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LIFE HISTORY OF THE BUTTERNUT CURCULIO, *CONOTRACHELUS JUGLANDIS* (COLEOPTERA: CURCULIONIDAE), IN MICHIGANJeffrey A. Corneil and Louis F. Wilson¹

The butternut curculio, *Conotrachelus juglandis* LeConte (Coleoptera: Curculionidae), injures the shoots and nuts of various species and hybrids of *Juglans* in eastern North America. This insect was described in 1876 (LeConte, 1876); its life history has been studied in Connecticut (Britton and Kirk, 1912) and in West Virginia (Brooks, 1922). Its range, however, extends from the New England states through southern Canada to the Great Plains and south to Kansas, Alabama, and Georgia, contiguous with the natural range of butternut (*J. cinerea*), its native host.

This weevil was found in 1975 in a hybrid *Juglans* research planting at the Kellogg Forest near Augusta in Kalamazoo County, Michigan. As little is known about this insect in Michigan, we undertook this study to learn its life history, some of its habits, and injury to its hosts. Although this weevil attacks young shoots and nuts, only the life history and damage on the shoots were studied because most of the trees were too young to bear nuts. Britton and Kirk (1912) and Brooks (1922) adequately discuss the damage to the nuts of walnuts and butternuts.

METHODS

This study was made in a mixed hybrid walnut plantation at the Kellogg Forest, Augusta, Michigan, in 1975 and 1976. Trees ranged from 1 to 6 m tall in 1975 at the start of the study.

Branch samples were collected at least weekly from the start of warm weather in the spring until autumn. For each sample we recorded oviposition sites, number of larvae, direction of larval feeding, and other aspects of larval behavior and habits. The pupal period was determined by collecting larvae in cone traps (46 cm diameter) as the larvae dropped to the ground. Soil-filled cups placed at the apices of the traps were collected one to two times each week and checked for pupation. Pupae were removed and caged for further development and adult emergence. Habits of the adults were observed in the field at the time of each collection.

LIFE HISTORY AND HABITS

Conotrachelus juglandis LeConte is univoltine in Michigan. Adults live for a full year or longer and the females oviposit from mid-spring until late summer, so there is considerable overlap of the life stages. The adult overwinters. Detailed descriptions of the life stages are given by Britton and Kirk (1912), Brooks (1922), and LeConte (1876).

The nearly white ovoid egg is smooth with a semi-glossy surface. Five freshly laid eggs averaged 0.93×0.57 mm. Britton and Kirk (1912) measured several eggs as 0.95×0.57 mm.

Oviposition begins about the second week of May in Michigan and continues until early August. Felt (1930) reported eggs first appearing in mid-June; Britton and Kirk (1912) found them the latter part of May in Connecticut. The female weevil oviposits in niches she chews in the young shoots. Because new shoots are just emerging at the start of egg laying, the first niches are on or near the base of the petioles of the leaves. As the season progresses and the shoot elongates, more niches are cut toward the tip. Each niche contains one egg in a small cavity that is flanked on three sides by a crescent-shaped slit. Porter (1932) suggested that the slit prevented the egg from being crushed by rapidly

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growing plant tissue. A flap of tissue usually conceals the egg, and frass pellets sometimes plug the niche opening. The egg may be situated either above or below the opening.

A frequency histogram of head capsule width measurements shows there are five larval instars. Cast head capsules with pupae and head capsules of larvae eclosing from the egg helped determine instar number more precisely. Mean head capsules were measured from 818 larvae (Table 1).

First instar larvae appear in mid-May. They eclose about 6 to 12 days after oviposition depending on the temperature (Britton and Kirk, 1912). Each small larva bores into the pith and feeds up or down the stem or into the bases of the leaf petioles. The pith is soft and green at this time. As the larva grows it makes a larger and longer tunnel in the pith and is restricted only by the pith diameter of the shoot and petioles. Oldest larvae are thus nearly always toward the shoot base where the pith diameter is largest, and the youngest larvae are near the tip. Two or more larvae occupying the same shoot are able to completely bore out the center of the entire shoot. Larvae running out of food and reaching the base of the new shoot usually feed into the cambium and girdle the shoot there; this is the major cause of shoot wilting and mortality. Partially hollowed-out shoots that do not break off usually survive.

The egg niche opening is enlarged during the larval growth period and it becomes the entrance to the larval tunnel and a "push out" hole to eject frass. An active larval gallery has frass accumulated at the entrance and a necrotic darkened area of tissue encircling the opening.

Britton and Kirk (1912) noted that larvae from eggs laid after 20 July in Connecticut died before maturity because the shoot tissues hardened. This was not observed in Michigan, but small larvae occasionally died in wilting shoots that were girdled by older larvae feeding below them.

The larval period lasts four to six weeks. Fully developed larvae, when through feeding, exit through the tunnel opening and drop to the ground. Most larvae leave during the early morning hours (Brooks, 1922) before the heat of the day. Larvae start dropping about mid-June in Michigan and they continue into late August. In West Virginia larvae left the shoots in mid-July and continued into early September (Brooks, 1922), and peak emergence occurred in late July with a second smaller peak in early August. On the ground the larvae seek soft soil or depressions to dig into. They burrow into the soil as deep as 3 inches and there each constructs a small earthen pupal cell.

Pupation occurs 7 to 10 days after the larva enters the soil, and the pupal period lasts between 15 and 20 days. Mean period from the time the larva enters the soil to adult emergence is approximately 27 ± 3 days for Michigan. First adults appear in the second or third week in July and the last adults have emerged by mid-September. Brooks (1922) recorded first emergences in mid-August in West Virginia. Young adults fly to the host trees and feed on the soft tissues of the shoot tips, leaf rachis, and on the leaflets. Most feeding occurs at night or during the early morning hours. Adults generally rest on the foliage or hide during the day.

As the leaves begin to discolor and cold weather arrives, the adults drop to the ground, crawl beneath the litter, and burrow into the soil beneath the tree's canopy.

Table 1. Measurements of 818 head capsules of *C. juglandis*.

Instar	No. Head Capsules	Mean Width and Standard Error (mm)
I	48	0.410 \pm .004
II	62	0.570 \pm .005
III	37	0.736 \pm .009
IV	138	0.960 \pm .006
V	533	1.240 \pm .003

There they overwinter in small cells. In May they emerge, return to the tree, seek mates, and the females soon after start ovipositing. Adults feed on the soft, new shoot and leaf tissues throughout the summer and die as autumn approaches.

DISCUSSION

The life history and habits of *juglandis* in Michigan are similar to those recorded for Connecticut (Britton and Kirk, 1912) and West Virginia (Brooks, 1922), except that the life cycle starts and progresses a few weeks earlier in Michigan. Our two years of data appear to bear this out, though small differences still occurred each year. The most notable difference is the early oviposition and subsequent early larval eclosion. There also appears to be a longer larval period owing to this. Whether more eggs are laid in Michigan because the adults are active longer was not ascertained.

Both the larvae and adults injure the host tree by their feeding on the new shoots. The main injury, however, is from larval tunneling in the pith and girdling at the base of the new shoots. Tunneling weakens the shoot so growth is arrested or breakage occurs from wind and snow. Girdling kills the shoot outright because the cambium is severed, and as most girdling occurs near the base of the new shoot, most or all of the season's growth is lost.

Adult injury occurs mostly during spring feeding when the shoots are small and succulent. Then feeding niches may cut through half of the shoot's diameter and cause it to wilt and die. After mid-June damage is less serious because the shoots are larger. After the new adults emerge in the fall they make numerous feeding wounds along the shoot, but these scar and callous usually without injury to growth or form. Adults also heavily skeletonize the leaflets. Feeding wounds on leaf petioles in the fall kill an occasional leaf but natural leaf fall occurs shortly thereafter anyway. Degree of injury and host preference is given by Wilson et al. (1979).

This weevil also has a life history that is similar to the black walnut curculio, *C. retentus* (Say), and most likely can be suppressed in a similar manner when necessary. Both weevils appear to be most amenable to suppression in the adult stage, either while feeding in late summer and autumn following emergence or in the spring after overwintering. Jaynes (1969) recognized the potential of fall spraying for controlling *retentus*. The adults feed for more than a month in the fall so there is a good chance they will readily eat or contact any persistent pesticide. Gibson and Kearby (1975), using Azinphosmethyl, obtained fair chemical suppression of *retentus* adults during the beginning of feeding and oviposition, and concluded such a program might be economically justifiable. Satisfactory suppression techniques have yet to be worked out for the butternut curculio.

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