United States
Department of
Agriculture

**Forest
Service**

Miscellaneous
Publication No. 1508

October 1992

Pest Risk Assessment of the Importation of *Pinus radiata* and Douglas-fir Logs from New Zealand

Scientific name of pest: *Sirex noctilio F.* (Siricidae)/ *Amylostereum areolatum* (Fr.) Boidin

Scientific name of host(s): *Pinus* spp., especially *P. radiata, Pseudotsuga menziesii, Larix, Picea,* and *Abies*

Distribution: Native in Eurasia, northern Africa; introduced in New Zealand, Australia, Brazil, Argentinia, and Uruguay

Summary of natural history and basic biology of the pest: *Sirex noctilio* is endemic to Eurasia and northern Africa, reaching its greatest density in the Mediterranean zone. *S. noctilio* is generally considered to be a secondary pest of trees following primary damage in its native range (Spradbery and Kirk 1978). It has become established in New Zealand (1900), Tasmania (1952), and the Australian mainland (1961), and recently in Brazil, Argentina and Uruguay. In Australia and South America it causes significant tree mortality and is considered a major pest (Taylor 1981; Bedding personal communication). In recent years in New Zealand, *S. noctilio* has not been considered a major pest species (Nuttall 1989).

Tree species attacked by *S. noctilio* in its native range are almost exclusively pines (e.g., *Pinus pinaster, P. sylvestris, P. nigra, P. pinea),* but it also has been recorded in fir and spruce (Spradbery and Kirk 1978). *Sirex noctilio* has been reported in larch and Douglas-fir (Krombein *et al.* 1979), but these reports are very rare occurences, or they may be mistakes in identification. The other species of European siricids are only rarely associated with pines (Spradbery and Kirk 1978). In New Zealand and Australia, the main host is *Pinus radiata*, a native tree of California. Under stress condition *Pinus* spp. are very susceptible to attack by *S. noctilio*.

The fungus *Amylostereum areolatum* occurs in close association with woodwasps, *Sirex* spp. Talbot (1977) states "Specific species of *Sirex* carry only one species of *Amylostereum.* In the case of *A. areolatum*, it is only known to be carried be three species of *Sirex*, none of which are known

from North America." These three species are *S. juvencus*, *S. noctilio*, and *S. nitobei* (Talbot 1977). The fungus is pathogenic in association with *Sirex*, mostly on *Pinus*.

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). After an initial flight period usually less than 2 miles, but with the potential of 100 miles (Bedding and Akhurst personal communication), females are attracted to physiologically stressed trees. They drill their ovipositors into the outer sapwood to assess the suitability for oviposition. At this time, a symbiotic fungus *(Amylostereum areolatum)* and a toxic mucus are injected into the sapwood along with the eggs (up to three separate eggs at a drill site). The fungus and mucus act together to kill the tree and create a suitable environment for the development of larvae. Crown wilt does not occur until a cross section of wood in at least one part of the stem has been invaded and killed by the fungus, which causes an inconspicuous white sapwood rot. 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 close to the bark surface and adults emerge about 3 weeks later (Taylor 1981).

Specific information relating to risk elements:

A. Probability of pest establishment

1. Pest with host at origin: *Low*

Sirex noctilio and *Amylostereum areolatum* are established in New Zealand. Historically, *S. noctilio* has been reported as a pest in New Zealand. However, because of the establishment of biological control agents and improved stand management, the occurrence of these organisms in plantation forests has been reduced. Volatiles from cut trees can increase the *S. noctilio* population in an area, and oviposition may occur on cut trees (Madden 1971). Required fumigation of logs will be highly effective in killing early stages in recently cut logs (Harris 1963a; USDA APHIS 1991). Other life stages of *S. noctilio* deep in the wood are not effectively treated by fumigation. However, the quality of logs desired for importation will minimize the likelihood of these later stages being present in the logs at the time of export.Therefore, the probability for logs intended for export to be infested with *S. noctilio* and *Amylostereum areolatum* is low.

2. Entry potential: *High*

Survival of *S. noctilio* larvae in logs can be very high. Survival greatly depends on a suitable moisture content for fungal growth, e.g., above 20% ODW (oven-dried weight) (Talbot 1977). Because its life cycle is generally a year or longer, it could

easily survive the transit period within logs and escape detection at the port of entry. Detection of either organism at the port of entry is unlikely.

3. **Colonization potential: *High***
S. noctilio has been transported to many parts of the world and has become established in pine plantations. A high probability is expected for pines within a 2-mile radius of ports of entry and/or destinations of the logs. Abundance of *Pinus* spp. in these areas would significantly increase the colonization potential. It is realistic to assume that other *Pinus* spp. in the United States would be susceptible to *S. noctilio.*

4. **Spread potential: *High***
If *S. noctilio* became established in Pacific Coast States, it is likely to spread throughout the Western United States, depending upon which pine species were suitable hosts. Most rapid spread would probably be through California, Arizona, New Mexico, Nevada, and Utah. Natural dispersal of *S. noctilio* has been estimated at 5 to 15 miles per year in Australia.

B. Consequences of establishment

5. **Economic damage potential: *High***
Sirex noctilio has the potential to cause significant mortality in overstocked pine plantations and unhealthy forest stands. In Australia, *S. noctilio* caused up to 80 percent tree mortality in *Pinus radiata* plantations over a 3-year period. 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).

An economic assessment of the effects of *Sirex noctilio* and *Amylostereum areolatum* is presented in chapter 5. Based on the assumptions presented, the economic effect ranges from $24 million to $130 million.

An efficient biological control agent is available that can reduce and maintain *Sirex noctilio* populations below the economic damage threshold. A parasitic nematode, *Beddingia siricidicola* (Bedding) (formerly *Deladenus siricidicola*) can be mass-produced and inoculated into *S. noctilio* populations as they invade and colonize new territories (Bedding and Akhurst 1974). Minimum cost to establish the nematode is estimated at $3.50/acre in plantations (Haugen and Underdown 1990, Haugen *et al.* 1990), but a less intensive program could be implemented in natural stands. See appendix H for additional information.

Some increased economic loss would occur because of log degradation and decay caused by *Sirex noctilio* and *Amylostereum areolatum.* This would be a minor effect relative to the actual economic loss from tree mortality.

6. **Environmental damage potential: *High***
The effect of *Sirex noctilio* on the native forests of the Western United States could be significant. If *S. noctilio* became established and caused mortality in the

remaining native stands of *Pinus radiata*, a significant reduction in the genetic base of *P. radiata* could occur. In the Sierra Nevada mixed conifer type, changes in stand composition could occur with the selective mortality of pines due to an invasion of *S. noctilio*, depending upon the susceptibility of these pine species to attack. The potential damage to these stands would be increased during droughts or other climatic events that reduce tree vigor. Also, an increase in *S. noctilio*-associated tree mortality may increase the populations of other destructive insect populations, such as bark beetles, by increasing the available food resource. The establishment of *S. noctilio* in the forests of the Western United States would affect the populations of other insects. *S. noctilio* would be in competition with the native siricids, and because *S. noctilio* is more aggressive, it may reduce or eliminate native species. An expanding *S. noctilio* population would result in population increases of the native parasites of siricids (e.g., *Rhyssa* spp, *Megarhyssa nortoni, Schlettererius cinctipes,* and *Ibalia* spp.), which could further decrease the native siricid fauna. If *S. noctilio* became established and caused significant mortality, the impact could be severe in wilderness areas, cause deterioration in watersheds, and threaten key environments of endangered species. See chapter 4 for additional information.

7. **Perceived damage (social & political influences): *High***
Ornamental plantings of pines (especially *P. radiata*) would be at risk if *S. noctilio* became established, but this is a relatively minor impact compared to the potential damage in natural stands and plantations.

Estimated risk: ***Moderate/High***

Additional remarks: The risk from importing untreated *Pinus radiata* logs from anywhere in the world where a *Sirex noctilio* population is established is great.

Selected bibliography:

Bedding, R. A. 1972. Biology of *Deladenus siricidicola* (Neotylenchidae) an entomophagous-mycetophagous nematode parasitic in siricid woodwasps. Nematologica 18:482-493.

Bedding, R.A.; Akhurst, R.J. 1974. Use of the nematode *Deladenus siricidicola* in the biological control of *Sirex noctilio* in Australia. Journal of the Australian Entomological Society 13: 129-135.

Bedding, R. A.; Akhurst, R.J. 1978. Geographical distribution and host preferences of *Deladenus* species (Nematoda: Neotylenchidae) parasitic in siricid woodwasps and associated hymenopterous parasitoids. Nematologica 24:286-294.

Coutts, M. P. 1969a. The mechanism of pathogenicity of *Sirex noctilio* on *Pinus radiata*. I. effects of the symbiotic fungus *Amylostereum* spp. (Thelophoraceae). Australian Journal of Biological Science 22:915-924.

Coutts, M. P. 1969b. The mechanism of pathogenicity of *Sirex noctilio* on *Pinus radiata*. II. effects of *S. noctilio* mucus. Australian Journal of Biological Science 22:1153-1161.

Coutts, M. P. 1969c. The formation of polyphenols in small blocks of *Pinus radiata* sapwood with and without the fungal symbiont of *Sirex*. Australian Forestry Research 4(1):29-34.

Harris, E.C. 1963a. Methyl bromide fumigation for wood-boring insects. International Pest Control 5(4): 15-18.

Haugen, D. A. 1990. Control procedures for *Sirex noctilio* in the Green Triangle: review from detection to severe outbreak (1977-1987). Australian Forestry 53:24-32.

Haugen, D.A.; Underdown, M.G. 1990. *Sirex noctilio* control program in response to the 1987 Green Triangle outbreak. Australian Forestry 53: 33-40.

Haugen, D.A.; Bedding, R.A.; Underdown, M.G.; Neumann, F.G. 1990. National strategy for control of *Sirex noctilio* in Australia. Australian Forest Grower 13(2): special liftout section No. 13. 8pp.

Horwood, D. W.; Morgan, F.D.; Stewart, N.C. 1970. Effect of contact insecticides against the woodwasp *Sirex noctilio*. Australian Forestry 34:49-59.

Hosking, G.P., 1978. *Prionoplus reticularis*. New Zealand Forest Service Forest Research Institute Forest Leaflet 35.

Kile, G. A.; Bowling, P.J.; Dolezal, J.E.; Bird, T. 1974. The reaction of *Pinus radiata* twigs to the mucus of *Sirex noctilio* in relation to resistance to *Sirex* attack. Australian Forestry Research 6:25-34.

Kirk, A. A. 1974. Siricid woodwasps and their associated parasitoids in the southeastern United States (Hymenoptera: Siricidae). Journal of the Georgia Entomological Society 9:139-144.

Kirk, A. A. 1975. Siricid woodwasps and their associated parasitoids in the southwestern United States (Hymenoptera: Siricidae). Pan-Pacific Entomology 51:57-61.

Krombein, K.V., et al. 1979. Catalogue of Hymenoptera in America north of Mexico, vol. 1, (Symphyta and Apocrita). Washington, DC, Smithsonian Institution Press.

Madden, J.L. 1971. Some treatments which render Monterey pine (*Pinus radiata*) attractive to the wood wasp *Sirex noctilio* F. Bulletin Entomology Research 60: 467-472.

Madden, J. L. 1988. *Sirex* in Australasia. In: Berryman, A.A., ed. Dynamics of Forest Insect Populations. New York: Plenum: 407-429.

McKimm, R. J.; Walls, J.W. 1980. A survey of damage caused by the sirex woodwasp in the radiata pine plantation at Delatite, Northeastern Victoria, between 1972 and 1979. Forestry Commission Victoria Forestry Technical Papers 28:3-11.

Morgan, F.D.; Stewart, N.C. 1966. The biology and behaviour of the woodwasp *Sirex noctilio* F. in New Zealand. Transactions of the Royal Society of New Zealand (Zoology) 7: 195-204.

Morgan, F. D.; Stewart, N.C.; Horwood, D.W. 1971. Translocation of insecticides in radiata pine and effectiveness on *Sirex noctilio*. Australian Forestry 35:133-142.

Neumann, F.G., and G. Minko. 1981. The *Sirex* woodwasp in Australian radiata pine plantations. Australian Forestry 44: 46-63.

Nuttall, M.J. 1989. *Sirex noctilio* F., sirex woodwasp (Hymenoptera: Siricidae). In: Cameron, P.J., Hill, R.L., Thomas, W.P., eds. Technical Communication No. 10. A review of biological control of insect pests and weeds in New Zealand 1874 to 1987. Wallingford, U.K.: CAB International Institute of Biological Control: 299-306.

Rawlings, G. B.; Wilson, N.M. 1949. *Sirex noctilio* as a beneficial and destructive insect of Pinus radiata in New Zealand. New Zealand Journal of Forestry 6(1):20-29.

Spradbery, J.P., and A.A. Kirk. 1978. Aspects of the ecology of siricid woodwasps (Hymenoptera: Siricidae) in Europe, North Africa and Turkey with special reference to the biological control of *Sirex noctilio* F. in Australia. Bulletin of Entomological Research 68: 341-359.

Talbot, P.H.B. 1964. Taxonomy of the fungus associated with *Sirex noctilio*. Australian Journal of Botany 12: 46-52.

Talbot, P.H.B. 1977. The *Sirex-Amylostereum-Pinus* association. Annual Review of Phytopathology 15: 41-54.

Taylor, K. L. 1976. The introduction and establishment of insect parasitoids to control *Sirex noctilio* in Australia. Entomophaga 21:429-440.

Taylor, K. L. 1978. Evaluation of the insect parasitoids of *Sirex noctilio* (Hymenoptera: Siricidae) in Tasmania. Oecologica (Berlin) 32:1-10.

Taylor, K.L. 1981. The sirex woodwasp: ecology and control of an introduced forest insect. In: The ecology of pests - some Australian case histories. Kitching, R.L.; Jones, R.E, eds. Melbourne: CSIRO: 231-248.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 1991. An efficacy review of control measures for potential pests of imported Soviet timber. Misc. Pub. 1496. Washington, DC.