RESPONSE OF *Dendroctonus brevicomis* AND *Ips paraconfusus* (COLEOPTERA: SCOLYTIDAE) TO COMBINATIONS OF SYNTHETIC PHEROMONE ATTRACTANTS AND INHIBITORS VERBENONE AND IPSDIENOL

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(Received February 8, 1991; accepted July 8, 1991)

**Abstract**—*Dendroctonus brevicomis* and *Ips paraconfusus* are sympatric bark beetle species colonizing *Pinus ponderosa* in western North America. Interspecific and intraspecific competition for resources is, in part, mediated through semiochemicals. The response of *D. brevicomis* to its attractant pheromone was significantly reduced by simultaneous release of either verbenone or racemic ipsdienol. Trap catch was significantly further reduced by including both inhibitors with the attractant pheromones. However, although the response of *Ips paraconfusus* was significantly inhibited with the addition of either verbenone or racemic ipsdienol, both compounds together did not result in a significant further reduction in trap catch. There was a trend for greater reduction in response of *D. brevicomis* to attractant pheromones with increased release rates of either 69% (+)-/31% (−)-verbenone or 84% (−)/16% (+)-verbenone. Response of associates to attractants and inhibitor combinations was also determined.

**Key Words**—*Dendroctonus brevicomis, Ips paraconfusus*, bark beetle, verbenone, ipsdienol, pheromones, inhibitors, Coleoptera, Scolytidae.

INTRODUCTION

The western pine beetle, *Dendroctonus brevicomis* LeConte, uses a combination of beetle-produced pheromones [(+)-exo-bre vicomin {(+)-exo-7-ethyl-5-methyl-6,8-dioxabicyclo[3.2.1]octane} and (−)-frontalin{(−)-1,5-dimethyl-6,8-dioxabi cyclo[3.2.1]octane}] (Silverstein et al., 1968; Kinzer et al., 1969;
Wood et al., 1976) and host odors, primarily myrcene (Bedard et al., 1969), during the aggregation phase of tree colonization (Wood, 1972). The engraver beetles, *Ips paraconfusus* Lanier and *I. pini* (Say), are sympatric with *D. brevicomis* in California and may colonize the same host material. *Ips paraconfusus* pheromone consists of three components: (-)-ipsenol[(-)-2-methyl-6-methylene-7-octen-4-ol], (+)-cis-verbenol, and (+)-ipsdienol[(+)-2-methyl-6-methylene-2,7-octadien-4-ol] (Silverstein et al., 1966). The pheromone of *I. pini* in California was initially described as a single component pheromone, (-)-ipsdienol (Birch et al., 1980a, b); however, there is some suggestion that a second component may be important to complete the pheromone blend (S.A. Teale, personal communication).

The pheromones produced have interspecific effects in addition to the intraspecific effect. Attraction of *I. pini* to its pheromone is inhibited by racemic ipsenol (Birch and Light, 1977) and to (+)-ipsdienol (Birch et al., 1980a, b). These compounds are components of *I. paraconfusus* aggregation pheromone. Similarly, attraction of *I. paraconfusus* to its pheromone is inhibited by (-)-ipsdienol (Light and Birch, 1979), a component of the aggregation pheromone of *I. pini. Dendroctonus brevicomis* was inhibited by actively boring *I. paraconfusus* (Byers and Wood, 1980). Subsequent studies by Byers and Wood (1981a) demonstrated that at least two of the constituents of *I. paraconfusus* pheromone must be present for the inhibitory effect.

Although the constituents of *D. brevicomis* pheromone function to attract individuals, high release rates of exo-brevicomin or myrcene may also function to interrupt the response (Tilden et al., 1981). Oxidation of tree-produced α-pinene by either beetles or by microorganisms results in production of verbenone. This compound found in male *D. brevicomis* (Byers and Wood, 1980) interrupts the response of *D. brevicomis* (Bedard et al., 1980) to its attractant pheromone. In addition, verbenone similarly inhibits the attraction response of *I. paraconfusus* (Byers and Wood, 1980, 1981a).

Colonization of conifers usually occurs as a community process. Although there may be a temporal separation, it would be expected that each species in the community would produce the components of its pheromone with the resulting potential for interspecific and intraspecific interactions. The objective of the study presented here was to determine how the compounds associated with inhibition would effect aggregation of *D. brevicomis* and *I. paraconfusus* if presented singly or in combination.

**METHODS AND MATERIALS**

The behavioral responses of *D. brevicomis* and *I. paraconfusus* to interspecific and intraspecific chemical signals were examined at two locations during July and August 1990. Each site had obvious tree mortality, and examination