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EXOTIC PEST THREATS

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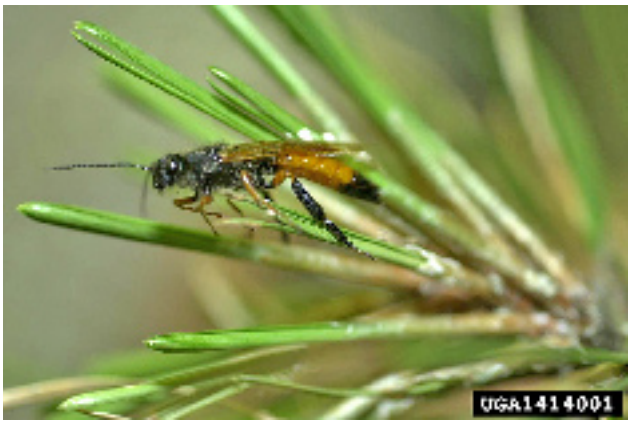
Sirex Woodwasp

Sirex noctilio Fabricius (Hymenoptera: Siricidae)

INTRODUCTION:

The Sirex woodwasp (SWW), *Sirex noctilio*, is an exotic, invasive pest considered one of the top 10 most serious forest insect pests worldwide. These woodwasps attack living pine trees and, in areas where they have been introduced, have caused extensive losses. In the U.S., a single SWW was first detected in an Indiana warehouse in 2002, but no others were found in a follow-up survey. Then in 2004, a female was collected in a funnel trap at a forest edge by a field in Oswego County, NY, indicating an established population existed. If not controlled, SWW poses a serious threat to pine forests and plantations in North America.



Adult male SWW, actual size. David R. Lance, USDA APHIS PPQ, Bugwood.org

DISTRIBUTION/SPREAD:

SWW is native to Europe, Asia, and North Africa, where it is regarded as a secondary pest. Most species of siricids are only minor pests in their native forests, but when accidentally imported to foreign lands where natural controls are lacking, they can be very damaging. Over a century ago SWW were accidentally introduced to New Zealand in solid wood packing materials, and subsequently became established in Australia, South America, and South Africa. In these Southern Hemisphere countries, SWW preferentially attack plantings of pine species introduced from North America, causing up to 80% tree mortality in some areas.

USDA APHIS reported that in North America, as of September 2011, SWW has been detected in New York, Pennsylvania, Michigan, Vermont, Connecticut, Ohio, and the Canadian province of Ontario. Based on its native range in Eurasia, SWW could establish anywhere in North America where pines grow. Recent detections of SWW outside of port areas raise the concern that the pest may rapidly spread and cause significant damage, especially in the vast pine plantations of the Southern U.S. With its history of large scale damage and the many pine species it has attacked elsewhere, this invasive pest could wreak havoc on the U.S. timber industry.

SWW adults are strong fliers and, with a life cycle of a year or more, larvae are easily transported in wood products, with or without bark (pallets, solid wood packing materials, firewood and logs). Experience has shown the wasp spreads rapidly and can move 25-30 miles per year. According to the USDA Forest Service, if no action is taken to contain SWW, it could spread across the entire southern pine region in 55 years or less, resulting in damages ranging from $2 billion to $11 billion. An Environmental Assessment, required as a first step before initiating a Domestic Interim Rule to institute quarantine measures for SWW in the U.S., was completed by APHIS in August 2008; however, it has not yet been announced if or when quarantine measures will go in effect.

HOST PLANTS:

The preferred hosts of SWW are pine species (*Pinus* spp.), especially Scots (*P. sylvestris*), Red (*P. resinosa*), and Eastern white (*P. strobus*) pines in the U.S. Elsewhere they are widely reported in Monterey (*P. radiata*) and loblolly (*P. taeda*) pines. In its native range, SWW attacks pines almost exclusively, but in the U.S. it also attacks and feeds in spruce (*Picea* spp.), fir (*Abies* spp.), larch (*Larix* spp.), and Douglas-fir (*Pseudotsuga menziesii*). Additional pine species reported to have been attacked or believed to be at risk from SWW are Austrian (*P. nigra*), Jack (*P. banksiana*), Jeffrey (*P. jeffreyi*), lodgepole (*P. contorta*), longleaf (*P. palustris*), maritime (*P. pinaster*), pitch (*P. rigida*), ponderosa (*P. ponderosa*), red shortleaf (*P. echinata*), slash (*P. elliottii*), and Virginia (*P. virginiana*) pines. SWW prefers stressed trees, but is the only known species of the woodwasp family that can also kill relatively healthy pine trees. Smaller trees under 6” (16 cm) in diameter are more likely to be killed, but SWW readily attacks larger trees that are damaged or stressed.

BIOLOGY and DAMAGE:

SWW usually produce one generation each year, but may take up to two years to complete a generation in cooler climates. This pest overwinters either as eggs or as larvae deep within the wood of a host tree. Adult wasps emerge June through September, with peak emergence in August. The adult SWW bores out of the tree leaving a characteristic round exit-hole which varies in diameter according to the size of the wasp. Adults live one to three weeks and do not feed, living off of fat stored in their bodies. Females are attracted to stressed pine trees and can begin laying eggs one day after emergence. If the female does not mate with a male, she will lay eggs that produce only male offspring; if she does mate, eggs will produce both male and female offspring.

The biology of siricid woodwasps is a complex interaction between several organisms: the woodwasp and toxic mucus produced by the adult female, a symbiotic wood-decaying fungus, and the host tree. Newly pupated adult female woodwasps take up spores of the symbiotic fungus, *Amylostereum areolatum*, from their host trees as they emerge and carry them in specialized abdominal glands called mycangia. When a female is ready to lay eggs, she drills her ovipositor into the outer sapwood, simultaneously injects toxic mucus, and deposits a single egg. Drill holes are perfectly round, usually located on the sunny side of trees, and may occur singly or in a cluster of 5 or 6 “drills” together. If several drills are clustered, one usually lacks an egg and instead is packed with spores of the symbiotic fungus. A single female may lay 25-450 eggs, averaging about 212.

The toxic mucus disables the tree’s network for transporting water and nutrients, causing the foliage to wilt and yellow. This creates ideal conditions for the development and spread of the fungus, which invades the vascular system of the tree, dries out the wood and breaks down cellulose. The mucus and fungus acting together lead to the death of the tree and engender favorable conditions for eggs to hatch, while also providing food for developing larvae. The fungus feeds on the killed wood, and the larvae actually feed on the fungus. Larvae hatch from the eggs after a minimum of nine days, but in cooler climates eggs may remain dormant for several months or even over the winter. As larvae grow, they bore galleries deep into and through the wood. There are usually six larval instars, and it takes about 10-11 months to complete the larval stage. Mature larvae pupate close to the bark surface, and adults emerge about 3 weeks later.

IDENTIFICATION:

- SWW are commonly called horntails because of the spear-shaped upturned spike (cornus) dorsally located on the last abdominal segment of the tail end of adults.
- Female adults additionally have a longer ovipositor and sheath located beneath the cornus on the last abdominal segment, extending straight back from the rear.

Adult male SWW, showing orange mid-section of abdomen and black hind legs (front 2 pairs of legs are orange). Pest and Diseases Image Library, Bugwood.org

Adult female SWW, showing solid dark-colored body and orange legs (all 3 pairs orange). Pest and Diseases Image Library, Bugwood.org

SWW larva showing spine. Paula Klasmer, Instituto Nacional de Tecnologia Agropecuaria, Bugwood.org

Pupa in chamber and frass packed larval tunnels. William M. Ciesla, Forest Health Management International, Bugwood.org

Foliage wilts, needles point straight down and turn light green/yellow to red/brown over several months. Dennis Haugen, Bugwood.org

Resin dribbles from oviposition drill wounds. Dennis Haugen, Bugwood.org

- Adults of both sexes have large, stout, cylindrical bodies, pointed at the tail tip. Woodwasps lack the narrow "wasp-waist" between the thorax and abdomen characteristic of many other wasp families.
- Female adults: the head and body are completely dark metallic blue/black; all 3 pairs of legs are orange; females may reach a length of 1.8" (4.5 cm), including ovipositors.
- Male adults: head and thorax are dark metallic blue/black; abdomen is black at the base and tail ends with the middle segment orange; the front 2 pairs of legs are orange, the hind pair is black; males range from 1-1.5" (2.5-4.0 cm) long.
- Both sexes have black antennae typically over 0.8" (20 mm) long, and four clear yellow/orange membranous wings.
- Eggs: are sausage-shaped, creamy white, ~ 0.06" (1.46 mm) long and ~ 0.01" (0.3 mm) wide.
- Larvae: are cylindrical, legless, creamy white grubs with distinct heads; 0.04-1.18" (1.06-30 mm) long; with a distinctive dark "spine" (or spike) at the rear of the abdomen.

WHAT TO LOOK FOR:

SWW are most likely to infest weak, injured, diseased, very rapidly growing, or otherwise stressed living host trees, and dead or fallen host trees.

Symptoms of SWW infestation include:

- Foliage wilts and the needles point straight down.
- Needles in tree crowns turn light green to yellow to reddish brown over 3-6 months.
- Resin beads or dribbles on the bark from oviposition drilling wounds.
- Oviposition drill holes are perfectly round, usually clustered in groups of 5 or 6.
- Drill sites are more common at mid-bole level (10-30+ ft or 3-9+ m) on trees 6-8" (> 15 cm) in diameter and larger.
- Meandering larval galleries abut 5-6" (12-15 cm) long, tightly packed with frass, expanding in diameter as they progress.
- Galleries initiate in the cambium, then turn in toward the heartwood, and may turn back out toward the bark prior to pupation.
- Larvae may be found in galleries beneath the bark, deep into heartwood, or deep in oviposition drill holes.
- Pupae are typically found in chambers about 2" (5 cm) below the surface of the bark.
- Fungal staining of the cambial layer beneath the bark. Stains are long, narrow, oval shaped brown bands along the grain, with drill hole(s) at the center.
- Round exit holes ⅛-⅜" (3-8 mm) in diameter created by adults emerging in year two.

MONITORING:

Regulatory agencies primarily survey for SWW by visual inspection of host trees. Visual inspection may be aerial, ground forest inspection by trained personnel for symptoms of damage, or ground checks of individual trees identified as potentially infested. The latter may require stripping bark away to check beneath for galleries, fungal staining, or larvae.

Traps for adults have low effectiveness, but Lindgren funnel, Panel Intercept and Cross vane traps have been used. Research continues to determine the best semio-chemical baits, but those currently in use include 70:30 alpha:beta pinene, PheroTech Sirex Lure or Synergy Lures, changed every 6-8 weeks. Optimal trap height is mid-bole, or about 10-30 feet.

A band of trap trees is a more effective monitoring device than traps using semio-chemical baits. Trap trees and logs 2-4 weeks old generally capture more SWW than baited traps of any sort. Stressed Scots or red pines are preferred as trap trees; white pines are misleading because they often show resin beads even without sirex infestation. The most effective time to chemically girdle trap trees is in June, and the herbicide Banvel has proven better than Garlon. Mechanical girdling should be done earlier in the year to allow more time for trees to desiccate, however this method has not proved as efficacious as the use of Banvel. Positive trap trees may also provide a source of infested trees for controlled nematode release, a biological control option.

Round exit holes vary in size from 1/8-3/8". Dennis Haugen, Bugwood.org

MANAGEMENT:

The Southern Hemisphere has no native siricid species, but North America has many, including several very similar to SWW. This makes it challenging to develop a management program for SWW in North America that will avoid impacting native species, which are considered minimally damaging and even beneficial in hastening the decay of trees that die from other causes.

Regulatory

In 2004, delimiting surveys implemented by APHIS, the USDA Forest Service, New York State regulatory agencies, and the Canadian Food Inspection Agency resulted in positive detections of SWW at multiple sites. In 2006, a Sirex Science Panel convened by the USDA AHPIS PPQ recommended a biological control program be established using parasitic nematodes, initiation of an aggressive multi-state trapping program, added SWW to the Cooperative Agricultural Pest Survey (CAPS), and called for regulatory quarantines restricting movement of high risk commodities from infested areas. These actions would be applicable to untreated pine roundwood (poles, posts, firewood, log home components, pulpwood), green pine lumber and products made from it, pallets, pine chips ≥ 1" (2.5 cm) thickness, dug Christmas trees and nursery stock ≥ 4" (10 cm) diameter at the soil line. A domestic Interim Rule adopting International Standards for Phytosanitary Measures (ISPM) was drafted in 2006, with the final draft set for review in 2008. Canada and the U.S. are in discussions regarding a cooperative "zonal approach" to regulate SWW.

Cultural Control

Silviculture practices to maintain and enhance stand vigor on an area-wide basis are important in preventing establishment. Such measures are not as effective on a property-by-property basis. Thinning and pruning overcrowded stands can be beneficial, but should be avoided during woodwasp flight season since these activities wound trees and may attract pests or leave trees susceptible to infestation.

Mechanical/Physical Control

Research is needed to determine the appropriate chip size of infested wood that would prevent larvae from surviving (assume 1 inch [2.5 cm] in 2 dimensions unless/until research demonstrates otherwise). Bark chips are not a concern with this pest, as eggs and larvae are in the wood. Pine nursery stock should be inspected and evaluated for risk prior to movement. Research is currently underway on treatments of wood products using heat and RF (radio frequency) microwaves.

Damage to interior of tree: frass packed mines and fungal stains. Note larva protruding from tunnel. Paula Klasmer, Instituto Nacional de Tecnologia Agropecuaria, Bugwood.org

Biological Control

A European species of parasitic nematode, *Beddingia siricidicola* (previously known as *Deladenus siricidicola* Bedding), has proven to be an efficient biological control agent of SWW in Australia, New Zealand and other Southern Hemisphere countries. Australia currently uses the highly infective Kamona strain of *B. siricidicola*, and in 2006 some were imported for the first North American controlled releases. In spring 2007, USDA APHIS scientists initiated controlled test releases of *B. siricidicola* at 5 sites in New York State, but early results show disappointingly low rates of parasitism. Nematodes lab-reared in the American strain of the *A. areolatum* fungus were released October 2007 at sites in NY and MI, and results are pending.

The nematodes feed on the symbiotic fungus and use SWW as a means of dispersal. The nematodes have two very different life cycles and adult forms depending on their environment. If no SWW larvae are present, the nematodes develop into a fungus-feeding form and grow and reproduce on the fungal hyphae within a tree. Where SWW larvae are present, juvenile nematodes develop into a parasitic form with a large stylet used to puncture the larvae's cuticles. Juvenile nematodes enter SWW larvae through these punctures, and female nematodes then reproduce within the bodies of their SWW host larvae without killing them. The newly produced juvenile nematodes enter and replace the egg contents of female SWW larvae, rendering them sterile. The parasitized female SWW adults that emerge will lay eggs filled with nematode juveniles instead of woodwasps, subsequently spreading nematodes throughout the forest.

By rendering *S. noctilio* sterile and using them for dispersal, the nematodes effectively regulate SWW populations below damaging levels. The nematode is easily mass-reared in laboratories and inoculated into infested trees. In Australia, trap trees are created in spring, nematodes are mass reared in labs throughout the summer, then in the fall trap trees are felled and inoculated with ~100,000 nematodes per tree. Research in Argentina has shown that female SWW infected with nematodes fly much shorter distances than uninfected wasps, indicating that inoculated trees should be spread over a wide area to ensure adequate dispersal of the nematodes. U.S. researchers have found that the growth rate of the North American strain of *A. areolatum* is about ⅓ that of the Australian strain and only about ¼ as many nematodes are produced, so research into an appropriate nematode release rate for N.A. continues.

In addition to the nematode, hymenopteran parasitoids have been introduced into SWW populations in the Southern Hemisphere, most of which are native to North America (e.g., *Megarhyssa nortoni*, *Rhyssa persuasoria*, *Rhyssa hoferi*, *Schlettererius cinctipes*, and *Ibalia leucospoides*). The impact of North American parasitoids needs further study. The parasitoid species that were used most effectively in Australia were actually North American species and are being recovered from Sirex in the U.S.

Chemical Control

Research is currently being conducted using pressure treatment with arsenical-like compounds and fumigation of pine wood materials up to 8" (20 cm) in diameter.

LOOK-ALIKE INSECTS:

There are more than a dozen species of native horntails in North America that attack conifers, and are considered minor pests of primarily dead or dying trees. The exotic Sirex woodwasp is much more aggressive and can attack living pines, leading to much greater damage. No keys to identify woodwasp larvae to the species level have been developed, but adult SWW can be distinguished from native horntails by the following characteristics:

- Antennae of SWW are always black.
- SWW ovipositor pits (slight indentations) are larger and closer together than the next most similar Sirex.
- SWW pits on the upper surface of the head are smaller and fewer, with sparse hairs sticking out of each; head has a "shiny" appearance because of fewer pits and less hair than native horntails.

- SWW mesoscutum pits are rasp-like in appearance, with hair sticking out of each pit.
- Female SWW's ovipositor is shorter than the forewing, and the saw sheath is shorter than the oblong plate.
- The tarsal pad of the female SWW hind leg is very short or small compared to that of other Sirex.
- The yellow pattern at the base of the metabia of the male SWW hind leg is much larger than that of other Sirex.
- *S. noctilio* larvae bore galleries deep into the wood, unlike bark beetle larvae, which typically stay just under the bark. This makes SWW more difficult to detect and eliminate.

Adult female SWW Actual Size:

How to Report a Possible Sighting/Infestation

In Maryland:
University of Maryland Cooperative Extension Exotic Pest Threats Website:
http://hgic.umd.edu/faq/sendAQuestion.cfm

Maryland Department of Agriculture: call 410-841-5920 to report suspect pests; visit http://www.mda.state.md.us/plants-pests/invasive_species.php for information.

Nationally: USDA-Animal and Plant Health Inspection Service (APHIS)
http://www.aphis.usda.gov/services/report_pest_disease/report_pest_disease.shtml

Where to Get More Information:

UMD Cooperative Extension Exotic Pest Threats Website: http://www.PestThreats.umd.edu/index.cfm

USDA AHPIS Plant Pest Information, Sirex noctilio webpage:
http://www.aphis.usda.gov/plant_health/plant_pest_info/sirex/index.shtml

USDA Forest Service Pest Alert NA-PR-07-05, June 2005:
http://www.aphis.usda.gov/plant_health/plant_pest_info/sirex/downloads/sirexpa.pdf

Images:

Aphis Survey Guide: http://www.aphis.usda.gov/plant_health/plant_pest_info/sirex/downloads/vsguide.pdf

The State of Queensland, Department of Primary Industries and Fisheries (Australia):
http://www2.dpi.qld.gov.au/forestry/8096.html

Project Participants: Chris Sargent, Research Assistant; Michael Raupp, Entomologist; Sandra Sardanelli, IPM Coordinator; Paula Shrewsbury, Entomologist; David Clement, Pathologist; Mary Kay Malinoski, Entomologist.

Selected References:

Borchert, D., G. Fowler, L. Jackson. 2007. Organism Pest Risk Analysis: Risks to the Conterminous United States Associated with the Woodwasp, *Sirex noctilio* Fabricius, and the Symbiotic Fungus, *Amylostereum areolatum* (Fries: Fries) Boidin. USDA-APHIS-PPQ-CPHST-PERAL: http://www.aphis.usda.gov/plant_health/plant_pest_info/sirex/downloads/sirex-pra.pdf

Forestry Health Technology Enterprise Team. 2006. Guide to the Siricid Woodwasps of North America. USDA Forest Service: http://www.fs.fed.us/foresthealth/technology/pdfs/GuideSiricidWoodwasps.pdf

USDA. 2007. *Amylostereum areolatum* (Fr.) Boidin Sirex-Fungus Pest Fact Sheet. USDA APHIS Center for Plant Health Science and Technology: http://www.aphis.usda.gov/plant_health/plant_pest_info/sirex/downloads/sirexfungus.pdf

Williams, D. W. 2007. White Paper (Appendix 1 to Sirex Science Panel Report): Potential non-target effects of *Beddingia siricidicola* when used as a biological control agent of *Sirex noctilio* in North America. USDA, APHIS: http://www.aphis.usda.gov/plant_health/plant_pest_info/sirex/downloads/sap12-14-06.pdf

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