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Response of Insects to Damaged and Undamaged Germinating Acorns

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Abstract

Damaged germinating northern red oak, *Quercus rubra* L., acorns in pitfall traps were significantly more attractive to two species of acorn insects than undamaged germinating acorns. Significantly more adults of the weevil *Conotrachelus posticatus* Boheman and the sap beetle *Stelidota octomaculata* (Say) were caught in traps containing germinating acorns cut into halves versus traps containing uncut, germinating acorns. Larvae of the acorn moth *Valentinia glandulella* (Riley) also preferred damaged over undamaged acorns, but few larvae were caught and the results were not analyzed.

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Introduction

Studies conducted since 1986 in Ohio and Pennsylvania have shown that insects are a primary factor in limiting oak seedling establishment (Galford et al. 1988, 1991a). Insects destroy great numbers of germinating acorns, especially acorns of northern red oak, *Quercus rubra* L., in the spring. Even when acorn crops are large enough to exceed the needs of wildlife, the surplus may be largely destroyed by insects as they germinate (Galford et al. 1991a).

There are three major species of insects that damage germinating northern red oak acorns in Ohio and Pennsylvania: a weevil, *Conotrachelus posticatus* Boheman; a moth, *Valentinia glandulella* (Riley); and a nitidulid sap beetle, *Stelidota octomaculata* (Say) (Fig. 1). *C. posticatus* overwinters as an adult and, depending on temperatures, may begin feeding on radicles of germinating acorns in late February to early March in Ohio and mid to late March in Pennsylvania. Gibson (1964) provided information on the biology of *C. posticatus* but did not indicate that the weevil is a serious pest of germinating acorns. *S. octomaculata* also overwinters as an adult and feeds on radicles of germinating acorns (Galford 1987; Galford et al. 1991b); it begins activity about 1 to 2 weeks after *C. posticatus.* Both species of insects reproduce in the cotyledons of acorns and their developing offspring usually complete the destruction of the acorns. *V. glandulella* overwinters as early instar larvae inside acorns damaged by rodents or other insects such as *Curculio* weevils or the *Cydia* moth or filbertworm. *V. glandulella* can be a secondary pest (Riley 1872; Murtfeldt 1894) or a primary pest (Galford 1986; Galford et al. 1991a) of acorns. *V. glandulella* also overwinters as larvae on or near undamaged acorns. In the spring as soon as acorns germinate, the moth larvae begin feeding on acorn radicles and then "bore" into the acorn cotyledons to complete development (Galford et al. 1991a). *V. glandulella* larvae are one of the earliest insects to damage germinating red oak acorns in the spring, beginning their activity several days before *C. posticatus.*

Laboratory and field studies demonstrated that *C. posticatus, S. octomaculata* and *V. glandulella* could feed and reproduce in germinating acorns, destroying their viability. Except for *C. posticatus,* the insects also feed and reproduce in nonviable acorns in which the cotyledons have turned brown. A preliminary laboratory test demonstrated that *S. octomaculata* preferred germinating acorns infested with *V. glandulella* over noninfested germinating acorns for reproduction. However, the sap beetles also reproduced in some acorns that originally were insect free. They readily fed on the radicles of all of the insect-free acorns. These observations prompted a field study in 1988 to determine the relative attractiveness of damaged and undamaged acorns to the insect species mentioned.

Figure 1.—Top to bottom: larva of *Valentinia glandulella,* adult *Conotrachelus posticatus,* and adult *Stelidota octomaculata.*

Methods

Pitfall trapping studies were conducted in an upland, 80+ year old oak-hickory stand in Vinton County in southern Ohio from late winter until late spring of 1988. The trap study sites were established on a south-facing midslope in a stand dominated by black oak, *Q. velutina* Lam., white oak, *Q. alba* L., and chestnut oak, *Q. prinus* L. Some northern red oak trees were located low on the slope and in the cove at the bottom of the slope.

Northern red oak acorns used in these studies were collected from a single isolated lawn tree so that the acorns would be homogeneous. They were stored at 5° to 7°C in dry sand or peat moss in sealed plastic bags. As they were needed for study, acorns were removed from storage and placed on moist paper toweling in loosely sealed jars to initiate germination.

Pitfall traps were constructed using 1-pint (473-ml) glass canning jars with two-piece metal lids. The sealing lid was replaced with ¼-inch mesh hardware cloth of equal diameter. The hardware cloth was glued inside the band with epoxy ribbon adhesive to prevent rodents from pulling it out. About 7 cm^2 of cotton wadding was placed in each jar along with 20 ml of distilled water. The moist cotton wadding kept the acorns from desiccating and providing a rooting medium. Five acorns that were just beginning to germinate were placed in each of the five jar traps. In each of five other traps were placed five germinating acorns cut longitudinally in half with a hand pruner. Lids were placed on the jars and the jars were buried with the lids flush with the ground. Rain shields for the traps were provided by positioning plastic lids (15 cm in diameter) about 7 cm above the tops of the traps.

On March 8, 1988, 10 pitfall trap sites were installed about 3 m apart in the previously described stand. The traps were removed and replaced with clean jars containing fresh acorn baits at intervals of 3 to 14 days until July 8, 1988, for a total of 18 trapping periods. A trap site was alternately baited with damaged or undamaged acorns to offset any difference due to trap site location. The old traps were placed in sealed plastic bags and returned to the laboratory where the contents were checked for insects. The acorns from the traps were placed in jars to rear *V. glandulella* larvae into adult moths. Most adult moths emerged within 8 to 10 weeks. After 10 weeks the acorns were dissected and any larvae or pupae found were counted.

Results and Discussion

Significantly more weevils and sap beetles were caught in traps baited with germinating acorns cut into halves than with whole germinating acorns (Table 1). The difference might have been even greater had it been possible to change the baits more frequently. Insects entering a trap and feeding on uncut germinating acorns the first night after trap deployment could have enhanced the attraction of that trap. Also, since nothing is known about the pheromones of *C. posticatus* and *S. octomaculata,* the insects initially trapped could have subsequently influenced the catch. Attraction of both sexes to the male-produced phermone of the nitidulid *Carpophilus hemipterus* (L.), the driedfruit beetle, is enhanced by volatiles from a food source (Bartelt et al. 1990). Thus, if *S. octomaculata* has a similar pheromone/host interaction, the insects initially trapped could have enhanced subsequent insect response to the traps.

Data on *V. glandulella* moth larvae were not analyzed because too few were trapped. However, more moth larvae were caught using cut acorns versus whole acorns. This moth overwinters as early instar larvae on or near acorns in forest litter. Thus, the area of attraction and response of the small moth larvae would be limited compared to the more mobile adults of *C. posticatus* and *S. octomaculata.*

The numbers of insects caught were lower than expected based on studies conducted in previous years in the area. However, 1987 and 1988 were below normal in rainfall and there were few acorns in autumn of 1987 for

Table 1.—1988 catch of acorn insects in 10 pitfall traps baited with undamaged germinating acorns or damaged acorns (germinating acorns cut into halves)

Trapping dates	Damaged acorns			Undamaged acorns		
	Weevils caught	Sap beetles caught	Moths caught	Weevils caught	Sap beetles caught	Moths caught
	Number					
3/8-3/22	0	0	0	0	0	0
3/22-3/25	4	0	10	2	0	8
3/25-3/29	2	0	1	3	0	0
3/29-4/1	7	1	3	3	2	2
4/1-4/5	4	2	0	0	0	0
4/5-4/7	6	4	0	0	0	0
4/7-4/12	2	2	0	1	1	1
4/12-4/15	1	2	0	0	4	0
4/15-4/20	1	2	1	0	2	0
4/20-4/26	4	8	0	1	0	1
4/26-5/5	12	10	0	1	2	0
5/5-5/12	18	17	0	2	5	0
5/12-5/18	26	25	0	1	5	0
5/18-5/27	6	14	0	2	7	0
5/27-6/1	0	6	0	0	3	0
6/1-6/15	3	10	0	0	3	0
6/15-6/24	0	5	1	0	0	0
6/24-7/8	0	0	0	0	0	0
Total	96[a]	108[b]	16	16	34	12

[a]Significantly different at 1% level from whole acorns (t test, t = 0.0317).

[b]Significantly different at 1% level from whole acorns (t test, t = 0.0116).

insect feeding. Insect activity also was slowed by cool temperatures until late April. The sudden drop in the catch of weevils in late May (Table 1) resulted from high temperatures which sent the weevils into reproductive diapause or aestivation until late summer.

The greater response by the insects to the cut acorns probably was due to increased volatiles emitted by the damaged acorns. In late summer and early autumn, the insects coming out of aestivation or newly emerged adults must quickly locate hosts suitable for feeding and reproduction. Fresh acorns damaged by rodents, birds, or other insects are readily detected by the insects and they migrate to the seed-bearing tree. Once beneath the tree, damaged acorns are the primary sources for feeding and reproduction of the insects. If white oak-type acorns, which geminate soon after falling, are present, feeding and oviposition will occur in undamaged acorns as soon as they germinate. In the case of red oak-type acorns, which do not germinate until the following spring, the acorn insects overwinter near or on the acorns and begin feeding soon after the acorns germinate in late winter or early spring.

In summary, damaged acorns are more attractive to the major insects that feed on germinating acorns. However, insect feeding and reproduction also occurs readily in undamaged germinating acorns once the insects are attracted to an area. In most years when only a few oak trees in the forest bear acorns, the crop is largely destroyed by a combination of concentrated rodent and insect feeding. As a result, few if any oak seedlings became established. In years of large to bumper acorn crops, the needs of both wildlife and insects are met and significant oak seedling establishment may occur. However, bumper acorn crops may not always result in good oak seedling establishment. The largest acorn crop in several years in central Pennsylvania in 1989 did not lead to good seedling establishment in the spring of 1990 even when acorns were protected from predation from most mammals (Galford et al. 1991a). Less than adequate moisture in late winter and early spring resulted in poor acorn germination and insects destroyed the majority of the acorns that germinated.

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