N O T E

Attraction of *Ips avulsus* (Eichoff) to Varying Enantiomeric Composition of Ipsdienol in Commercially Available Lures[1]

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Three major species of *Ips* bark beetles (Coleoptera: Scolytidae) in the southeastern United States, *I. avulsus* (Eichoff), *I. calligraphus* (Germar), and *I. grandicollis* (Eichoff), attack all species of pines in their range, sometimes causing significant tree mortality (Thatcher, 1960 USDA Forest Service Occasional paper 180, 25 pp.) Coincident with region-wide drought, pine mortality due to *Ips* has been severe throughout the southeastern United States in recent years. For example, losses in 1999 were estimated at about U.S. $13 million dollars, second only to the southern pine beetle in value lost from insect-caused mortality (Report on losses caused by forest insects, Southern Forest Insect Work Conference, 2000).

Before effective monitoring, management or research programs can be developed and implemented for *Ips* beetles in the Southeast, effective lures must be identified for each species. Ipsdienol has been identified as an aggregation pheromone for *I. avulsus* (Vité et al. 1972, Can. Entomol. 104: 1967-1975; Hughes 1974, J. Insect Physiol. 20: 1271-1275). In addition, the enantiomeric composition of ipsdienol appears to be important. The primary aggregation pheromone for *I. avulsus* was identified as (–)-ipsdienol, while its antipode was found to be an antiaggregant (Vité et al., 1972; Skillen et al., 1997, USDA Forest Service, FHTET-96-15). However, Birgersson et al. (1995, Proc. of a Joint IUFRO Working Party Conference, 1994, pp. 12-18) successfully captured *I. avulsus* using racemic ipsdienol in combination with lanierone, a strong synergist to ipsdienol for attracting *I. pini* (Teale et al., 1991, J. Chem. Ecol. 17: 1159-1176). Seybold (1995, J. Chem. Ecol., 21: 995-1016) also found that *I. avulsus* produced primarily (+)-ipsdienol. Thus, managers and researchers alike are uncertain about which lures should be used to trap this species.

Synthetic ipsdienol lures are available from a commercial source in 97% (–) and 50% (–) (= racemic) formulations (Phero Tech, Inc., Delta, BC). Because the 97% (–) lure costs about 5 times more than the racemic lure (about U.S. $30.00 versus $6.00)

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a comparison of the two lures is of interest. The objective of this experiment was to determine whether the additional expense of the 97% (–) ipsdienol lure is justified by an increased attractiveness to *I. avulsus,* and to provide a foundation for further experiments to clarify uncertainties about the role of enantiomeric composition of ipsdienol in the behavioral ecology of *I. avulsus.*

This experiment was conducted in three states—Florida, Louisiana, and Texas—so that the results could be generalized at least across the southern geographic range of *I. avulsus.* At each location, 20 Lindgren funnel traps (12-funnel; Phero Tech, Inc.) were individually hung from poles at least 50 m apart. Ten traps were baited using the combination of 97% (–) ipsdienol with lanierone (bubble caps; elution rates of 110 µg/d and 10 µg/d @ 25°C, respectively; Phero Tech, Inc.) and ten traps used racemic ipsdienol with lanierone (identical elution rates), all randomly assigned. Beetles were collected from traps intermittently for about 2 wks at each location in 2001 (Trinity Co., TX: 16 to 30 May; Rapides Parish, LA: 14 to 30 May; Hernando and Sumter counties, FL: 2 to 14 July), at which time the total number of *I. avulsus* caught per trap was determined. Each trap was considered an independent experimental unit. One trap was eliminated from the Texas data due to failure of the collection cup; thus, data from 59 traps were subjected to analysis. Statistical analysis was done by subjecting data to a Friedman test for two-way layout (distribution-free equivalent of a two-way analysis of variance) (Hollander and Wolfe 1973, John Wiley and Sons, NY) using state and lure as the independent variables and trap catch per day as the dependent variable. All statistical evaluations were done with the SAS system for statistical analysis (Version 6.12, SAS Inc., Cary, NC).

Commercially available racemic lures caught more *I. avulsus* than the 97% (–) lure when used in combination with lanierone ($S = 40.1$; $P < 0.0001$; Fig. 1). Mean daily

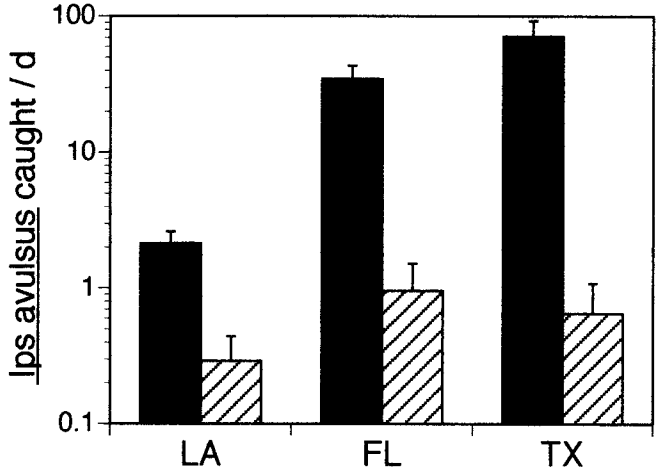

Fig. 1. Mean (+SE) daily catch of *Ips avulsus* (Eichoff) in funnel traps baited with lanierone and racemic ipsdienol (solid bars) or lanierone and 97% (–) ipsdienol (hatched bars) in Louisiana, Florida, and Texas in 2001. Note that the Y-axis is on a log scale.

catch in traps baited with the racemic lure was much greater in all three states, with the number of *I. avulsus* caught ranging from about 7.5× (LA) to over 100× (TX) when compared to the 97% (–) lure. The wide range in catch observed among locations in this experiment (Fig. 1), suggests that the racemic lure is more effective than the 97% (–) lure under a variety of environmental conditions and/or population densities.

This experiment demonstrates that *I. avulsus* is attracted to the racemic ipsdienol lures in combination with lanierone. When using commercial products, monitoring of this species should proceed with the racemic lure, saving money from the more enantiomerically pure 97% (–) lure while capturing far more individuals. Further experiments must be done to elucidate the relative importance of the (+) enantiomer as an aggregant versus its (–) antipode as an antiaggregant. *S*-(–)-ipsenol, an aggregation pheromone for *I. grandicollis,* synergized the attraction of *I. avulsus* to ipsdienol (Hedden et al. 1976, Nature 261: 696-697). However, the racemic mixture of ipsenol had no effect on catch when lanierone was present (Birgersson et al. 1995). Determination of the optimal combination, and the lability of individual components, will require further experimentation. Regardless, the notion that the (–) enantiomer of ipsdienol is the active aggregation component for *I. avulsus* and that the (+) enantiomer is an antiaggregant is apparently incorrect when deployed in combination with lanierone.

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