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FIELD OBSERVATIONS OF LARVAL BEHAVIOR OF *DATANA INTEGERRIMA* (NOTODONTIDAE) IN ILLINOIS

Black walnut, *Juglans nigra* L., is an important nut, ornamental, and timber species in the eastern United States. Tree farmers, homeowners, nut growers, and foresters plant many acres of this tree each year. The role of insects in tree development is of concern to the owners. The walnut caterpillar, *Datana integerrima* G. & R., is a major defoliator of black walnut and other species of the Juglandaceae. This study was initiated in 1975 to better understand the relationship of the walnut caterpillar and other insects to the establishment and development of trees in such plantings.

Datana integerrima was described by Grote & Robinson in 1866 (Proc. Entomol. Soc. Philadelphia 6: 12–13). Their larval description was limited to the fifth stage. Packard (1895, Mem. Nat. Acad. Sci. USA 7: 105, 120–122) described and illustrated the five larval stages. Life history studies were made by Baerg (1928, Ark. Agric. Exp. Sta. Bull. 224: 9–16), Haseman (1940, Mo. Agric. Exp. Sta. Bull. 418, 15 p.), and Hixson (1941, Okl. Agric. Exp. Sta. Bull. B-246, 29 p.). Limited bionomic and behavioral data are available in these studies. The insect is reported to feed on apple (Grote & Robinson, op. cit.), willow, honey locust, thorn, beech, apple, and oak (Packard, op. cit.; Forbes, 1911, Ill. Agric. Exp. Sta. Bull. 151: 470–472; Houser, 1918, Ohio Agric. Exp. Sta. Bull. 332: 226–229), and azalea (Cochran, 1976, U.S. Dept. Agric. Coop. Plant Pest Rep. 1(40): 675).

Information presented here is based on field observations of colonies of walnut caterpillar larvae in central and southern Illinois. Egg masses and larval colonies found on the foliage of large black walnut, pecan (*Carya illioensis* (Wangenh.) K. Koch), the hickories (*Carya* spp.), and English walnut (*Juglans regia* L.), were clipped off with pruners and transferred onto twigs or leaflets of smaller trees of the same species. The twigs and leaflets were tied or clipped to the foliage of the smaller trees to prevent dislodgment. Placement of the egg masses and colonies on smaller trees facilitated close observation of larval behavior, collecting predators and parasites, and recovery of mature larvae. Other than the initial transfer, the study was conducted under natural conditions. Movements and behavioral reactions of some colonies that defoliated the trees were recorded. Approximately 75 colonies were used (ca. 46,500 larvae), but behavioral characteristics were not quantified. Most observations were made during daylight hours. However, some colonies and egg masses were collected at night and placed in plastic bags to be relocated the next day.

Egg masses are always found on the lower leaflet surface. The larvae are gregarious and, upon eclosion, first stage larvae spin silk over the egg mass then move to the upper leaflet surface while depositing a silken trail during their movements. As other larvae emerge they crawl over and follow the trails spun by earlier emerging larvae, while spinning their own silken trails. The larvae devour the surface tissues, giving the leaflet a skeletonized appearance (Fig. 1). After feeding on the upper surface the larvae expand their feeding activities to nearby leaflets, and then feed on either surface.

Second stage larvae feed from the edge of the leaflet and devour the entire leaflet except the larger veins, later they leave only the main vein. Third stage larvae initially leave the main vein, but later devour it leaving only a petiolar stub as do the fourth and fifth stages.

Most movements of the larvae on the leaflets, rachides, branches, and stems occur as a colony. During these movements the larvae spin large quantities of silk on the branches, twigs and leaf rachides. After initially feeding, individual larva wander short distances over the leaf rachis and adjacent foliage depositing silk as they wander, but wandering larvae usually return to the main colony after a brief period of time, maintaining the contiguity of the colony. A rachis, twig, or small branch may be completely covered by silken trails as a result of this wandering. Larvae may use silk deposited

FIGS. 1–4. **1,** black walnut foliage skeletonized by first stage walnut caterpillar larvae; **2,** a colony of fourth stage walnut caterpillar larvae molting to the fifth stage on the foliage of a black walnut tree; **3,** a fifth stage walnut caterpillar larva returning to the foliage along a silken trail; **4,** colonies of fourth and fifth stage walnut caterpillar larvae on the same foliage of a black walnut tree.

during their wanderings as a means by which to return to the colony and the colony may later follow the silken trails when moving to molting or new feeding sites on the host plant. Movement away from the main colony appears to be an age dependent factor. The larvae become less gregarious during the 5th stage and tend to separate into smaller groups.

Just prior to molting the larvae congregate and spin a molting pad to which they cling during the molting process. The first and second molts generally occur on the foliage. The third and fourth molts normally occur on the bole of the tree or larger branches, occasionally these molts take place on the foliage (Fig. 2). In a large fourth stage colony the molting pad is usually large (ca. 24 × 24 cm) and the larvae are found on and in the pad. Upon completion of the molting process the larvae return to the foliage following silken trails deposited earlier (Fig. 3). They generally return to the same foliage area they were in before molting. If the foliage is depleted the larvae seek additional food on the same branch before moving to other branches. As the larvae mature they tend to move to higher branches.

Larvae of different stages congregate together if there is more than one colony on the same tree (Fig. 4). Different stages may occasionally be found at the same molting site and all stages frequently feed on the same leaflets during periods of high population. The larvae mingle on all sized trees during these periods, particularly when the silken trails of the colonies cross. The larvae are defensive. When threatened, the larvae arch their bodies so as to raise the thorax and posterior body segments from the surface of the substrate. If the disturbance persists, the larvae often secrete a droplet of fluid (found to have an approximate pH of 9.5) from between the mandibles and make quick

TABLE 1. Plants on which walnut caterpillar larvae were found after they abandoned defoliated black walnut and other host trees in Illinois.

Plant species	Common name
Acer saccharum Marsh.	sugar maple
Erigeron annuus (L.)	daisy fleabane
Erigeron canadensis (L.)	horseweed
Festuca sp.	tall fescue
Liquidambar styraciflua L.	sweetgum
Liriodendron tulipifera L.	tuliptree
Pinus sylvestris L.	Scotch pine
Platanus occidentalis L.	sycamore
Quercus imbricaria Michx.	shingle oak
Rosa multiflora Thunb.	multiflora rose
Rubus sp.	blackberry
Solidago sp.	goldenrod
Ulmus alata Michx.	winged elm

up-and-down or sideways movements with the anterior and posterior segments of the body striking the surface of the leaflet. Under natural conditions the entire colony usually reacts in unison. This response is frequently sufficient enough to distract many predators and parasites.

A larva need not be touched or prodded to initiate the alarm or defensive reaction. Touching the leaf rachis, leaflet, or the branch on which the larvae are clinging often induces the defensive reaction in a colony. Little or no reaction to wind is seen.

Three to four days after the last molt, larvae continue to feed, but readily drop from their feeding site to the ground when the foliage and/or branches they occupy are shaken. The larvae do not spin silk as they drop. This reaction, displayed only by nearly mature fifth stage larvae when they are disturbed, is probably defensive. At this stage the larvae are turgid and some are injured upon hitting the ground or other objects. Vibrations, such as those caused when a branch is touched or even those caused by an ichneumonid alighting on a leaflet are probably the causative factor in initiating the larval defensive response.

Walnut caterpillar larvae abandon trees when the foliage becomes sparse or when the tree is defoliated. The larvae scatter in all directions upon leaving the tree and are apt to ascend any nearby plant. Third, fourth, and fifth stage larvae, abandoning defoliated trees, disperse around the base of the tree; some return and reascend the tree. After crawling over several branches, larvae reascending the tree soon descend and disperse. Initially the larvae move only short distances from the base of the tree, then they move to greater and greater distances. When a larva travels a distance of ca. 2 m it generally continues in a direction away from the tree it abandons. This dispersal process continues for several hours. They ascend grass stems, weeds, other nearby trees (Table 1) and crawl through the litter on the ground. The larvae do not feed on these plants and abandon them in ca. 24 hours. Directional polarized light from the sun appears to have little influence on larval orientation since many larvae wander north, as well as other directions, upon abandoning defoliated host trees (Doane & Leonard, 1975, Canad. Ent. 107: 1333–1338).

Farris & Appleby (1979, Univ. Ill. Agric. Exp. Sta. DSAC 7: 12–18) indicate larvae feed and survive only on species of Juglandaceae. Early reports of larval feeding on other plants may be due to larval abandonment of host trees and patterns associated with search for suitable food resources. Species of *Datana* larvae are difficult to distinguish in the first four stages. Early workers may have misidentified the different *Datana* species, resulting in the present confusion concerning their host plants.

At maturity the larvae become very flaccid, are restless, cease feeding, release their grasp and roll off the branch or rachis of the host tree and drop to the soil. Upon reaching the ground the larvae remain quiet for 3–4 s then begin to wander, finally burrowing into the litter and soil where pupation occurs. Their flaccid condition suggests that the digestive tract is purged before dropping and this probably offers some protection against injury upon landing.

The larvae generally pupate 1–3 cm deep in sod, 1–7 cm in loose soil and in heavy litter on the ground. They do not spin a cocoon before pupating. A cell is made in the soil or litter around the pupa by larval/pupal movements made during the pupation process.

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M. E. FARRIS AND J. E. APPLEBY, *Illinois Natural History Survey and Illinois Agricultural Experiment Station, Urbana, Illinois 61801.*

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ANTS ASSOCIATED WITH *HARKENCLENUS TITUS*, *GLAUCOPSYCHE LYGDAMAS*, AND *CELASTRINA ARGIOLUS* (LYCAENIDAE)

Larvae of many lycaenid species are assoicated with ants. The latter feed on secretion from the larvae and presumably offer them protection against predators and parasitoids. Despite the fact that a number of North American lycaenid larvae are reported to be myrmecophilous, with few exceptions, the associated ants are largely unknown. During 1976 and 1977, we made observations of *Harkenclenus titus* (Fabricius), *Glaucopsyche lygdamas* (Doubleday), and *Celastrina argiolus* (Linnaeus) at several localities in Washtenaw Co., Michigan. Although all of these species have long been known to be myrmecophilous, there are few published records of the species of ants involved (see below). These preliminary observations are presented in the hope that they will stimulate further observations on this facet of lycaenid biology. Ants tending late instar larvae were collected at one locality in Washtenaw Co., in the vicinity of Embury Road (T1S R3E sect. 15), during 1977. Unless otherwise indicated, all identified ants are from this locality. The following summarizes our results.

Harkenclenus titus. Several late instar larvae were found feeding on the green fruits of *Prunus* sp. (possibly a hybrid between *P. serotina* Ehrh. and *P. virginiana* L.) (Rosaceae) on 22 May. Some were tended by *Formica subsericea* Say, and others by *Camponotus nearcticus* Emery. There are no previous reports of identified ants associated with this species.

Glaucopsyche lygdamas. The larvae of this species feed on the inflorescences of *Lathyrus venosus* Muhl., *Vicia caroliniana* Walt., and *V. villosa* Roth. (all Leguminosae) at various localities in Washtenaw Co. On 22 and 28 May, late instar larvae were found feeding on the flowers of *V. villosa,* an introduced species that occurs in open fields. Some of these larvae were tended by *Formica subsericea,* and others by an undetermined species of *Formica* in the *microgyna* or *rufa* species group.

Myrmecophily in this species was first noted by Brower (1911, Entomol. News 22: 359–363), but only Downey (1965, Entomol. News 56: 25–27) has identified ants involved. He found three species (*Formica comptula* Whlr., *Formica* sp. ? *rufa* group, and *Tapinoma sessile* (Say)) tending larvae feeding on *Lupinus argenteus* Pursh at one locality in South Dakota.

Celastrina argiolus. Females of the spring flight oviposit on the flower buds of sev-