cornus) at the end of their abdomen. Females have another appendage at the end of their abdomen, called an ovipositor, which is used to drill into wood to lay eggs. The southeastern U.S. is home to several species of native woodwasps, many of which look similar to the Sirex woodwasp (Fig. 4). Even among individuals within a species, there can be a lot of variation in appearance and size. For instance, females of the woodwasp *Sirex nigricornis* (Fig. 4M and N), which is native to North America, can have a black or reddish abdomen, and males (which are uncommon, and rarely captured in traps) may have a yellow stripe or entirely yellow abdomen. Because of these similarities with different species and different color patterns, if you think you've found a Sirex woodwasp, it is very important to have it identified by a professional. Please see the "Resources" section at the end of this document for help in identifying a local forest health professional.

Life Cycle

Development from egg to adult is 1-3 years, but one year is expected in the southeastern U.S. Adults emerge in mid to late summer (July – August), only live for up to two weeks, and do not feed – using their energy instead to reproduce[13]. Females drill tiny holes into the wood where they first test the suitability of the tree (Fig. 5). If the tree is suitable, females will deposit eggs, inject a toxic mucus, and inoculate a symbiotic fungus. The mucus helps stress trees, while the fungus helps larvae digest and extract nutrients from the wood[3,4,16]. Larvae can eat the fungus, and the fungus also helps break down the wood and make it easier for larvae to digest. Sirex woodwasp larvae are cream-colored, legless, and have a spine at the tip of the abdomen (Fig. 6A). Larvae chew through the wood, creating and enlarging meandering tunnels as they grow (Fig. 6B). Larvae consume both wood and the fungus deposited by the female. Larvae overwinter inside their tunnels, pupate in early summer, and exit trees as adults in mid- to late summer[13].

Figure 5. Dead female Sirex woodwasp with ovipositor stuck in the tree.

Figure 6. Sirex woodwasp larva (A) and damage (B).

Host Trees

All hard pines in the southeastern U.S. are either confirmed or likely hosts for the Sirex woodwasp (Table 1), which also rarely attacks fir, spruce, and larch[15]. This insect prefers pines with a diameter of 6" and larger, though it will attack trees <2" in diameter. Native pines in the southeastern U.S. appear to vary in their susceptibility to the Sirex woodwasp based on laboratory experiments[2,6], and two pine species common in the Southeast – loblolly and slash – are known hosts for the Sirex woodwasp in other parts of the world. In some parts of Uruguay, up to 70% damage was recorded in some stands[12]. Thus, there is potential for widespread damage on southeastern host trees.

Host Tree Con-

The European woodwasp usually attacks trees that are already under some sort of stress. These stressors can include drought, poor management, competitive stand conditions (e.g.

Table 1. Host use by the European woodwasp on native pines in the southeastern U.S

Common name	Scientific name	Likely susceptibility?	Confirmed as host?
Loblolly pine	*Pinus taeda*	Very high	Yes
Shortleaf pine	*Pinus echinata*	High	Yes
Slash pine	*Pinus elliottii*	High	Yes
Virginia pine	*Pinus virginiana*	High	Yes
Longleaf pine	*Pinus palustris*	Medium	Yes
Pitch pine	*Pinus rigida*	Medium	Unknown
Pond pine	*Pinus serotina*	Medium	Unknown
Sand pine	*Pinus clausa*	Medium	Unknown
Spruce pine	*Pinus glabra*	Medium	Unknown
Table mountain pine	*Pinus pungens*	Medium	Unknown
Eastern white pine	*Pinus strobus*	Low	Yes

References: 6, 14, 15, and the USDA FS FHTET Steering Committee (http://www.fs.fed.us/foresthealth/technology/pdfs/host_species_susceptibility.pdf)

suppressed or overtopped trees), genetically inferior trees, or other pest infestations. Healthy, dominant pines are infrequently attacked, and very infrequently killed[8,11].

Infestation Diagno-

Affected trees can be identified by several characteristics. Often, the most noticeable is beads of resin that run down the trunk of the tree (Fig. 7). This is the tree's response to females drilling into the tree to test it for suitability. Once the eggs hatch and larvae start feeding in the wood, needles begin to wilt and change to a yellowish, then reddish, color. Once wasps have completed development, adults create holes in the wood when they exit the tree. These emergence holes are almost perfectly round, ~1/4" in diameter (Fig. 8), and tend to appear in groups of varying sizes[1]. Often, a single tree may have a lot of emergence holes while neighboring trees have few or none. Sirex woodwasp emergence holes cannot be distinguished from native woodwasp emergence holes - both types of holes overlap in size with emergence holes of other insects, such as parasitoids of woodwasps, and other wood borers, who also tend to live in dead and dying trees and have a similar life cycle (i.e. immatures develop in wood, adults chew their way out when they emerge).

Forest Manage-

The southeastern U.S. has many of the characteristics that make for excellent Sirex woodwasp habitat. Large areas of preferred host trees (pines), coupled with a mild climate and multiple stress agents (e.g. overstocked stands, droughts, native pest insects and disease) that generally can stress pines make this region favorable for insect establishment should the Sirex woodwasp arrive. For this reason, preventative techniques, such as timely stand thinnings, truly are the best management. Since the Sirex woodwasp primarily attacks stressed or weakened trees, it is important to promote stand health through proper silvicultural practices[7,8] (Fig. 9). Further, select tree species that are adapted to local environmental and soil conditions when planting, and manage your stand by thinning to recommended levels (it is usually recommended that southern pine stands having a basal area >120 ft^2/ac be thinned to <80 ft^2/ac). Stand management recommendations for the southern pine beetle would simultaneously reduce the hazard to Sirex woodwasp infestation and damage (see http://www.barkbeetles.org/standvisual/ for more information, or contact your local forestry professional). Overall, tree resistance (maintained by promoting healthy pine stands) is one of the most important factors in preventing Sirex woodwasp infestations[9].

Figure 7. Resin beading (A) and running (B) on pines as a result of Sirex woodwasp oviposition.

Figure 8. Sirex woodwasp emergence holes.

Natural Enemies

In its native range, a diverse group of natural enemies is believed to regulate Sirex woodwasp populations. The southeastern U.S. is home to a diverse community of natural enemies (Fig. 10) and potential competitors of native woodwasps, and experts believe these insects may help, in part, to limit Sirex woodwasp populations. Several parasitoid wasps native to North America attack the Sirex woodwasp[5]. In some cases, these parasitoids have caused substantial mortality to Sirex woodwasp populations[5], and would likely be important components of an integrated pest management program. Parasitic nematode species have been effective in managing populations of Sirex woodwasp in several Southern Hemisphere countries and show some potential in North America[10]. These nematodes live in the tree and infect Sirex woodwasp larvae during their development. They do not kill the larvae, rather, they remain inside the insects and sterilize the adult. Should the Sirex woodwasp reach the southeastern U.S., natural enemies will be an important component of an integrated pest management plan for this pest.

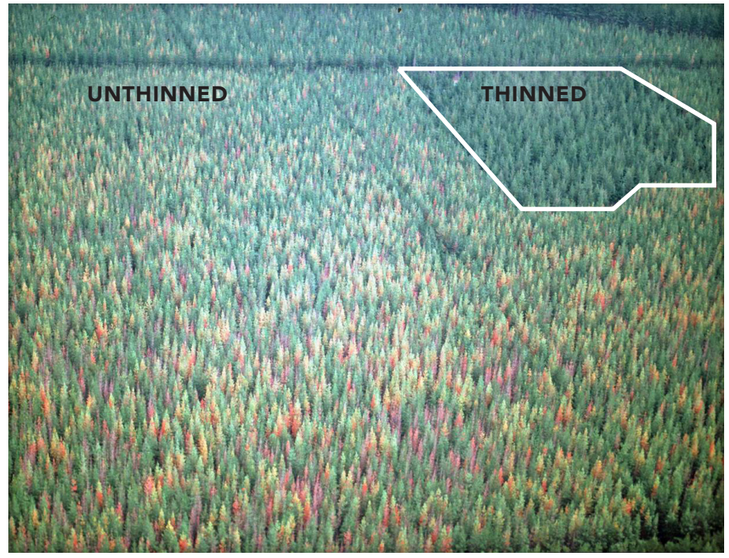

Figure 9. Sirex woodwasp damage in an unthinned pine plantation in Australia. The unthinned portion has nearly 70% mortality, while the thinned section has no mortality.

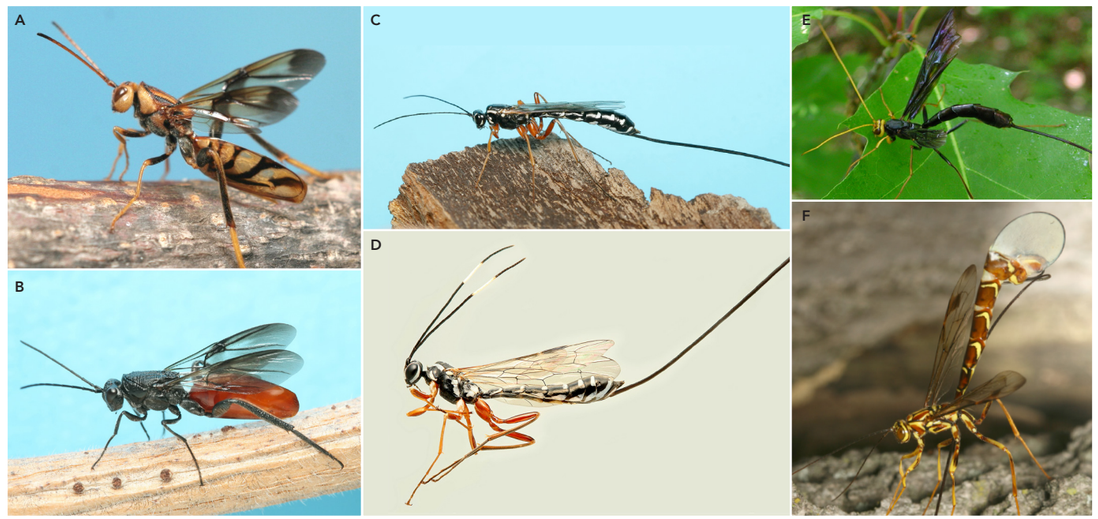

Figure 10. Natural enemies of woodwasps in the southeastern U.S.: Ibalia anceps *(A),* Ibalia leucospoides *(B),* Rhyssa peruasoria *(C),* Rhyssa lineolata *(D),* Megarhyssa atrata *(E),* Megarhyssa macrura *(F).*

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Resources

For the location and phone numbers of state agencies in the southeastern U.S. providing forestry assistance and information, see the following websites:

Alabama Forestry Commission: http://www.forestry.alabama.gov/

Arkansas Forestry Commission:
http://forestry.arkansas.gov/Pages/default.aspx

Florida Forest Service: http://www.floridaforestservice.com/

Georgia Forestry Commission: http://www.gatrees.org/

Kentucky Division of Forestry:
http://forestry.ky.gov/Pages/default.aspx

Louisiana Department of Agriculture and Forestry:
http://www.ldaf.state.la.us/

Mississippi Forestry Commission: http://www.mfc.ms.gov/

North Carolina Forest Service: http://www.ncforestservice.gov/

Oklahoma Forestry Services: http://www.forestry.ok.gov/

South Carolina Forestry Commission:
http://www.state.sc.us/forest/

Tennessee Division of Forestry:
https://www.tn.gov/agriculture/section/forests

Texas A&M Forest Service: http://texasforestservice.tamu.edu/

Virginia Department of Forestry: http://www.dof.virginia.gov/

For the location and phone numbers of University Extension personnel in the southeastern U.S. providing forestry assistance and information, see the following websites:

Alabama Cooperative Extension System:
http://www.aces.edu/main/

University of Arkansas Cooperative Extension Service:
http://www.uaex.edu/

University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS):
http://solutionsforyourlife.ufl.edu/

University of Georgia Extension: http://extension.uga.edu/

Kentucky Cooperative Extension Service:
https://extension.ca.uky.edu/

Louisiana Cooperative Extension Service:
http://www.lsuagcenter.com/

Mississippi State University Extension Service:
http://extension.msstate.edu/

North Carolina Cooperative Extension:
https://www.ces.ncsu.edu/

Oklahoma Cooperative Extension Service:
http://www.oces.okstate.edu/

Clemson Cooperative Extension (South Carolina):
http://www.clemson.edu/extension/

University of Tennessee Extension:
https://extension.tennessee.edu/

Texas A&M AgriLife Extension: http://agrilifeextension.tamu.edu/

Virginia Cooperative Extension: http://www.ext.vt.edu/

To locate a consulting forester:

Association of Consulting Foresters:
http://www.acf-foresters.org/acfweb.

Click on "Find a Forester", then select your state in the "People Search – Public" search page.

For more information on how to select a consulting forester, go to:

http://msucares.com/pubs/publications/p2718.pdf

http://texashelp.tamu.edu/011-disaster-by-stage/pdfs/recovery/ER-038-Selecting-a-Consulting-Forester.pdf

http://www.uaex.edu/environment-nature/forestry/FSA-5019.pdf

Additional information on the Sirex woodwasp is available at:

http://southernforesthealth.net/

http://www.woodwasps.com/

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Figure 3: A and C, Steven Vallery, Oregon Dept. of Ag., Bugwood.org; B and D, Henri Goulet, Agriculture and Agri-Food Canada.

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Figure 6: A, Bernard Slippers, Forestry and Agricultural Biotechnology Institute; B, Vicky Klaser, Instituto Nacional de Tecnologia Agropecuaria, Bugwood.org.

Figure 7: A, Laurel J. Haavik, University of Kansas; B: Dennis Haugen, Bugwood.org.

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