

# The courtship of the elm bark beetle

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Fig. 1: The smaller European elm bark beetle feeding in the crotch of a small elm twig.

*Disproving a previous assumption about the beetle's courtship behavior may lead to new ways of controlling Dutch elm disease.*

**T**he smaller European elm bark beetle, *Scolytus multistriatus* (Marsham), is responsible for most spread of the devastating Dutch elm disease. As it feeds in crotches of small twigs (fig. 1), the beetle deposits spores of the Dutch elm disease fungus, which then germinate and infect the elm.

Larvae of the beetle overwinter beneath the elm bark and, when spring temperatures permit, continue development into pupal and adult stages. As the adults bore exit holes from their pupal chambers, they ingest and also pick up on their bodies the sticky spores of the Dutch elm disease fungus. Emerging beetles of either sex fly to the periphery of healthy elm crowns and feed briefly in elm twig crotches.

Little is known about why the smaller European elm bark beetle feeds in elm twig crotches. Entomologists believe that such feeding is not mandatory and that, when it occurs, the beetle uses the feeding cavity in the crotch as protection, waiting for favorable weather conditions before selecting a breeding site.

Female beetles select breeding sites in dead elm wood and release a pheromone —

an odor — which attracts both sexes from a considerable distance. The aggregated beetles mate there and begin to construct egg galleries beneath the bark. We observed similar aggregation and courtship behavior in living elm tissue, during the beetle's feeding in the crotches of small twigs.

In the laboratory, we observed and photographed courtship by both sexes in the twig crotches, which resulted in successful copulation. The text and photographs here are based on 100 samples of each of two sequences: courtship behavior of the male when the female was in the feeding cavity, and courtship behavior of the female when the male was in the feeding cavity.

## Courtship by males

The male is always ready for courtship. However, copulation takes place only if the female's body is fully inside the twig crotch. On the average, 6 to 10 hours appear to be necessary for the female to excavate the feeding cavity so that her whole body can enter the cavity (fig. 2) and become receptive to courtship.

The male, released at this time on the elm twig 5 centimeters from the cavity, is strongly attracted to the female. His frontal dipping posture (fig. 3) and the depressed position of his antennae indicate the first awareness of the female's presence in the cavity (upper left background). Communication between the sexes may be initiated by sound, by pheromone, or both. The male begins a series of tiny movements, dipping his head and depressing his antennal clubs.

Immediately afterward, the male contacts the female (fig. 4), touching her abdomen by brushing it with his dense setae (hairs). More head dipping follows, usually twice, and then he pushes her into the cavity. This behavior may be repeated as many as 25 times, until the female becomes receptive. If the female briefly opens her genital chamber, the male quickly goes through a series of gyrating motions, circling around the twig. The male then returns and con-

tacts the female's abdomen once more by brushing her, tapping her sides with his antennae and aggressively pushing her inside while repeatedly extending and retracting his aedeagus (fig. 5).

At this moment, the male might attempt copulation (fig. 6). This is usually unsuccessful, because the female's genital chamber does not stay open long enough. If, after this first attempt, the female still rejects the male by pushing him back violently, he then retreats and rests briefly not far away. Soon, he returns to the first step of the courtship sequence (fig. 3).

If, however, the male is not rejected, and the female keeps her genital chamber open while he brushes her and taps her sides with his antennae, he gyrates once more and begins copulation in an inverted back-to-back position (fig. 7).

After the male's aedeagus successfully penetrates into the genital chamber, the fe-

male retreats into the cavity, so that only the pronotum and head of the male are visible (fig. 8). The male stays motionless for 20 to 30 seconds with his antennae clubs tightly depressed.

### Courtship by females

Both sexes bore into the twig crotch in a similar manner, with no significant difference between male and female behavior as they feed alone. When the male is feeding and the female is attracted to the cavity, her courtship can be characterized as an aggressive or even violent attempt to push out the male and replace him in the cavity (fig. 9). The female appears to acknowledge the presence of the male by jerking her head in many directions. She rushes toward the male's abdomen, begins to tap it with her antennae while pushing him inside the cavity. The male responds by strongly pushing back. This behavior quickly intensifies to



Fig. 2: The female is in the feeding cavity.



Fig. 3: Communication begins between the male (identified by dense setae, or hairs) and the female (hidden in cavity).



Fig. 4: The male contacts the female's abdomen.



Fig. 8: Only the pronotum and head of the male are visible during mating.



Fig. 9: When the male is in the feeding cavity, the female approaches and contacts his abdomen.



Fig. 10: The male pushes back the female.

the point that the male rushes completely out of the cavity and back in again (fig. 10).

The pushing stops, and the female continues to tap the male's abdomen with her antennae and nudge him gently with her head. She then releases a fecal pellet, at which time her genital chamber opens and closes several times (fig. 11).

Pushing back and forth begins once more, but with greater intensity. This time, the male's responses are so strong that he continues to push the female back even after he is entirely outside the cavity. Once the male has backed too far outside the cavity, he seems to become disoriented, and the female quickly enters the cavity.

After the capture of the cavity, an average of 30 percent of the males retreat to the tip of the twig and rest there for at least half an hour. The other 70 percent of the males, however, immediately begin the male courtship behavior previously described until

mating occurs. We observed that, after the male contacted the female's abdomen, his aedeagus extended (fig. 12), and the mating took place in seconds (fig. 13). In contrast, during courtship initiated by the male, the same sequence took several minutes.

### Conclusions

Many other bark beetle species in the Scolytidae family feed in the living portions of their host plant (twigs, shoots), but they breed only in the dead wood of the same host. The use of behavior-modifying chemicals, such as pheromones, to control *Scolytus multistriatus* has been based on the assumption that copulation occurs only in dead elm phloem, where females excavate egg galleries and also mate.

Our studies show that *S. multistriatus* mating is associated also with feeding in living elm tissue — that both sexes can initiate courtship, and that courtship by either sex

occurs after the opposite sex excavates the cavity in twig crotches. These observations may influence further studies to identify the chemical messages used by *S. multistriatus* in feeding, mating, and egg-laying, and may lead to new control strategies. They also suggest that similar behavior may occur in other bark beetle species that feed in twigs or shoots and whose pheromones have not been identified.

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Fig. 5: He extends his aedeagus.



Fig. 6: He attempts unsuccessfully to mate.



Fig. 7: Successful mating. (This behavior is inconspicuous.)



Fig. 11: The female releases a fecal pellet.



Fig. 12: After the male is replaced in the cavity by the female, he contacts the female with extended aedeagus.



Fig. 13: Mating follows.