

# EVALUATION OF *BEDDINGIA SIRICIDICOLA* AS A BIOLOGICAL CONTROL AGENT OF *SIREX NOCTILIO* IN NORTH AMERICA

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## ABSTRACT

*Sirex noctilio* F. was identified in 2005 from bark beetle trap collections in Oswego County, NY, the previous autumn. This exotic invader does not seem to be under natural control, is already distributed over a wide area in the United States and Canada, and poses a serious threat to pine forests and plantations in North America if it is not controlled. Its most effective natural enemy, the entomopathogenic nematode (*Beddingia (Deladenus) siricidicola* (Bedding)), has been used very successfully as a biological control agent in management programs in the Southern Hemisphere. *Sirex* nematode's remarkable biology facilitates its use as a management tool. It can occur in two forms: a mycetophagous form that feeds on the *Sirex* symbiotic fungus, *Amylostereum areolatum* (Fries) Boidin, as it builds populations inside a tree and an entomopathogenic form that attacks *S. noctilio* larvae and ultimately sterilizes the woodwasp adults. We report on our recent activities to use the nematode in a developing biological control program, including consideration of some ecological challenges and issues in adapting the system for use in North America.

Australian scientists have investigated the biology of *Sirex* nematode during the past 30 years and developed technology for delivering it as an effective biological control agent. The Australian biocontrol program schedules activities through three seasons. In the spring, trap trees are created. Plots of 10 suppressed pine trees at the edge of a plantation are treated with an herbicide. The trees die slowly and attract *S. noctilio* females to attack them in their stressed state. In the summer, the nematodes are mass reared by Ecogrow Ltd., the licensed commercial nematode producer in Australia. Nematodes are delivered in lots of one million, which are sufficient to treat 10 trees. In the fall, the trap trees

are felled and inoculated with nematodes. A special hammer is used to punch holes into the xylem; nematodes are then injected into the holes mixed in a polyacrylamide gel and they swim into the cut tracheid fibers of a tree.

Given the environmental differences between Australia and North America, transferring the biological control technology poses some ecological challenges. Two broad areas for discussion are (1) the ecological factors that affect nematode establishment and spread in North America and (2) the possible effects of nematode releases on non-target native species, especially other siricid woodwasps. Within-tree competition is one important ecological factor. *Pinus* species are exotic in Australia, and native pine feeding organisms are non-existent. By contrast, pine trees in North America contain numerous indigenous species, including borer competitors for *S. noctilio*, fungus competitors for *A. areolatum*, and nematode competitors for *B. siricidicola*. Climate is another factor affecting nematode growth and reproduction. Overall, the area into which the nematode will be introduced—currently New York and Pennsylvania—is much colder and wetter than Australia. Multiple strains of *A. areolatum* from different areas of origin and with varying growth rates also pose a challenge. The North American fungus strain isolated from *S. noctilio* in New York State grows at approximately one-third the rate of the strain used for mass rearing in Australia. This difference in growth of the fungus resource also affects the growth rate of nematodes and results in lower yields, by a factor of about four, in our mass rearing process. Another important factor in nematode ecology is tree species. North America has many native and exotic pine species with individual physiological characteristics that may affect nematode growth, development, and reproduction differently.

The possible effect of the nematode biological control program on non-target native species, especially siricids, is an issue of concern to the ecological community. North America contains 17 species of siricid woodwasps that use *Pinus* spp. as a resource, as well as their parasitoids and other borer species. A review of the literature suggests that the only taxa that may possibly be at risk are species of the pine-feeding Siricinae, most of which are associated with the fungal symbiont *Amylostereum chailletii* (Pers. ex Fries) Boidin. Because *B. siricidicola* lives only on *A. areolatum*, siricids using *A. chailletii* have a refuge from nematode parasitism. Of primary non-target concern among the North American siricids are three *Xeris* species, which do not have a fungal symbiont and may feed on either *A. areolatum* or *A. chailletii*. The effects of nematode parasitism on those species are unknown currently.

We have made much progress in transferring biological control technology for *S. noctilio* to North America in the short time since the pest was first detected. During 2006, we set up a lab for rearing nematodes. We received fungus and nematode cultures from Australia in December 2006 and have maintained them for over a year, mass rearing them in summer 2007.

We carried out a controlled release experiment during 2006-2007. The goals of the study were to test the Australian inoculation methodology, assess the establishment of Australian nematodes in American *Pinus* species, and evaluate overwintering survival of the exotic nematodes under New York winter conditions. The release was “controlled” in that trees were inoculated in the fall 2006, but samples were taken in spring 2007 and remaining tree materials were destroyed before insect emergence. A controlled release was necessary for several reasons. Primarily, the environmental assessment from APHIS Environmental Services that was needed for a full release was not finished by the desired release date in early November. In addition, we did not want nematodes and fungus to escape because of lingering non-target concerns and because of the aggressive growth characteristics of the Australian fungus, respectively. In all, 73 Scots pines (*P. sylvestris*) and 22 red pines (*P. resinosa*) were inoculated at five sites in Oswego,

Onondaga, and Madison Counties, New York. Naturally struck trees that were heavily attacked by *S. noctilio* were selected. Three 60-cm sample billets were removed from each tree in March and reared in screened barrels. Almost 2,700 *S. noctilio* adults emerged in summer 2007, and their dissection to determine the nematode parasitism rate is still in progress. Additional controlled releases were made in October 2007 at five sites in New York and Michigan. All nematodes for those releases were mass reared on the North American isolate of *A. areolatum*.