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OBSERVATIONS OF THE GALLERY HABITS OF *TRYPODENDRON RETUSUM* (COLEOPTERA: SCOLYTIDAE) INFESTING ASPEN IN CENTRAL MICHIGAN

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ABSTRACT

A monogamous pair of adult *Trypodendron retusum* construct a gallery system consisting of an entrance tunnel and from two to five lateral tunnels into the sapwood of aspen. Inoculation of the mutualistic fungus *Ambrosiella ferruginea* by the female beetle, was followed by oviposition in shallow egg cradles. Two instars were observed as the larvae enlarged their cradles. The number of cradles per gallery system was correlated to the length of the gallery system. Progeny adults with a sex ratio of approximately 1:1 emerged from late June to early August to overwinter in the litter.

Trypodendron retusum LeConte infests suppressed, dead, windthrown, or cut *Populus* species, primarily *P. grandidentata* Michaux (bigtooth aspen) and *P. tremuloides* Michaux (trembling aspen), throughout the natural range of these host trees from Alaska to New Brunswick south to California, New Mexico, and West Virginia (Wood 1982). Accounts of the habits of the beetle are brief (Hubbard 1897, Leach et al. 1940). Abrahamson et al. (1967) described the fungal transmitting gland, called the mycangia, of *T. retusum*. The mutualistic fungus *Ambrosiella ferruginea* (Mathiesen-Kaarik) Batra was associated with this beetle by Batra (1967) and Roeper et al. (1980). The purpose of this study is to describe the galleries constructed by the parent adults, habits of the larval instars, and the emergence of progeny adults.

METHODS

Infested bigtooth aspen trees were found at the Alma College Ecological Tract, 1.6 km SW of Vestaburg, Montcalm County, Michigan, during the collecting seasons of 1982 and 1985. Infested aspen trees (n = 19) were cut down over the course of the collecting seasons from early April to October. Each week two approximately 1.0-m-long sections from an infested log were returned to the laboratory. Each section was then waxed on its cut ends with paraffin to prevent desiccation. One section was then stored at 4°C to prevent further activity of the beetles within, and the other section was exposed to ambient daily temperatures that allowed the beetles to continue gallery construction. From this continuous supply of infested material some of the log sections were sub-sectioned each week into 10-cm lengths and carefully dissected. Measurements of gallery systems were taken with a flexible ruler or an ocular micrometer using a stereoscopic microscope. Larvae were stored in 70% ethanol and later measured under a compound microscope with an ocular micrometer in order to establish head capsule widths.

Emergence studies were conducted using five 0.5-m heavily-infested aspen log

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sections. Starting in mid-May 1985, log sections were waxed on the cut ends and loosely surrounded by heavy, reinforced, window plastic secured with duct tape which led to a collecting funnel and jar containing water and mineral oil. The logs were exposed to daily ambient temperature while suspended in a shaded outside area through November. Collections were made bi-weekly, and emerged beetles were preserved in 95% ethanol until counted.

OBSERVATIONS AND DISCUSSION

Construction of Gallery System

Spring flight and infestation by the beetles were initiated in early April and continued until early May. As the galleries of *T. retusum* were systematically dissected, they were categorized into three arbitrary phases of gallery construction: the initial tunneling phase, the developing incomplete tunneling phase, and the mature gallery system. The female beetle initiated the gallery construction and bored quickly, within a day or two, straight through the bark and into the sapwood of the bole. Bored material excavated during this initial phase was pushed out the tunnel entrance. The male beetle joined in activity within a day or two following mating and copulation, which occurred at the tunnel entrance or the surface of the tree. Solitary females were observed in only two of 17 tunnels in this initial phase, indicating the monogamous pairing of beetles within a tunnel system was established very early. The female was always deeper in the tunnel, with the male found nearer the entrance hole. The female appeared to do most of the tunnel boring and moved the bored material out to the male who pushed it out the entrance hole. The straight entrance tunnel of the primary tunnel penetrated approximately 20 mm at a right angle to the bark surface and then followed a ring of sapwood parallel to the bark surface. The first bend in the tunnel later became a lateral tunnel. The tunnels appeared white and freshly bored, with only a few small patches of brownish-red stain of the growing mutualistic fungus *Ambrosiella ferruginea*. A whitish plug of fungal growth was observed proliferating from the openings of the mycangia as the female inoculated the excavated tunnel. Primary tunnels at the end of the initial phase had a mean length of 49.5 mm (S.E. = 4.1 mm, range 18-84 mm, n = 17); the initial phase took approximately five to ten days.

The second phase of gallery construction began when the boring female returned to the original bend of the straight entrance tunnel and initiated a second curved lateral in the opposite direction, roughly following the same tree ring of sapwood that the first lateral transversed. The second lateral tunnel was lengthened until it was approximately the same length as the first lateral tunnel. Patches of fungal growth became more evident along the walls of the entrance tunnel and especially down the older portion of the lateral tunnels, but never occurred at the end of the lateral which had just been extended. Soon after the construction of the second lateral tunnel, shallow cradles were gouged vertically either up or down along the lateral tunnel into opened tissue of the sapwood. A single egg covered with a mixture of boring material and some fungal cells was oviposited into each shallow cradle. Four to seven cradles were found along each lateral tunnel and tended to be located toward the end. These egg cradles were spaced between 2.0 and 8.0 mm apart ($\bar{x}$ = 4.0 mm, S.E. = 0.2). No cradles were found near the junction of the two laterals or along the entrance tunnel.

Bright (1976) stated that several pairs of *T. retusum* could be within the same gallery system occupying different lateral tunnels, but we observed only a single monogamous pair of beetles in each gallery system. The male remained located at or near the entrance, with the female active deeper in the tunnel system. As many as three additional laterals were constructed by the female, either by extending the main entrance tunnel deeper into the sapwood where it later curved to form a lateral, or by the construction of lateral branches from one or both existing laterals close to the origin of the first lateral tunnels. Inoculation of the ambrosia fungus, construction of egg cradles, and oviposition then

occurred in each new lateral tunnel. The continued enlargement of the galleries lasted from three to four weeks after the primary entrance tunnel was initiated. At this time the ambrosia fungus formed a continuous lining throughout the entire gallery system following the general pattern described by Farris and Chapman (1957) for *T. lineatum* infesting Douglas fir.

Larval Activity

The larvae of *T. retusum* hatched within a week after eggs were laid. They began to enlarge their cradles vertically into the wood until they were slightly larger than those of the adult beetle, about 4.8 mm in length. The cradle opening in the tunnel was covered with a mass of wood borings and fungal growth. The larvae gnawed on the walls and the end of their cradles. Wood fragments egested by the larvae as fecal pellets did not appear significantly changed by passage through the larval gut. The ambrosia fungus, which grew in patches on the walls of cradles, was ingested along with the wood fragments and apparently completely digested by the larvae. The fungus never formed a continuous lining within the cradle as was observed in the main tunnels of the galleries. The larval fecal pellets were pushed out into the tunnel through a small opening in the material covering the cradle. Adult beetles, still found in the tunnels at this time, pushed the larval fecal material along the tunnel and out the initial entrance hole onto the bark surface. The insect frass deposited on the bark surrounding the entrance hole was much darker in appearance than that deposited during the initial phase of gallery construction.

Two larval instars were observed for *T. retusum;* this was consistent with the number previously recorded for *T. lineatum* by Balfour (1962). The head capsules had two distinct sizes. The head capsule width for the first instar ranged between 0.37–0.48 mm ($\bar{x}$ = 0.44 mm, S.E. = .004, n = 48); that of the second instar had a mean width of 0.72 mm (S.E. = 0.004, n = 68, range 0.66–0.79 mm). The estimated development time for both larval stages was from three to four weeks. The pupal stage lasted slightly over a week, with the pupae characteristically facing downwards in the enlarged cradle. The light-brown adults then developed and darkened with age.

Mature Gallery Systems

The mature gallery system with the tunnel extension, cradle construction, and oviposition completed has the following characteristics. The entrance tunnel penetrated directly to a mean depth of 23.4 mm (S.E. = 2.1, n = 30, range 5–55 mm). The number of lateral tunnels in mature gallery systems varied from two to as many as five, with an average of 3.1 lateral tunnels (S.E. = 0.3, n = 27 galleries). The average length of the combined lateral tunnels per gallery system was 86.1 mm (S.E. = 2.4, n = 38, range 25–109 mm). Within the 27 completed galleries studied, the average number of cradles per gallery was 12.4 (S.E. = 2.5, range 3–34 niches). Complete cradles indicated the successful development of full-term progeny larvae. Incomplete cradles shorter than normal full length were observed, but were not included in the above observations. Various causes for these abortive cradles included poor growth of ambrosia fungus, growth of non-ambrosial fungi, mites, and other invertebrate predators, which were occasionally observed with the gallery system. A correlation (r = 0.643) was found between the number of cradles per gallery system and the lengths of the respective galleries.

Emergence

Only a few progeny and no parental adults were observed (from gallery systems studied from late August to October). The adults of *T. retusum* emerged presumably from their

Table 1. Summer emergence of *T. retusum* progeny adults from five infested aspen sections in two week intervals. No beetles emerged prior to or after the time periods indicated.

Dates	Males	Females
16–30 June	2	0
1–14 July	30	26
14–28 July	28	26
29 July–11 Aug.	3	3
Totals	63	55

brood galleries to overwinter in the forest litter, as has been observed with other *Trypodendron* species. The first adult leaving the brood galleries of five infested sections of aspen set in emergence enclosures was recorded on 20 June. Most of the beetles emerged in July (Table 1). Adult beetles were generally fully pigmented, but some were light tan. Some of the emerging beetles undoubtedly represented parental beetles but whether they overwintered a second year is unknown. The sex ratio of the emerged beetles was approximately 1:1 (Table 1).

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