Biological Control of Japanese Beetle In Michigan Through Parasite and Pathogen Introduction

David Smitley
Department of Entomology
Michigan State University

January 27, 2006

Project Summary: In 1999, two insect parasites of Japanese beetle (*Tiphia vernalis* and *Istocheta aldrichi*) and one protozoan pathogen (*Ovavesicula popilliae)*, were collected in Connecticut and introduced into research plots on 5 golf courses in Michigan. For each introduction site, control plots were established at a different golf course located nearby, for a total of 10 golf course sites. In 2005 we returned to the same golf courses to sample for Japanese beetle and the introduced parasites and pathogen. *T. vernalis* was not found, *I. aldrichi* was detected at 4 of 10 locations, and *O. popilliae* was found at all introduction sites and two control sites, sometimes at epizootic levels (> 20% infection). Populations of Japanese beetle on golf courses where *O. popilliae* is epizootic are now much lower than levels in 1999 and 2000. In 2006 we will attempt to demonstrate long-term biological control of Japanese beetle by comparing the population density of Japanese beetle at 5 locations with little or no *O. popilliae*-infection to the same at 5 locations with moderate to high levels of infection.

Introduction: At this time Japanese beetle (*Popillia japonica* Newman) is one of the most destructive pests of golf courses, sod farms, home lawns, street trees, gardens, vineyards, blueberries, and nursery crops in Michigan and insecticides are used frequently to minimize beetle damage. The nursery industry is the most vulnerable. Losses in sales are estimated at 10% per year ($100 million) because nursery stock cannot be shipped to other states unless it is certified free of Japanese beetle (Smitley 1996). The finding of a single Japanese beetle larva can result in restriction of an entire nursery field. Japanese beetle is also a serious pest of blueberries because adults may cling to berries, sometimes all the way through a mechanical sorting belt and to the processor. Even one beetle in processed food can jeopardize an entire crop. Grapes are also a preferred food of Japanese beetle. Feeding damage to grapes in Southwest Michigan sometimes cause yield reductions. For property owners, and the landscapers and arborists they hire, Japanese beetle is one of most serious defoliators of trees and shrubs in southern Michigan, causing frequent defoliation of lindens, roses, sycamores, Japanese maple, birch, chestnut, sassafras, hibiscus, crabapple, ornamental cherries, roses, mountain ash, and Virginia creeper (Johnson & Lyon 1988). In heavily infested areas, insecticides must be applied several times in July and August to maintain foliage on these plants. Japanese beetle larvae are also the most damaging pests of golf courses in Michigan (Potter 1998). Adults are attracted to moist turf where they prefer to lay their eggs. The larvae feed on turf roots, sometimes causing extensive damage. Costly insecticides are routinely applied to prevent injury to fairways, tees and greens. Recreational turf, industrial turf, home lawns and sod farms also may be damaged from Japanese beetle larvae (Vittum 1995).

Long-term studies of Japanese beetle populations in the eastern United States suggest the highest populations and most severe damage occurs during a 10 to 30-year period after initial establishment. Populations may then decrease and begin to fluctuate, usually at much lower levels, as parasites and pathogens become established.

In 1999 and 2000, the most promising parasites and pathogens of Japanese beetle (*Tiphia vernalis*, *Istocheta aldrichi* and *Ovavesicula popilliae*, were collected in Connecticut and introduced to 5 golf course sites in Michigan (Fleming 1968, Figure 1). *Tiphia vernalis* is already established in several eastern states, including Tennessee, where it is believed to be helpful in limiting populations of Japanese beetle. *Istocheta* was introduced from Japan into several eastern states about 50 years ago and is now

Figure 1. Adult Japanese beetle on a rose petal (left), *T. vernalis* larva feeding on a Japanese beetle grub (center), *aldrichi* depositing an egg on the pronotum of a Japanese beetle.

well established there, parasitizing some 5 - 20% of the beetles, although detailed studies of this have not been published. The protozoan pathogen, *Ovavesicula popilliae* is epizootic in the state of Connecticut where a state-wide survey revealed that 25% of all of the Japanese beetle larvae collected were infected (Hanula 1990). *O. popilliae* is believed to substantially reduce the fecundity of females. It may also effect the survival of larvae and pupae, because the malpighian tubules (serve the same function as kidneys) are severely compromised by the pathogen (Figure 2).

Results in 2005: In 2005 we returned to the 10 golf courses in the original study to sample for Japanese beetle and the introduced parasites and pathogen. Japanese beetles adults were collected in 2 traps per golf course from mid July to mid August. Japanese beetle grubs were collected from all around 2 fairways at each golf course. A total of over 600 grubs were brought back to the laboratory and frozen in water for dissection and pathogen analysis. We have finished dissecting all the grubs except the ones from Pine Valley. *T. vernalis* was not found, *I. aldrichi* was detected at 4 of 10 locations, and *O. popilliae* was found at all introduction sites and two control sites, sometimes at epizootic levels (> 20% infection) (Table 1). Populations of Japanese beetle on golf courses where *O. popilliae* is epizootic are now much lower than they were in 1999 and 2000. *O. popilliae* appears to be providing good biological control of Japanese beetle at sites near Battle Creek and Kalamazoo. This is the only place in Michigan where *Ovavesicula* was found in 1999 and 2000 before introductions were made. At introduction sites in the Detroit area (data in red print in Table 1), *O. popilliae* is now infecting grubs all along fairways where it was introduced, including plots 50 m away from the original introduction plots, but not on fairways >100 m away from the introduction plots and not on control golf courses. An exception is Cracklewood where 19% of the grubs along the fairway where *O. popilliae* was introduced are now infected, compared with 3% infected grubs in an adjacent fairway. This means that at Cracklewood, *O. popilliae* has already begun to spread to adjacent fairways. What is needed at this time is documentation of population regulation of Japanese beetle by *O. popilliae*, and estimates of how fast it spreads after introduction. We plan to do this over the next 3 years, if my Project GREEEN proposal is funded.

Table 1. Establishment and spread of *O. popilliae* to epizootic levels from 2000 to 2005 at 7 of 10 golf courses in this study. Japanese beetle grubs from the remaining 3 golf courses are still in the freezer awaiting assay for the pathogen. Percent infection in 2005 is listed in blue print for the Kalamazoo area where the *O. popilliae* was found as a result of natural spread in 2000, and in red print for the Detroit area where *O. popilliae* was not detected in 2000. Fairways where *O. popilliae* was introduced in 2000 are indicated with a '+'.

Golf course site	***O. popilliae* Introduction site**	***O. popilliae* % infection 2000**	***O. popilliae* % infection 2005**	**JB adults with *Istocheta***
Medalist #5			**11**	
Medalist #4	+	**0**	**0**	**4***
Binder Park #18			**51**	
Binder Park #6		**0**	**31**	**0**
Eastern Hills #7			**43**	
Eastern Hills #5	+	**20**	**17**	**0**
Kalamazoo CC #15			**17**	
Kalamazoo CC #1		**6**	**20**	**2**
Bloomfield Hills CC #13			**0**	
Bloomfield Hills CC #6		**0**	**0**	**2**
Willow #9	+		**5**	
Willow #10		**0**	**0**	**0***
Orchard Lake CC #10			**0**	
Orchard Lake CC #15	+	**0**	**10**	**0***
Cracklewood #6			**3**	
Cracklewood #4	+	**0**	**19**	**0**

*Sites where *Istocheta* was introduced in 2000

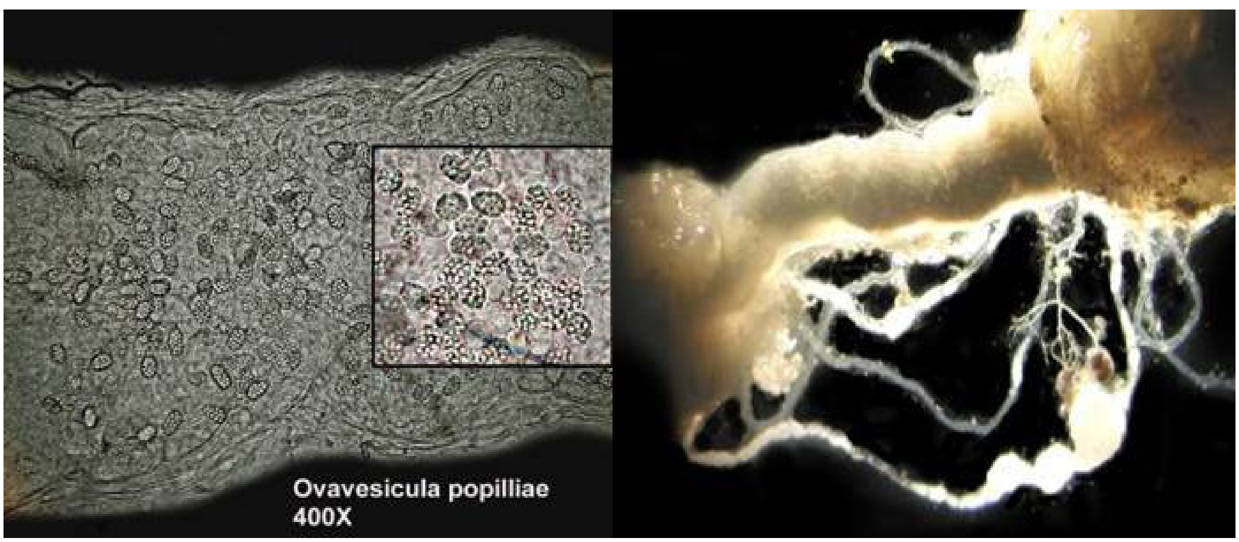

Figure 2. *O. popilliae* infection of Japanese beetle can be diagnosed by the presence of raspberry-like spores in the malpighian tubules (left). Heavy infection causes knotting, swelling and dysfunction of the tubules (right).