

Insect Parasitoids Reared from Adult Root Weevils Collected in Washington

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Abstract

This paper provides a brief account of natural enemies of root weevils as reported in the literature and focuses on a pilot survey of parasitoids and their adult root weevil hosts. Field-collected adult root weevils were caged in petri dishes with food and held at room temperature until death. Parasitoids that emerged were held until adults emerged. Two, and possibly three, species of tachinid and one species of braconid, as yet unidentified, were reared from several species of root weevil adults. This suggests an area for future research into the impact of parasitoids on root weevil populations and the potential for including natural enemies in an integrated pest management (IPM) program.

Introduction

The research on root weevils has a long and impressive history. Smith (1932) summarized historical and his own extensive research on the black vine weevil (*Otiorhynchus sulcatus* Fabricius); Wilcox et al. (1934) provided an extensive coverage of the weevils in strawberries in Oregon, with an excellent synthesis of existing literature and their own investigations. Much of the early work on root weevils was focused on the taxonomy or biology of the weevils, with especially heavy emphasis on the control of root weevils. It is not surprising therefore, that research focused on the worst and most common species of weevil: the black vine weevil, *Otiorhynchus sulcatus* F.; strawberry root weevil, *O. ovatus* L.; clay-colored weevil, *O. singularis* L.; rough strawberry root weevil, *O. rugosostriatus* Goeze; woods weevil, *Nemocestes incomptus* Horn; and obscure root weevil, *Sciopithes obscurus* Horn.

Until recently, research focused on pesticides that would control large populations of pest weevils. Aside from a few studies and observations, relatively little information on the predators and parasites of root weevils was available. Both Smith (1932) and Wilcox et al. (1934) summarized the information on insect parasitoids in a single paragraph.

As citizens began to voice their concerns about pesticide impact on human health and the environment, many of the pesticides (aldrin, dieldrin, heptachlor, chlordane, and DDT) that were highly effective against root weevils were banned. Under the Food Quality Protection Act requiring that manufacturers submit data for reregistration of pesticides, many others have been voluntarily cancelled and others have been banned. This has provided incentives and improved funding opportunities for investigations into alternatives such as

the use of predators and parasitoids in production systems. In general, there has been a shift away from the heavy emphasis on broad spectrum pesticides to an integration of pesticides that target the pest and are less harmful to beneficials in the system. An increased emphasis in augmenting naturally occurring predators and parasitoids is also evident.

Insect Parasitic Nematodes and Fungi

Researchers working on insect parasitic nematodes and fungi have been at the forefront of biological control of root weevils. It is currently possible to purchase the insect parasitic nematodes *Steinernema carpocapsae*, *S. feltiae*, and *Heterorhabditis bacteriophora* and the insect parasitic fungi *Metarhizium anisopliae* and *Beauveria bassiana* for the control of root weevils. Oregon State University entomologists Ralph Berry and Jie Liu have surveyed the coastal areas in Oregon and have isolated native species of nematodes better adapted to the cooler winters of the Pacific Northwest. One species, *Heterorhabditis marelatus*, shows particular promise at lower temperatures (Berry 2000, Gentle 2001). The literature on insect parasitic nematodes and fungi for root weevils is abundant. This topic deserves special consideration and is beyond the scope of this paper.

Predators

Smith (1932) and Wilcox et al. (1934) have both summarized the world literature on natural enemies of root weevils. Various researchers have reported predators of root weevils, mainly of black vine weevil. They list moles, hedgehogs, skunks, and deer mice; a number of birds, including starlings and poultry; and lizards and toads. The insect predators on weevil larvae

and/or adults included staphilinid and carabid beetles, ants, mites, various spiders, and a digging wasp (Wilcox et al. 1934). Currently, some researchers are investigating the effectiveness of carabid beetles as predators of weevils in nurseries (Cowles 1995).

In this pilot study of parasitoids, carabid beetles were sometimes observed during nocturnal surveys. Spiders were the most obvious predators of root weevils; silk-wrapped root weevils were commonly found in or below spider webs, especially along house foundations and in stairwells.

Parasitoids

There is a paucity of information on the parasitoids of root weevils. Feytaud (1914) mentioned that *Blacus tuberculatus* (Hymenoptera: Braconidae) parasitized adult black vine weevils. A few authors have documented that tachinid flies parasitize weevils. Wilcox et al. (1934, p.24) cited Thiem (1922) as stating that “the Tachinid parasite from larvae (*B. sulcatus*), believed to be *Pandelleia sexpunctata* Pand., seems to be of greater value [than mites or toads].” However, Wilcox also wrote that “Weed (1884), Lovett (1913), and Treherne (1914) were unable to find any parasites of *B. ovatus*.” Smith (1932) reported that “Feytaud... stated that *sulcatus* larvae were comparatively free of parasites. The present writer found no insect parasites of any of the stages in his studies.” Perhaps the lack of parasitoids in early studies discouraged further research in this area.

Bell and Clarke (1980) found that *Dolichotarsus* (Brooks) “sp. unknown” (Diptera: Tachinidae) had parasitized an average of 32 percent of the obscure root weevils, *Sciopithes obscurus* collected weekly from rhododendrons. Ninety-six percent of the parasitized weevils came from a single garden located in Springfield, Oregon. The ovarioles in parasitized adults were not completely developed and oocytes did not mature. In addition, the weevils died when the larvae emerged to pupate.

Blackith (1986) reported on a braconid (*Pygostolus sticticus* Fab.) parasitizing *Otiorhynchus singularis* L. in Ireland. McGavin and Graham (1993) recorded *Otiorhynchus rugosostriatus* as a new host for *Dirhicnus ramealis* (Nees) (Hymenoptera: Chalcidoidea; Pteromalidae). Compared to insect parasitic fungi and nematodes, there are still relatively few published papers on parasitoids of root weevils or their potential contribution to an overall IPM program.

In the course of a study of root weevils in nurseries, landscapes, public gardens, and wild areas in Washington, about 15 tachinid flies emerged from caged lilac weevils (*Otiorhynchus meridionalis* Gyll.) This suggested the possibility that parasitoids might be present in other weevils from a variety of study sites and prompted a new direction for research. This pilot study had the objective of determining if naturally occurring parasitoids of adult root weevils occur in Washington.

Methods and Materials

Root weevils were collected from a variety of sites throughout the year. At night, weevils were handpicked from plants or dislodged from damaged plants onto a beating sheet. Additionally, one grower daily collected weevils hiding under board traps. The weevils collected from each site were stored in plastic containers, each with one square of unscented toilet tissue (SCOTT® 1000 Tissue). This reduced condensation in the container and prevented drowning (and decomposition) of the weevils in the free moisture that formed when containers were refrigerated on hot days. In this manner, weevils survived and remained healthy in refrigeration for a month or more.

Weevils from each site and date were separated by species, placed in petri dishes, and labeled. When there were only a few of one species from a site, several consecutive dates were combined. Each petri dish received a small amount of *Rhododendron* ‘Blue Diamond’ foliage and a single crumpled square of the unscented toilet tissue. The petri dishes were then sealed

with a 0.25-inch strip of Parafilm (Parafilm® Laboratory Film; American National Can™, Chicago, IL). Petri dishes were then placed in a tray and held at normal room temperature (daytime high = 74°F; nighttime low = 65°F).

Each week weevils were transferred to a new petri dish and given fresh *Rhododendron* ‘Blue Diamond’ foliage. Any parasitoid puparia or cocoons were removed to another container, sealed with Parafilm®, and held until the adult emerged. Occasionally, parasitoid adults were found to have emerged in the Petri dish. The number of weevils possibly killed by fungi (determined infected if white fungus mycelia were emerging from joints, mouth, or anus) was also recorded. It took up to 30 hours per week (depending on number of Petri dishes and number of weevils per dish) to transfer weevils to new dishes and food, remove parasitoids, and tabulate the week’s mortality and causes. Some of the weevils in this study lived for a year.

Results

The information reported here must be considered preliminary until the data analysis has been completed. At that time information on the species of host weevil, collection sites, and emerged parasitoid species and number will be available. By rough count, more than 50 parasitoids were reared in this study. Both tachinids (Diptera: Tachinidae) and braconids (Hymenoptera: Braconidae) emerged in the laboratory setting. Some mortality of parasitoid pupae occurred.

Most of the parasitoids were reared from weevils in the genus *Nemocestes* (*N. incomptus* Horn and *N. montanus* Van Dyke), the predominant species collected daily from board traps at the nursery site. Parasitoids have been reared from other weevil species as well. The data have yet to be compiled.

Tachinid flies were the most numerous parasitoid to emerge (primarily from species in the genus *Nemocestes*). As near as can be determined (by cadavers in the petri dishes) only one parasitoid emerged per host. The tachinid larva left the host and pupated in the petri dish. It appeared that they emerged from between the abdomen and thorax, resulting in a separation of the two sections. There are two and possibly three species not yet identified.

Daniel J. Bennett tentatively identified the braconids as belonging to the subfamily Euphorinae and genus *Microctonus*, (email, Bennett 2000). Goulet and Huber (1993) stated that this is a “genus said to attack adult beetles especially weevils, carabids and chrysomelids” though there was no mention of weevil hosts. The braconid larvae exited from the weevils and spun whitish to cream-colored silken cocoons. They emerged a week or two later but the point of exit from the cadaver was indeterminate. None of the tachinid or braconid parasitoids were observed in the field at night. And although two species of ichneumonid wasps (Hymenoptera: Ichneumonidae) were collected, no ichneumonids emerged from the weevils in the lab.

Insect parasitic fungi were suspected (by the fungus emerging from body openings) to have caused the gradual death of weevils in the lab. However, subsequent attempts by Denny Bruck (ARS laboratory, Corvallis, Oregon, personal communication) failed to isolate insect parasitic fungus species. Mortality seemed to be highest when condensation developed in the dishes; however, weevils that died naturally had the more typical fungal bloom associated with mold.

Discussion

It is hardly surprising that parasitoids of root weevils have received little study: the process of collection, observing, and rearing parasitoids from adult weevils in a controlled environment is for the very patient. The period for emergence of the parasitoids is lengthy, or unpredictable, and they are easily overlooked because of their small size.

The presence of even relatively modest numbers of parasitoids in weevil populations in Washington, observed in this study, is an encouraging sign. Braconid wasps in the genus *Microctonus* have been reported as naturally occurring and they also have been released for control of other weevils in the United States and elsewhere (Goulet and Huber 1993). Coupled with new

and fairly targeted control tactics, it seems possible that augmentive releases or conservation of natural populations of parasitoids could be developed and would provide one more management tool for root weevil control.

Parasitoids now have been documented as occurring in root weevils in Washington. The cadavers and parasitoids have been curated and photographed and voucher specimens will be provided to the Maurice T. James Entomological Collection at Washington State University, Pullman. The results are presented here to encourage further study of the presence and impact of parasitoids in research programs and to stimulate consideration of their potential role in an IPM program.

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Parasitoids and Predators of Root Weevils in Washington



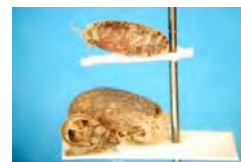
Photo by Eric LaGasa

Adult tachinid

The adult flies are somewhat smaller than a small house fly.

Typical tachinid puparia and cadaver of *Nemocestes*.

Typically, the larva emerges from between the thorax and abdomen, resulting in separation of the thorax from the abdomen.



Puparium (top) cadaver (bottom) (Photo by Daniel J. Bennett)

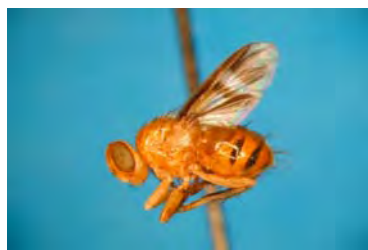


Photo by Daniel J. Bennett

Tachinid from *Otiorhynchus meridionalis* Gyll.

Adult fly that emerged from lilac weevil collected from a landscape in East Wenatchee (Douglas Co.), WA. It remained unnoticed in the rearing cage for some time as the adult weevils were only kept for preliminary observation.

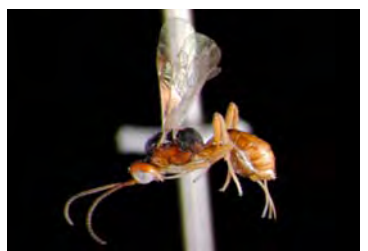


Photo by Eric LaGasa

Braconid wasp (Hymenoptera: Braconidae: Euphorinae)

These small parasitoid wasps were reared from several species of root weevils. Subjectively, they seemed to emerge more frequently from smaller *Nemocestes*, such as *N. montanus* Van D.



Adult cadaver and braconid pupal cocoon (Photo by Daniel J. Bennett)

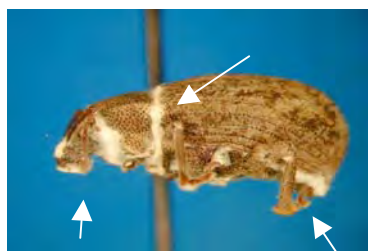


Photo by Daniel J. Bennett

Entomophagous fungus (indicated by arrows)

- Several entomophagous fungi have been reported from root weevils including *Beauveria bassiana* and *Metarhizium anisopliae*. It is typical for these fungi to emerge from joints, mouth, and anus.
- There are no plans to identify the fungi from these weevils. However, all cadavers have been kept and labeled with root weevil species, collection site, date of collection, and date of weevil death and are available for further study.



Predators in nurseries and landscapes

- Researchers are investigating whether carabid beetles could play a role as biological control agents for root weevils.
- Adult carabid beetles were not very abundant in the landscapes and nurseries but were occasionally observed or collected. In a 1999 unpublished pitfall trap study of Oregon nurseries, some traps were filled with carabid beetles. Pitfall traps were not deployed in this study.

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