BEHAVIOR AND ECOLOGY OF EXOTIC AND NATIVE SIRICIDS AND THEIR HYMENOPTERAN PARASITOIDS IN SOUTHERN PINE STANDS

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ABSTRACT

The Eurasian woodwasp, *Sirex noctilio* Fabricius (Hymenoptera: Siricidae), is an introduced invasive pest in North America. This siricid woodwasp is native to Europe, Asia, and Africa where it is considered to a secondary colonizer of conifer trees. However, it is a primary colonizer of conifer trees in its non-native zone in the Southern Hemisphere. *Sirex noctilio* is a polyphagous woodwasp with a wide host range, mainly in commercially important pine species and occasionally on larch, fir, and spruce. *Sirex noctilio* kills trees through a combination of female oviposition activity, introduction of phytotoxic mucus, and fungal spores for larval feeding, and it can cause up to 80 percent tree mortality. The extensive conifer forests of North America may be at high risk because native trees lack the necessary host resistance mechanisms to defend themselves, as has been found for the exotic emerald ash borer on North American ash trees.

In North America, *S. noctilio* has been found in the Great Lakes region, specifically in New York, Pennsylvania, Michigan, Ontario, and Vermont, but it may yet be found in other states through a greater detection effort. It is expected that if *S. noctilio* is not contained or eradicated, then populations of *S. noctilio* may become established in other parts of the U.S. The risk of introductions into the Southeast is relatively high due to the high volumes of international commodities moving through this region. Forests in the southeastern U.S. are dominated by southern pine species that are known to be highly susceptible to colonization by *S. noctilio*. Further, the presence of many plantations in the Southeast indicates that this region has a high potential for invasion and economic impacts by *S. noctilio*.

We have two projects related to the potential invasion of *S. noctilio* in the southeastern U.S. The first project is to develop spatially referenced risk models of *S. noctilio* that incorporate host preference information on 8 to 10 southern conifer tree species. The susceptibility of southern conifer species to colonization by *S. noctilio* will be assessed using feeding bioassays. The second project is to compare the species complex of native siricids and their hymenopteran parasitoids in the Appalachian, Piedmont, and Coastal Plain regions of the Southeast. We also intend to assess the host-specificity and parasitism rates of siricid wasps by hymenopteran parasitoids in various species of southern pines. A

rich complex of potential competitors and established parasitoids in the southern pine stands may hinder the establishment and spread of the populations of *S. noctilio*, if introduced in this region.

We determined the oviposition and colonization preferences of *S. noctilio* on loblolly (*Pinus taeda* L.), Virginia (*Pinus virginiana* Mill.), and Scots (*Pinus sylvestris* L.) (control) pines in June 2009. For the host choice experiment, four logs each of the three pine species (loblolly, Virginia, and Scots) in two diameter classes (small and large) were placed in random locations within an arena. Males and females of *S. noctilio* were released within the arena. The activities of adult *S. noctilio* on logs (e.g., ovipositing, sitting, or walking) were observed. Logs were then individually enclosed in mesh sleeves for storage. For the host no-choice study, two large diameter class logs of each of the three pine species were individually enclosed in mesh sleeves. Male and female *S. noctilio* were introduced into each sleeve. Observations similar to those in the host choice experiments were taken. Once the wasps finished emerging in fall 2009, we dissected the logs to record data on host preference. Preliminary results indicate that in the host choice experiment, significantly more males and females of *S. noctilio* were observed on Virginia than on Scots or loblolly pines. Female *S. noctilio* were observed drilling with their ovipositor in the southern pine logs, especially on Virginia pine. In general, more adults of *S. noctilio* were found and emerged from larger than smaller diameter Virginia pines, indicating a host preference. In 2010, we will conduct host choice and no-choice experiments with 8 to 10 southern pine species, assess antennal responses of female *S. noctilio* to bark volatiles, and determine differences in wood and resin quality of southern pines to explain the above patterns.

To sample native siricids and their hymenopteran parasitoids, we established sampling plots in three states: Georgia (Piedmont region), and Louisiana and Virginia (Coastal regions) in fall 2009. These sampling plots had experienced recent disturbance such as thinning and/or clearcutting activities that may attract more native siricids and their parasitoids. The timing of sampling varied across the regions to allow us to trap during the maximum activity of siricid wasps during the year. To assess the species complex of native woodwasps and their parasitoids in each state, we established 30 intercept panel traps that are widely used for monitoring *S. noctilio*. Each intercept trap was (1) unbaited, (2) baited with commercially available *Sirex* lure (alpha- and beta-pinenes), or (3) baited with *Sirex* lure and high release ethanol. We are also assessing the viability of these lures in catching siricids across the southeastern U.S. In Georgia, we are further testing whether funnel or intercept traps were more efficient in catching native siricids. Another 30 funnel traps with the identical baits were placed in the same locations in Georgia. Hymenopteran parasitoids were sampled using 10 Sante traps (similar to Malaise traps) placed high in the canopy. Traps were emptied every 14 days.

To further compare the species complex of these two taxa in different pine species, we created trap logs in each state. In late August 2009, we cut down two trees each of loblolly and shortleaf (*Pinus echinata* Mill.) pines in Virginia. In late September 2009, we cut down three trees of slash pine (*Pinus elliottii* Engelm.) and two of longleaf pine (*Pinus palustris* Mill.) in Georgia. In Louisiana, we are also testing the effects of different methods of inducing tree decline and mortality and the effects of different times of the year on the colonization activity of woodwasps. In treatment 1, we girdled and applied herbicide (dicamba) to four loblolly pine trees between September 1 and October 1, 2009. In treatment 2, we cut down four loblolly pine trees during the week of November 2, 2009. In treatment 3, we cut down four loblolly pine trees during the week of November 16. A panel intercept trap was attached to each of the trees, and the traps are being emptied every 14 days. In fall 2010, we will cut these trees into logs (34 trees across states) and place them in emergence cages to rear out woodwasps and their parasitoid species.

Preliminary results from the trapping experiments indicate that we have caught a total of 70 woodwasps, with the greatest numbers in Virginia, followed by

Louisiana and Georgia. Five species of woodwasps have been indentified; all these species are known to be present in the Southeast. *Sirex nigricornis* Fabricius was the most abundant woodwasp species, followed by *Sirex edwardsii* Brullé, *Eriotremex formosanus* (Matsumura) (exotic), *Urocerus cressoni* Norton, and *Tremex columba* (Linnaeus). About equal numbers of woodwasps were caught in the traps baited with *Sirex* lure and those with *Sirex* lure with ethanol, indicating that either of these lures could be used to monitor native woodwasps in these areas. In 2010, we will resample these sites for wasp communities, add North Carolina and Florida to the sampling, rear out all parasitoids to assess specificity, and further explore the individual effects of monoterpenes on wasp catches and diversity.

Overall, results from the two projects will assist in evaluating which southern pine species may be better able to withstand invasion by *S. noctilio*. We intend to geospatially reference the host preference data with existing host density, type, and condition maps to provide recommendations for relative susceptibility of southern pines to invasion by *S. noctilio*. Further, our projects will provide important biological information about the existing communities of native siricid and parasitoid wasps in southern pine species for biocontrol management options in the future. Since the southeastern U.S. is currently ahead of the invasion curve of *S. noctilio* in North America, it provides us with a unique opportunity to assess the host preference and complex of potential native competitors and parasites of *S. noctilio* before this exotic species arrives in the southern pine stands.