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**PHEROMONE-BASED AGGREGATION IN *ORTHOTOMICUS CAELATUS* (EICHHOFF)  
(COLEOPTERA: SCOLYTIDAE)**

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**Abstract**

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Two field experiments were conducted to determine if *Orthotomicus caelatus* (Eichhoff) was attracted to pine bolts infested with conspecifics and to assess the roles of the sexes in attraction. Traps baited with pine bolts artificially infested with males attracted both males and females, but traps baited with uninfested bolts or bolts with females caught very low numbers of beetles. The addition of females to bolts with males reduced the attraction produced by males in a second experiment. Bolts with males and females did not reduce the attraction produced by other males in adjacent bolts, suggesting that females do not produce a masking pheromone. The pheromone system of *O. caelatus* is similar to those known for other species in the Ipini in which males initiate gallery construction, produce an attractant, and attract females and opportunistic males. Preliminary gas chromatographic analyses of extracts of hindguts and frass from males boring on pine bolts suggested the presence of ipsdienol and ipsenol, two commonly occurring pheromones in other species of the Ipini. The pheromone system of *O. caelatus* is discussed with regard to the complexity of the pine bark beetle guild in the southeastern United States.

**Résumé**

On a effectué deux expériences de terrain afin de savoir si *Orthotomicus caelatus* (Eichhoff) est attiré par des bûches de pin infestées d'individus conspécifiques et de comprendre le rôle des sexes dans le phénomène d'attraction. Des pièges appâtés de bûches de pin infestées artificiellement de mâles ont attiré des mâles et des femelles, alors que des pièges appâtés de bûches non infestées ou infestées de femelles seulement ont attiré peu de charançons. Dans une deuxième expérience, l'ajout de femelles à des bûches portant déjà des mâles a réduit l'effet d'attraction obtenu avec des mâles. Des bûches porteuses de mâles et de femelles n'ont pas réduit l'effet attirant de bûches adjacentes porteuses de mâles, indiquant que la femelle ne produit pas de phéromone masquante. Le système phéromonal de *O. caelatus* est similaire à ceux d'autres Ipini dont c'est le mâle qui initie la galerie, produit un attractant et attire des femelles et des mâles opportunistes. L'analyse chromatographique préliminaire d'extraits d'intestin et de fèces de mâles en train de forer des bûches de pin indique la présence d'ipsdienol et d'ipsénol, deux phéromones communément rapportées chez d'autres Ipini. On discute du système phéromonal de *O. caelatus* en rapport avec la complexité de la guildes des charançons des pins du sud des USA.

**Introduction**

*Orthotomicus caelatus* (Eichhoff) is a widely distributed and common species of bark beetle that infests coniferous trees of the Pinaceae throughout North America (Wood 1982). *Orthotomicus caelatus* breeds in the phloem of logging slash and the boles, branches, and root collar regions of host trees that are moribund or severely stressed. Because the species is not aggressive, it is considered to have little or no economic significance (Baker 1972; Furniss and Carolin 1977; Drooz 1985). The ecological role of *O. caelatus* is that of a secondary bark beetle (Stark 1965) that generally infests host material already being colonized by other phloeophagus insects. Because *O. caelatus* is a common associate in different groups of coniferous bark beetle species throughout North America (e.g. Beal and Massey 1945; Reid 1955), its role in interspecific interactions and its mechanism of host colonization are of interest. Very little is known about the biology and host selection behavior of this common insect (Wood 1982).

While conducting a field experiment on pheromones of the eastern sixspined engraver, *Ips calligraphus* (Germar) (unpublished data), we discovered that *O. caelatus* might use

an attractant pheromone. Small slash pine bolts, *Pinus elliottii* Engelm. var. *elliottii*, artificially infested with 10 males of *I. calligraphus* and wrapped with aluminum screening, were deployed with bark beetle traps to assess the responses of feral *I. calligraphus*. No *I. calligraphus* were trapped at those bolts, but many individuals of *O. caelatus* were attracted and caught in traps. At first we suspected that *O. caelatus* was attracted to *I. calligraphus* pheromones because of the taxonomic similarity of the two species (Wood 1982) and the fact that related species of bark beetles are sometimes cross-attractive (e.g. Lanier and Wood 1975; Birch *et al.* 1980). However, upon inspection of the pine bolts we found that *O. caelatus* had passed through the mesh of the aluminum screening and were colonizing the bolts. We therefore investigated the possibility of a beetle-produced attractant in *O. caelatus* with controlled experiments, the results of which are reported here.

### Methods and Materials

Two field experiments were conducted in a 16-year-old slash pine plantation located east of Gainesville, Alachua Co., FL. The first experiment, conducted 25 September to 9 October 1987, was designed to determine if either males or females produced an attractant while feeding on host material. Slash pine bolts, approximately 15 by 25 cm, were cut from the upper boles of standing trees. Adult *O. caelatus* used as sources of attractant were trapped alive while responding to attractive bolts in our *I. calligraphus* experiment described above. Beetles were sexed according to differences in morphology of the elytral declivity (Wood 1982). The three treatments in the first experiment were as follows: (1) a bolt only as a control; (2) a bolt artificially infested with six females; and (3) a bolt artificially infested with six males. Beetles were confined with pieces of saran screening in 2-mm-diameter holes drilled through the phloem and evenly spaced on the bark of the bolts. Bolts were completely covered with multiple wraps of 30-mesh saran screening and 18-mesh aluminum screening to prevent escape of introduced beetles and volunteer attacks by other insects. Treatment bolts were hung adjacent to the mid-point of 16-unit multiple funnel traps (Lindgren 1983). Traps were hung from PVC pipe standards so that the collecting jars were within 30 cm of the ground. The three treatments were deployed in five completely randomized blocks. Traps within an experimental block were spaced 20 m apart in a row, and blocks were spaced at least 30 m apart.

Because the first experiment showed that males were attractive (see below), the second field experiment, conducted 3–25 March 1988, examined the effect of females on the attraction produced by males. Beetles used in this experiment emerged in the laboratory from slash pine logs; bolts for the experiment, 15 by 25 cm, were cut from 16-year-old slash pines. The three treatments in the second experiment were as follows: (1) a slash pine bolt artificially infested with eight males; (2) a male-infested bolt to which two females were added to the galleries with each of the eight males (total of 16 females); and (3) a bolt with eight males deployed beside another bolt containing eight males with 16 females, as in the second treatment. Males were introduced onto all bolts and, for bolts in the second and third treatments, females were added 1 day later. Bolts were screened and deployed with funnel traps as in the first experiment; four completely randomized blocks were established. The second treatment was designed to determine if the presence of females in bolts with males reduced the male-produced attraction, and the third treatment tested the possibility that volatiles from bolts with paired males and females might interrupt the response of beetles to the attractant from bolts with males only.

Data from both field experiments, recorded as the numbers of male and female *O. caelatus* trapped at each treatment in each block for the duration of the study were transformed by calculating  $y = \sqrt{x + 0.5}$ . Transformed data for the responses of males and females separately were subjected to analysis of variance followed by the Student-Newman-Keuls test for means comparisons.

