some type of pheromone. Two insects that fall into this category are the white pine weevil (*Pissodes strobi*) and the pine shoot beetle (*Tomicus piniperda*). In both, strong primary attraction has been demonstrated, but the investigation of secondary attraction has been problematic.

We are using a combination of GC-EAD, GC-MS, and multivariate analysis to ascertain the identities of chemical odor components in these two insects in a manner akin to general image analysis as opposed to the deterministic, bioassay-driven approach. Volatiles are sampled by aeration at frequent and regular intervals throughout the host colonization process to ensure that brief periods of signal emission, if any, are sampled. Volatiles are screened for detectability by GC-EAD. By excluding compounds that cannot be detected by the insect, the number of compounds is greatly reduced. A factor analysis is then conducted and the outlier samples are identified. Chemical compounds (variables) with high loadings on the appropriate factors are then considered good candidates for behavioral experiments. In *T. piniperda*, these compounds also gave EAD responses comparable to *alpha*-pinene at concentrations several orders of magnitude less. We are currently conducting field and laboratory experiments with the newly-identified compounds in *T. piniperda*.

VARIATION IN SEMIOCHEMICAL MESSAGES WITHIN A SPECIES' GEOGRAPHIC RANGE: DOES IT MATTER?

Donald M. Grosman[h]

The southern pine beetle (SPB), *Dendroctonus frontalis* Zimm., utilizes several semiochemicals as part of its communication system. Among these are two chiral pheromones, frontalin (F), in operational use for predicting regional population trends, and verbenone (V), currently being evaluated as a means to suppress the growth of infestations. Experiments were conducted to determine if production of and response to these pheromones vary across the SPB's geographic range.

One experiment involved collection and quantification of chiral semiochemicals released from SPB-infested logs from eight infestations in Texas (TX), South Carolina (SC), and Virginia (VA). Significant geographic differences were found in the quantities and chiralities of F and V released from infested host material within and among these geographic areas. The enantiomeric ratios of F ranged from 12.4%(+):87.6%(-) in SC to 39.3%(+):60.7%(-) in TX, whereas V ranged from 62.3%(+):37.7%(-) in SC to 76.7%(+):23.3%(-) in VA.

The response of SPB from two or three geographic areas to different enantiomeric ratios of F and V (released at rates comparable to those used in surveys and infestation suppression) was evaluated via walking and trapping (V only) bioassays. In both experiments, male SPB response to both F and V was significantly greater than that of females. Males showed little or no geographic differences in response to V and responded similarly to each ratio. Female SPB response to V differed considerably among geographic areas and enantiomeric ratios.

The studies indicate that the chiralities of F and V released from SPB-infested logs can vary considerably among geographic areas; however, with regard to V, different enantiomeric ratios of the compound are equally effective at inhibiting SPB response. This suggests that a single enantiomeric ratio (preferably the cheapest) can be used effectively to suppress the growth of infestations throughout the beetle's contiguous range. Additional field trials are needed to determine if similar conclusions can be made with regard to SPB response to F.

THE PROSPECTS OF EMPLOYING SEMIOCHEMICAL AND VISUAL DETERRENTS IN PROTECTING TREES FROM BARK BEETLES

B. L. Strom,[i] L. M. Roton,[i] J. L. Hayes,[i] and R. A. Goyer[j]

Tree protection tactics based on semiochemicals are being investigated by many forest scientists but their consistent effectiveness remains a concern. One approach toward increasing the efficacy of such treatments is to combine semiochemically-based tactics with deterrents that disrupt other cues necessary for host finding and colonization. In this study we attempted to deter colonization of southern pine beetle (SPB), *Dendroctonus frontalis*, through disruption of the visual stimulus created by a dark, vertical silhouette. White paint was chosen as one easily evaluated deterrent since it is visually dissimilar to loblolly pine bark and readily available.

Studies were conducted at eight sites in Florida and Louisiana during the summer and fall of 1995. With funnel traps, three semiochemical (frontalure only; frontalure and verbenone; frontalure and 4-allylanisole) and two visual (black paint; white paint) treatments were evaluated. Additional experiments in Louisiana included beetle arrivals at Plexiglass sticky panels (black, clear, white) baited with frontalure (two replications), and beetle attacks of trees painted (white or black, to 4m height) in front of active infestations.

We found that 4-allylanisole in funnel traps reduced trap catch of SPB significantly (~50% reduction) when compared to frontalure alone. Verbenone had no effect on trap catch; not unexpected since elution rates were ~1/4 that recommended for disruption. The visual deterrent, white paint, reduced trap catch of SPB more than any semiochemical (~70% on average). The combination of 4-allylanisole and white paint reduced trap catch by ~90% (as compared to frontalure), which was significantly lower than any other treatment. Plexiglas sticky panels gave similar results, with white panels catching the fewest beetles, followed by clear and then black (each significantly different from each other). Trees painted white to 4m also altered normal SPB colonization and were attacked primarily above the paint. Trees painted black were colonized in a pattern not discernibly different from unpainted trees.

These results show that visual disruption of SPB is possible, and when combined with semiochemicals, may improve efficacy of tree protection programs where insecticidal control tactics are not desired or feasible.

COMPARISON OF LINDGREN AND THEYSOHN TRAP EFFICACY FOR SOUTHERN PINE BEETLE AND *IPS* SPECIES

K. W. McCravy,[k] J. Nowak,[k] C. W. Berisford,[k] and G. K. Douce[l]

The Lindgren multiple-funnel trap is widely used throughout North America in bark beetle detection and survey programs, while the German-made Theysohn slot trap is commonly used in Europe, especially for trapping of *Ips* engraver beetles. In this study, we compared the effectiveness of Lindgren and Theysohn traps in collection of southern pine beetles (SPB), *Ips* spp., and two bark beetle predators, *Thanasimus dubius* (Cleridae) and *Temnochila virescens* (Trogossitidae), using paired comparison tests.

Six pairs of frontalure-baited traps were placed in an active SPB infestation in Oconee National Forest, Greene Co., GA, in September and October, 1994. Lindgren traps collected 1556 SPBs and 334 clerids compared to 1149 and 88 collected in Theysohn traps. Differences for both insects were significant (SPBs: P=0.03; clerids: P=0.0001).

Trapping for *Ips* spp. was done in September through October, 1995 in three sites that had received cut-and-leave treatments for SPB control. At each site, four pairs of traps were set up. At two of the sites, traps were baited with ipsdienol for collection of *I. avulsus* and *I. calligraphus*; at the third site, ipsenol was used for collection of *I. grandicollis*. Theysohn traps captured greater numbers of all three species than did Lindgren traps: 754 versus 470 *I. avulsus* (P=0.008), 23 versus 17 *I. calligraphus* (NS), 114 versus 72 *I. grandicollis* (P=0.055). Lindgren traps again caught more clerids (46 versus 11, P=0.02), and also more trogossitids (41 versus 10, P=0.01).

Results indicate that Lindgren traps capture greater numbers of SPB and predators, while Theysohn traps show greater efficiency in collection of southeastern *Ips* spp. The greater efficiency of Lindgren traps in capturing bark beetle predators could be an advantage in bark beetle prediction systems that rely on estimates of natural enemy populations. However, if one is more interested in conservation of these natural enemies, Theysohn traps would be preferable.

ELUTION DEVICES: CONSIDERATIONS FOR ENTOMOLOGISTS

Dan Miller[m]

Semiochemicals are critical for the reproductive success enjoyed by forest insects, especially bark beetles. Forest entomologists desire elution devices that release these semiochemicals in order to better understand the behavioral ecology of insects, and hopefully mitigate their impacts. Using live insects is expensive, and problematic at best. Luckily, elution devices are commercially available. They generally consist of a plastic container filled with semiochemical. Semiochemicals pass through the plastic membrane into the atmosphere. The technology is not very