USDA Interagency Research Forum on Gypsy Moth and Other Invasive Species
January 16-19, 2001
Loews Annapolis Hotel, Annapolis, Maryland

AGENDA

Tuesday Afternoon, January 16

REGISTRATION
POSTER DISPLAY SESSION I

Wednesday Morning, January 17

PLENARY SESSION ..... Moderator: J. Robert Bridges, USDA-FS
Welcome
Michael McManus, USDA-FS

The Siege of Invasive Species in Midwestern Ecosystems
Robert N. Wiedenmann, Illinois Natural History Survey

The Brown Spruce Longhorn Beetle in Halifax: Pest Status and Preliminary Results of Research
Jon Sweeney, Natural Resources Canada

PLENARY SESSION ..... Moderator: Robert Mangold, USDA-FS

The National Council on Invasive Species
Lori Williams, Department of the Interior

A Multi-year Project to Detect, Monitor, and Predict Forest Defoliator Outbreaks in Central Siberia
Max McFadden, The Heron Group, LLC

Wednesday Afternoon, January 17

GENERAL SESSION ..... Moderator: Cynthia D. Huebner, USDA-FS
Invasive Plants: Organismal Traits, Population Dynamics, and Ecosystem Impacts
Presenters: E. Nilsen, Virginia Polytechnic Institute & State University; D. Gorchov, Miami University of Ohio; F. Wei, State University of New York at Stonybrook; K. Britton, USDA-FS; C. D'Antonio, University of California at Berkeley

GENERAL SESSION ..... Moderator: Kathleen Shields, USDA-FS
Research Reports
Presenters: J. Colbert, USDA-FS; J. Elkinton, University of Massachusetts; J. Cavey, USDA-APHIS

POSTER DISPLAY SESSION II

Thursday Morning, January 18

GENERAL SESSION ..... Moderator: Victor Mastro, USDA-APHIS
Asian Longhorned Beetle
Presenters: M. Stefan, USDA-APHIS; D. Nowak, USDA-FS; S. Teale, SUNY College of Environmental Science and Forestry; B. Wang, USDA-APHIS; R. Mack, USDA-APHIS

GENERAL SESSION ..... Moderator: Kevin Thorpe, USDA-ARS
Research Reports
Presenters: S. Frankel, USDA-FS; B. Geils, USDA-FS; D. Gray, Natural Resources Canada

Thursday Afternoon, January 18

GENERAL SESSION ..... Moderator: Vincent D'Amico, USDA-FS
Gypsy Moth in the Midwest
Presenters: D. McCullough, Michigan State University; A. Liebhold, USDA-FS; W. Kauffman, USDA-APHIS; A. Diss, Wisconsin Department of Natural Resources; L. Solter, Illinois Natural History Survey; K. Raffa, University of Wisconsin

GENERAL SESSION ..... Moderator: Vincent D'Amico, USDA-FS
Research Reports
Presenters: B. Hrašovec, University of Zagreb, Croatia; E. Burgess, Hort-Research, Auckland, New Zealand; C. Maier, Connecticut Agricultural Experiment Station

Friday Morning, January 19

GENERAL SESSION ..... Moderator: Sheila Andrus, USDA-FS
Asian Longhorned Beetle: Detection and Monitoring Panel Discussion
Panel Participants: J. Aldrich and A. Zhang, USDA-ARS; R. Haack, USDA-FS; D. Lance and B. Wang, USDA-APHIS; D. Williams, USDA-FS; S. Teale, SUNY College of Environmental Science and Forestry; M.T. Smith, USDA-ARS; K. Hoover, The Pennsylvania State University

GENERAL SESSION ..... Moderator: David Lance, USDA-APHIS
Asian Longhorned Beetle: Control Options Panel Discussion
Panel Participants: V. D'Amico, USDA-FS; T. Poland and R. Haack, USDA-FS; A. Hajek, Cornell University; L. Hanks, University of Illinois at Champaign-Urbana; M. Keena, USDA-FS; B. Wang and W. McLane, USDA-APHIS; Z. Yang, Chinese Academy of Forestry; M.T. Smith, USDA-ARS

Closing Remarks

CONTENTS

INTEGRATING A BIOLOGICAL CONTROL PROGRAM INTO EDUCATION AND OUTREACH

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ABSTRACT

Purple loosestrife is an exotic weed that severely threatens the natural composition of wetlands in northern Illinois. The most promising method to restore the natural state of these wetlands is using biological control to reduce weed populations to levels low enough to allow native vegetation to flourish. The purple loosestrife biological control program at the Illinois Natural History Survey (INHS) has flourished as a result of a strong partnership among state, county, and city land managers; administrators; educators; and scientists from a variety of organizations. Although we rear the insects at INHS, we train and support others in rearing their own – thereby weaning them from us. The long-term sustainability of the Survey's project relies on engaging partners to take more responsibility for the project's implementation — and enjoy the project's successes. One major benefit of this project and its partnerships has been appreciation of the role of biological control by diverse partners, and strong recognition of and support for the Natural History Survey on other projects.

Biological control is, at its heart, a hands-on discipline. However, processes associated with biological control can seem arcane to the general public. We have developed and implemented curriculum materials for Illinois classrooms, using the purple loosestrife project to bring greater awareness and understanding of, and participation in, the Survey's biological control project. Using "Biodiversity in Illinois" as a starting point, we train educators about the importance of the state's native biodiversity, the value of wetlands and native wetland organisms, and how exotic, invasive species affect Illinois' wetlands. We teach them about the processes of biological control and ways to implement biological control of purple loosestrife into their classroom curricula. Educators are trained and students are engaged in the process of understanding how biological control fits into maintaining biodiversity. Students raise and release *Galerucella* beetles in partnership with the Survey's Biological Control Program, thus greatly multiplying our efforts. To date, over 200 educators have been trained and have used these materials in their classrooms, with the majority rearing their own beetles and releasing them into nearby wetlands. Even more heartening, approximately 75% of educators previously trained continue to use the materials two or three years after first participating.

OBSERVATIONS ON *ANOPLOPHORA GLABRIPENNIS* IN SOUTH KOREA IN SUMMER 2000

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ABSTRACT

The Asian longhorned beetle (*Anoplophora glabripennis* (Motschulsky)), which was introduced into the United States from China about 10 years ago, continues to pose a serious potential threat to hardwood forests in North America. Because it is not known to be established, all research in the U.S. must be carried out in quarantine facilities. Thus, we chose to continue our investigations of the ecology of *A. glabripennis* in South Korea, an area where it is endemic. We carried out experiments and observations in a planting of about 40 silver maples (*Acer saccharinum* L.) in Mt. Sorak National Park in Kangwon Province during July and August of 2000. Our two primary research objectives were to assess the effectiveness of ultraviolet (UV) light in attracting adult beetles and to investigate the dispersal of adults. Those objectives address two critical needs for the eradication program in the U.S.: a method to monitor for *A. glabripennis* and an assessment of how far it may have spread since its introduction. We tested a UV light apparatus with a water trap to catch any beetles attracted to the lamps. We investigated adult dispersal using two approaches: harmonic radar and capture-mark-recapture of individual beetles. The first technique involved attaching radar-reflective antennas to individual beetles and tracking them with a portable radar detection device. The second technique involved marking individual beetles with numbers in sequence as they were encountered and noting their subsequent movements. Because silver maple is exotic to Korea, an additional objective this year was to try to identify native host tree species of *A. glabripennis*. Doing so would help to resolve the question of whether the beetle is native or introduced in South Korea and provide a basis for beginning to investigate its ecology in natural forest stands. Investigating the ecology of *A. glabripennis* in healthy, closed forest stands in South Korea may provide insights as to how big a problem the beetle may pose should it become established in similar habitats in the U.S..

Experiments carried out in quarantine at the USDA ARS Beneficial Insects Introduction Research Laboratory in Newark, DE, in 1999 suggested that adult beetles move toward sources of UV light. Following up on this result, we developed a UV light water trap for

testing in South Korea. The trap consisted of two 4-Watt UV lamps powered by rechargeable batteries and mounted over a pan containing water and a few drops of liquid detergent. Our hypothesis was that beetles would be attracted from the host tree toward the UV light source and drown in the pan of water. Each of our two experimental replicates included an unlighted pan as a control. Trials were carried out for about four hours per night (~2230-0230 hr) on nine nights without rain. Although the UV light water traps caught considerable numbers of Lepidoptera and other insects and arthropods, they failed to trap any *A. glabripennis* under trees in which beetles were known to be present. We concluded that either beetles were not attracted to the UV light sources or the traps failed to capture them if they were attracted.

Tracking *A. glabripennis* with harmonic radar involved attaching small radar-reflective antennas to individual beetles, releasing them, and then relocating them periodically using a portable radar device. Two new types of harmonic radar antennas were tested. Both were light but relatively strong and did not seem to hinder flight. An improved technique for attaching the antennas was developed that kept them on beetles for up to a week. Antennas were tied transversely across the dorsal side of the pronotum. However, the beetles were very rough on antennas, and those that remained attached tended to become twisted or broken and, thus, had a short detection range. Our biggest limitation in this work was the low beetle population, which constrained tests to just six individuals. Beetles were found up to a week after release, and none of the beetles moved beyond trees very near those on which they were released initially. The harmonic radar system needs definitive testing where beetles are plentiful, preferably in China.

At the start of the study on dispersal using a capture-mark-recapture approach, all silver maple trees in the study area were numbered. Beetles were painted sequentially with red numbers as they were encountered. The beetle population was censused twice daily over the course of three weeks and tree locations of numbered individuals were recorded. The advantage of this approach over other capture-mark-recapture methods is that it permits monitoring of the movement of individual beetles. Of the 29 beetles marked during the first week of the study, 12 were recaptured many times up to 14 to 17 days after their initial capture. All but two of them remained on the same tree or on neighboring trees (within about 10 meters) over the course of the observations. The exceptions, a female and a male, moved to trees about 100 m across an open space from the trees on which they were marked. Of the same group of 29 beetles, five were marked but never recaptured and five were recaptured only once during three weeks. It is not known whether they left the observation area or died unobserved. We conclude tentatively that *A. glabripennis* individuals did not move much within our study area. However, the 10 beetles that were recaptured only once or not at all may have been dispersers that left the area. Our inability to assess the fates of those individuals is a clear limitation of this capture-mark-recapture approach in assessing dispersal.

In an effort to identify native host trees of *A. glabripennis*, we searched forest stands around the study area intensively. Beetles were found attacking nearby *Acer mono* Maximowicz, a common tree species in the surrounding natural forest. Subsequently, we found beetles on *A. mono* at another location about 20 km north of our study area. The geographical range of *A.*

mono extends from South Korea to Manchuria in the northeastern corner of China. After learning that *A. mono* was a host, we traveled to Mt. Chiri National Park, which is near the southern coast of South Korea, to explore a new area for *A. glabripennis*. The common maple in that park was *Acer truncatum* Bunge, a species closely related to *A. mono*. We examined many trees that were tapped for sap production, but were unable to find any beetles or obvious evidence of their activity. Later, we found *A. glabripennis* attacking *A. truncatum* at Mt. Songni National Park in the center of the country. Based on our observations, we speculate that *A. glabripennis* is a specialist on native Asian *Acer* species in South Korea and is itself a native species. *Anoplophora glabripennis* appears to be a rather rare species in its natural habitats, leading us to speculate that its populations are under some form of natural control and that stands of healthy native host trees are relatively resistant to it. Apparent differences in susceptibility of the native host species, *A. mono*, and the exotic host species, *A. saccharinum*, which was heavily attacked by *A. glabripennis* at our study site, may result from intrinsic physiological or biochemical differences between them and from water stress on the latter trees, which were planted around a parking lot.

INVESTIGATIONS OF NATURAL ENEMIES FOR BIOCONTROL OF *ANOPLOPHORA GLABRIPENNIS* (MOTSCH.)

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ABSTRACT

The Asian longhorned beetle (ALB) (*Anoplophora glabripennis* Motsch.) is a recent invader to the U.S. from China, with known infestations in New York (New York City and Long Island) and Illinois (Chicago). Although ALB is currently limited in distribution within the U.S., its potential for spread into other North American landscapes at risk is alarming and demands greater attention. The only method used to control ALB in China and the U.S. at present is through the removal of infested trees, and the current emphasis of much research is directed towards eradication. However, in the event that eradication is not successful, either in the known infestations in New York and Chicago, or in as yet undetected infestations elsewhere, alternative pest management approaches must be developed. In addition, even with complete eradication, new introductions are likely to occur as a result of the challenges of interception of infested cargo. For example, current interception efforts are focused on cargo that enters the U.S. directly from China, while cargo from other countries, which in fact originated in China, is extremely difficult to track and intercept. Collectively, therefore, survey, evaluation, and mass rearing of natural enemies of ALB in China, as well as similar investigations of natural enemies of related cerambycids in the U.S., have been initiated. The objectives of this research include the identification of highly effective and host-specific, self-propagating natural enemies of ALB that possess a high potential for establishment (classical biocontrol, which tends to be the most cost effective approach for biological control), as well as those natural enemies that could be easily reared and utilized in inundative-release programs. In addition, since a long-term management goal may more realistically be to slow the ecological damage of this invader, native natural enemies (to the U.S.) that adapt to ALB and/or its host trees may be of particular interest.

Compared with other longhorned beetles, relatively few natural enemies of ALB have thus far been identified. Prior to the initiation of these studies, no egg parasitoids of ALB had been reported. On the other hand, larval parasitoids had been reported, including *Dastarcus longulus* Sharp (Coleoptera: Colydiidae), *Scleroderma guani* Xiao et Wu (Hymenoptera: Bethylidae), *Bullaea* sp (Diptera: Tachinidae), and *Megarhyssa* sp. (Hymenoptera: Ichneumonidae). Likewise, pupal parasitoids had also been reported, including *D. longulus, S. guani*, and *Aprostocetus* sp. (Hymenoptera: Eulophidae). Among these, *D. longulus* and *S.*

guani appeared to be the most important among these natural enemies of ALB since they were reported to be larval-pupal parasitoids.

In many areas, *D. longulus* has been reported to have parasitization rates of 50-70%. Female *D. longulus* lay eggs in frass and sawdust in a host gallery or on the host gallery wall. First instar larvae possess thoracic legs and crawl about in search of a host. Upon finding an acceptable host, the larvae lose their thoracic legs and attach to the body of its host for feeding. It is an ectoparasite, feeding singly or gregariously on its host (1-27 individuals per host), but in all cases the host is killed. *D. longulus* is considered to have the highest potential for use in biological control of ALB.

S. guani usually parasitizes longhorned beetle species whose larvae are small, ca. 15 mm in length. It is an idiobiont ectoparasitoid. Female wasps first paralyze their host by stinging, which immobilizes the host, and then lay eggs on the host body. Larvae are gregarious while developing on their host. After hosts are consumed, mature wasp larvae spin cocoons and pupate. Parental wasps remain with their young until they have completed their development and emerged as adult wasps. Should their eggs or larvae become separated from the host, parental wasps have been observed to return them to the host. Most female wasps are apterous. *S. guani* can be mass reared for biocontrol. Therefore, *S. guani* has great potential for use in the biological control of ALB larvae, specifically 1st to 3rd instars.

1999

Surveys for natural enemies were conducted in Shaanxi, Shanxi, Hebei, Xinjiang, NeiMongol (Inner Mongolia), Heilongjiang, and Shandong Provinces. As such, while over 560 ALB eggs were collected, no ALB egg parasitoids were recovered. However, four ALB larval parasitoids were found, including: *D. longulus*, *S. guani*, *Zombrus sjostedti* (Fahringer)(Hymenoptera: Braconidae), and *Megarhyssa* sp..

Initial studies of *D. longulus* resulted in parasitization rates of 25-95% in Shaanxi Province. Furthermore, these studies showed that 1-18 individual *D. longulus* completed development on a single host larva and resulted in 100% ALB larval mortality. Preliminary studies of *S. guani* showed that it could parasitize both ALB larva (3rd and 4th instar) and pupa. Preliminary studies of the biology and behavior of *Aprostocetus prolixus* LaSalle et Huang (Hymenoptera: Chalcidoidea: Eulophidae, Tetrastichinae), an egg parasitoid of *Apriona germari* (Hope)(Coleoptera: Cerambycidae), indicated that it may have potential as an ALB egg parasitoid, and thus studies were planned for 2000.

2000

A total of 1,256 ALB eggs was collected in Shaanxi, Hebei, and Ningxia Provinces, but no egg parasitoids were again identified. However, an egg parasitoid of *Batocera horsfieldi* (Hope), another important longhorned beetle pest of popular in China, was collected and appears to be a new species. Description of this species is in progress.

Studies of *D. longulus* were continued and showed that it overwinters as an adult in the crevice of old bark as well as in the soil near ALB-infected trees. A total of 650 overwintering adults were collected during this survey. Results indicated that its life span

may exceed 5 months and that it can be reared with artificial diet in 30 days. Finally, indications are that *D. longulus* population levels are lower in monocultural stands than in species rich stands. This corresponds with higher ALB population levels in monocultural stands than in species rich stands. Although studies are still in progress, results indicate that *D. longulus* may be selected as an effective biological control agent of mature ALB larvae.

Studies of the larval parasitoid, *S. guani*, resulted in the identification of an excellent substitute host for mass rearing *S. guani.* The substitute host is inexpensive and easily obtained. In addition, lab and fields experiments were conducted, and results confirmed that *S. guani* can control young ALB larvae. A parasitization rate of approximately 65% was obtained in lab studies, and field studies are still in progress.

Studies of *A. prolixus,* an egg parasitoid of *A. germeri*, indicated that this parasitoid does not diapause. While control temperature experiments showed that *A. prolixus* emergence could be adjusted to coincide with ALB oviposition and that the wasp could parasitize 20-50% of *A. germari* eggs, it did not parasitize ALB eggs. Additional studies are planned.

SUMMARY

BIIR is currently the only U.S. lab examining insect parasitoids, and several promising ALB-specific biological control agents have already been identified. The research on rearing natural enemies is an important weapon for pest management and current results are encouraging. Collectively, these studies should contribute greatly to the development of an Integrated Pest Management Program for ALB in the U.S..

PROGRESS ON ALB SEMIOCHEMISTRY

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ABSTRACT

We isolated, identified, and synthesized two male-specific compounds from the Asian longhorned beetle (ALB). July 1999 field tests in China failed to demonstrate attraction of flying beetles to these compounds, with or without a mixture of six host volatiles. However, Y-tube olfactometer tests conducted during the 2000 season showed that the synthetic alkyl ethers are significantly attractive to walking ALB females and males. A patent has been granted (http://ott.ars.usda.gov/inv/A347907.htm) for the use of these heretofore unknown compounds (4-(*n*-heptyloxy)butanal and 4-(*n*-heptyloxy)-1-butanol) to assist in trapping the beetles. Negotiations are ongoing with potential licensees/CRADA partners to develop the technology. Traps are being designed to catch beetles walking on host trees; these new traps, baited with the male-specific dialkyl ethers, will be tested in China by CAIBL scientists during the 2001 season. In addition, past laboratory and field observations indicated that ALB males are territorial and that males recognize females upon antennal contact. Therefore, we plan to chemically identify the ALB female contact recognition pheromone since, for example, these chemicals may also be useful in inducing beetles to enter traps.

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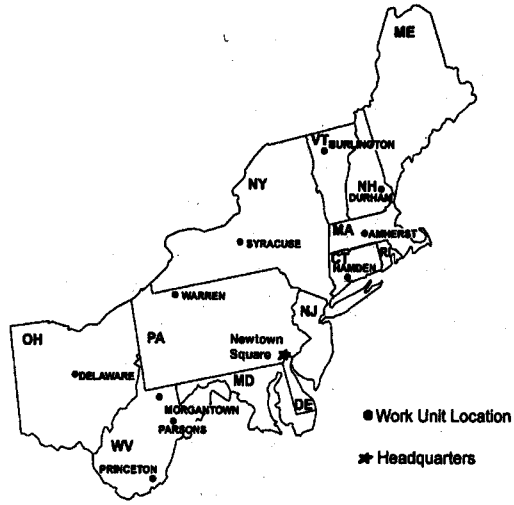

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