Sirex noctilio

IDENTITY

Name: *Sirex noctilio*

Pest Authorities: Fabricius

Taxonomic Position: Insecta: Hymenoptera: Siricidae

Sub-specific Taxon:

Pest Type: Insect

Common Name(s):
avispa taladradora de la madera (South America - Spanish)
Eurasian woodwasp (South Africa - English)
sirex woodwasp (Australia & New Zealand - English)
vespa-da-madeira (Brazil - Portuguese)

Synonym(s):

RISK RATING SUMMARY

Numerical Score: 9

Relative Risk Rating: Very High Risk

Uncertainty: Very Certain

RISK RATING DETAILS

Establishment Potential Is High Risk

The relevant criteria chosen for this organism are:

- Organism has successfully established in location(s) outside its native distribution
- Suitable climatic conditions and suitable host material coincide with ports of entry or major destinations.
- Organism has demonstrated ability to utilize new hosts
- Organism has active, directed host searching capability or is vectored by an organism with directed, host searching capability.
- Organism has high inoculum potential or high likelihood of reproducing after entry.

Justification: *Sirex noctilio* has established in many Southern Hemisphere countries with exotic pine plantations; many of the pine species are native to North America. This woodwasp would find climatic conditions suitable for establishment over most of North America (Carnegie et al. 2006). *S. noctilio* is attracted to stressed and weakened trees, and it can fly long distances to find suitable host trees.

Spread Potential Is High Risk

The relevant criteria chosen for this organism are:

- Organism is capable of dispersing more than several km per year through its own movement or by abiotic factors (such as wind, water or vectors).
- Organism has demonstrated the ability for redistribution through human-assisted transport.
- Organism has a high reproductive potential
- Potential hosts have contiguous distribution.
- Newly established populations may go undetected for many years due to cryptic nature, concealed activity, slow development of damage symptoms, or misdiagnosis.
- Eradication techniques are unknown, infeasible, or expected to be ineffective.
- Organism has broad host range.

Justification: Natural dispersal of *Sirex noctilio* has been estimated at 30 to 50 km per year in Australia (Haugen et al. 1990). All life stages are easily transported in unprocessed logs, lumber, and solid wood packing materials. All pine species appear to be susceptible, thus it has a wide expanse of potential hosts across North America. Early detection of a population is unlikely in North America, since low level pine mortality is common by native insects, and *S. noctilio* would be easily mistaken for some of the native siricids. Eradication has not been successful in the Southern Hemisphere under optimal situations (isolated areas with only pine plantations); thus, eradication would be very unlikely in North America with widespread native pine stands.

Economic Potential Is High Risk

The relevant criteria chosen for this organism are:

- Organism attacks hosts or products with significant commercial value (such as for timber, pulp, or wood products.
- Organism directly causes tree mortality or predisposes host to mortality by other organisms.
- Damage by organism causes a decrease in value of the host affected, for instance, by lowering its market price, increasing cost of production, maintenance, or mitigation, or reducing value of property where it is located.
- Organism may cause loss of markets (domestic or foreign) due to presence and quarantine significant status.
- Organism has potential to be a more efficient vector of a native or introduced pest.

Justification: *Sirex noctilio* has become a major pest in the pine plantations of Australia, New Zealand, South America and South Africa. It has caused up to 80% tree mortality in the most susceptible plantations. It has the potential to cause significant tree mortality in North America, especially in overstocked and stressed pine plantations and natural forests. Attacked trees usually die within a few months, and the value of the tree for commercial products is quickly lowered.

Environmental Potential Is High Risk

The relevant criteria chosen for this organism are:

- Organism is expected to cause significant direct environmental effects, such as extensive ecological disruption or large scale reduction of biodiversity.
- Organism is expected to have indirect impacts on species listed by Federal, Provincial, or State agencies as endangered, threatened, or candidate. This may include disruption of sensitive or critical habitat.
- Organism may attack host with small native range.

Justification: Changes in stand composition could occur due to *S. noctilio*-associated pine mortality. *Sirex noctilio* would be in direct competition with native siricids, and because it is more aggressive, it may reduce populations of those species. The remaining native stands of *Pinus radiata* and *P. torreyana* could be impacted, if *S. noctilio* became established there.

HOSTS

Under stressed conditions, many pine species appear to be susceptible to attack by *S. noctilio*. Pines attacked by *S. noctilio* in its native range include *Pinus pinaster*, *P. sylvestris*, *P. nigra* and *P. pinea*. In Australia, New Zealand and South Africa, the main host is *Pinus radiata*. In Brazil and Uruguay, the main host is *Pinus taeda*. Other known hosts are North American pines species in plantations in the southern hemisphere including *Pinus banksiana*, *P. contorta*, *P. echinata*, *P. elliottii*, *P. jeffreyi*, *P. palustris*, *P. patula*, and *P. ponderosa* (Klasmer et al. 1998, Maderni 1998).

Sirex noctilio has also been reported from *Abies* spp. and *Picea* spp., but these hosts accounted for less than 1% of the emergence (Spradbery and Kirk 1978). They conclude that *S. noctilio* is virtually confined to *Pinus* species. *Sirex noctilio* has been reported in *Larix* spp. and *Pseudotsuga menziesii* (Krombein et al. 1979), but these reports are either very rare occurrences or incorrect identifications.

GEOGRAPHICAL DISTRIBUTION

Africa:

Native to northern Africa: Algeria, Morocco and Tunisia (Spradbery & Kirk 1978). Established in South Africa (Tribe 1995).

Asia:

Native to Asia including the Near East, Russia (Siberia) and Mongolia (Medvedev 1993).

Australasia & South Pacific:

Established in New Zealand (1900), Tasmania (1952) and the Australian mainland (1961) (Taylor 1981).

Europe:

Native to Europe and reaches its greatest density in the Mediterranean zone (Spradbery and Kirk 1978).

North America:

Has been frequently intercepted at ports of entry (Haack and Cavey 1997). Specimen caught in a trap in Fulton, New York during September 2004 (Hoebeke et al. 2005), and an established population subsequently detected in Oswego, New York during May 2005. Also caught in traps in Canada along Lake Ontario and St. Lawrence River during 2005.

South America:

Established in Uruguay (1980), Argentina (1985), Brazil (1988), and Chile (2001) (Carnegie et al. 2006).

BIOLOGY

Much of the research on *S. noctilio* has been conducted in Australia and New Zealand, so the following information relates to the situation in these countries. *Sirex noctilio* normally completes one generation per year in southeastern Australia, but a portion of a population may take 2 years in the cooler climates of Tasmania and New Zealand (Taylor 1981). In Australia, adults emerge from early summer to early winter with peak emergence in late summer or early autumn. Males usually predominate, with sex ratios of 4:1 to 7:1 (Morgan and Stewart 1966, Neumann and Minko 1981). Females are attracted to physiologically stressed trees after an initial flight, which is usually less than 3 km, but with the potential of up to 200 km (Bedding and Iede 2005). They drill their ovipositors into the outer sapwood to inject a symbiotic fungus (*Amylostereum areolatum*) and toxic mucus (Talbot 1977). The fungus and mucus act together to kill the tree (Coutts 1969a, 1969b, 1969c). If the tree is suitable, eggs are laid into the sapwood (up to three separate eggs at a drill site). Fecundity ranges from 21 to 458 eggs, depending upon size of the female (Neumann and Minko 1981). The eggs usually hatch within 10 to 15 days, but some may overwinter in cooler climates. Unfertilized eggs develop into males, while fertilized eggs produce females. All larval instars feed on the fungus as they tunnel through the wood. Larval galleries may penetrate to the center of a tree. The number of instars varies from 6 to 12, and the larval stage generally takes 10 to 11 months. Mature larvae pupate in the wood, close to the bark surface, and adults emerge about 3 weeks later (Madden 1988, Taylor 1981).

PEST SIGNIFICANCE

Economic Impact: *Sirex noctilio* has the potential to cause significant mortality in overstocked pine plantations and stressed forest stands. In Australia, *S. noctilio* caused up to 80 percent tree mortality in *Pinus radiata* plantations. In 1 year, *S. noctilio* killed 1.75 million trees in 141,000 acres of plantations aged 10 to 30 years (Haugen and Underdown 1990). The potential damage due to *S. noctilio* in Australia was estimated at between US$16 and US$60 million per year (Bedding & Iede 2005). Brazil considers *Sirex noctilio* as a major threat to its pine plantations and has implemented an intensive pest management program (Iede et al 1998).

Loblolly pine plantations in the southeastern United States could sustain significant economic losses due to an introduced population of *S. noctilio*. Pine forests of the western United States could be impacted by *S. noctilio* establishment. Even with a conservative estimation of tree mortality, an economic analysis projected losses of $24-130 million in the western states over 30 years (USDA Forest Service 1992). A later analysis projected losses at three introduction points over 30 years with the following results: $48-607 million for Georgia, $7-76 million for Minnesota, and $7-77 million for California (USDA 2000).

Environmental Impact: The effect of *S. noctilio* on the native pine forests of the United States could be significant. Changes in stand composition could occur with the selective mortality of pines due to an invasion of *S. noctilio*. The potential damage to these stands would be increased during droughts or other climatic events that reduce tree vigor. A significant reduction in the genetic base of *Pinus radiata* and *P. torreyana* could occur if *S. noctilio* became established in the remaining native stands.

An increase in *S. noctilio*-associated tree mortality may increase the populations of other destructive pests, such as bark beetles or root rots. The establishment of *S. noctilio* in the North American forests could affect the populations of other insects. *S. noctilio* would be in competition with native siricids, and because *S. noctilio* is more aggressive, it may reduce populations of native species. An expanding *S. noctilio* population could result in population increases of the native parasitoids of siricids (e.g., *Rhyssa* spp., *Megarhyssa nortonii*, *Schlettererius cinctipes*, and *Ibalia* spp.), which could further decrease the native siricid fauna (Kirk 1974, 1975).

Control: Management tactics for *S. noctilio* have been successful in the pine plantations of Southern Hemisphere (Haugen et al. 1990, Oliveira et al. 1998, Tribe and Cillie 2004). Detection at an early stage of sirex establishment (e.g., in a locality before any compartment reaches 0.1% annual sirex-associated tree mortality) is critical in implementing a successful management program (Haugen et al. 1990). Silvicultural and biological controls are the main tactics that reduce the risk of *S. noctilio* outbreaks.

For silvicultural management, on-time first thinning of a plantation is key. Keeping a pine stand growing vigorously is an effective preventative measure. *Sirex noctilio* needs stressed, weakened and suppressed trees for rapid population growth and to reach outbreak populations. Thinned stands may sustain some damage during droughts or other stresses, but major outbreaks are unlikely. Thinning and pruning should be avoided during the *S. noctilio* flight season, because these activities wound trees, thus increasing their susceptibility to attack.

The key biological control agent is the parasitic nematode, *Deladenus (=Beddingia) siricidicola*. This nematode only feeds on the specific fungus (*A. areolatum*) that the woodwasp injects into the tree, but when the nematode is close to a *S. noctilio* larva, it molts into an infective form and penetrates the larva. Ultimately it sterilizes the female woodwasp (Bedding 1972, Bedding and Akhurst 1978). The nematode is highly density dependant and it regulates the *S. noctilio* population below the damage threshold. This nematode can be mass-produced in the laboratory and inoculated into *S. noctilio* populations as new areas are invaded (Bedding and Akhurst 1974).

Several parasitoid species have been introduced into infested areas in the Southern Hemisphere. However, most of these parasitoids are native to North America, so release of additional siricid parasitoids in North America should not be needed. The native parasitoid species would probably exert some level of natural control on *S. noctilio* populations.

DETECTION AND IDENTIFICATION

Symptoms: Trees attacked by *S. noctilio* begin to show crown symptoms a couple months after peak adult emergence. The crown turns light green to yellow to red. Beads or dribbles of resin, resulting from oviposition wounds, may be visible on the bark along the entire bole or a section of the bole. If the bark is cut away, a dark fungal stain in the cambium is evident that runs vertically from each oviposition site. Larval galleries are packed with a fine powdery frass and can occur throughout the wood, even to the center of large trees. Exit holes are round and vary from 3-8 mm in diameter (Haugen & Hoebeke 2005).

Morphology: Adults are usually 20 to 35 mm in length. The female is uniformly metallic bluish-black with reddish-yellow legs and has a prominent ovipositor. The male is bluish-black with an orange band on the middle segments of the abdomen. Its fore and middle legs are reddish yellow, while the hind legs are thickened and black. Antennae of both sexes are black. The yellowish-white larva is a typical siricid with a round head, rudimentary legs, and a hard black spine on the posterior segment. Fully grown larvae can exceed 30 mm in length (Haugen & Hoebeke 2005).

Testing Methods for Identification: More than a dozen species of siricids occur in North America, and a key for adult siricids, including *S. noctilio*, was developed by Smith and Schiff (2002). For positive identification of *S. noctilio*, adult specimens need to be confirmed by a specialist. Larval stages of the Siricidae cannot be reliably identified beyond Family by morphological characters. However, DNA analysis is being developed, so all stages of siricids can be identified to species by molecular techniques (Nathan Schiff, USDA Forest Service, Southern Research Station, Stoneville, MS, personal communication).

MEANS OF MOVEMENT AND DISPERSAL

Sirex noctilio is likely to spread throughout North America. Natural spread of sirex population has been estimated at 30-50 km per year in Australia (Haugen et al. 1990). Adult females have a high fecundity and are capable of long dispersal flights (Bedding and Iede 2005). Also, human-assisted transport of sirex in logs, lumber, and solid wood packing materials within North America would greatly increase the rate of spread into uninfested areas.

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