RHINONCOMIMUS LATIPES— A POTENTIAL BIOLOGICAL CONTROL AGENT FOR MILE-A-MINUTE WEED (*POLYGONUM PERFOLIATUM*)

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ABSTRACT

Many invasive species, such as mile-a-minute (MAM) (*Polygonum perfoliatum*), pose major threats to biodiversity, ecosystem integrity, and agriculture throughout the United States. Mile-a-minute, native to Eastern Asia, is a particular threat to forest regeneration. Since it has been determined that eradication is no longer feasible, a possible biological control agent, *Rhinoncomimus latipes*, was introduced into the United States in July of 2004. It was anticipated that the introduction of this weevil would minimize the propagation of the invasive species allowing native plant species to reconstitute their normal populations. To determine the possible effectiveness of the weevil, two small quadrats with a limited number of mile-a-minute plants were set up at Washington Crossing State Park. A total of 652 weevils were released in the designated release site quadrat where the effects of the weevil could be examined. A control site was set up to observe the growth rate of mile-a-minute and both sites were monitored weekly. The results showed that the early release of the weevil in a small area eliminated the mile-a-minute from that quadrat. Since the number of mile-a-minute plants in each quadrat was limited, the plants in the release quadrat were quickly reduced in number causing the mile-a-minute berry production also to be reduced. It was determined that mile-a-minute grows best in sunny areas, and that other invasive weeds such as Japanese stilt grass (*Microstegium vimineum*) are strong competitors with mile-a-minute. Therefore, other factors such as drought, shade, and other plant species can play a part in the success of mile-a-minute.

INTRODUCTION

Mile-a-minute (*Polygonum perfoliatum*) (MAM) is a persistent, annual vine in the Buckwheat family (*Polygonaceae*). The weed was accidentally introduced into the United States in the early 1930s at a plant nursery in York County, Pennsylvania (MAM 2005). Mile-a-minute quickly became established and spread mainly throughout the northeastern U. S. infesting nurseries, orchards, floodplains, and openings in forested areas. The purpose of this project is to find a more efficient method of effectively controlling the continuing spread of MAM throughout New Jersey.

P. perfoliatum grows extremely rapidly and can reduce plant diversity in certain areas. It is a huge threat to forest regeneration because it out-competes tree seedlings. Mile-a-minute was selected by the USDA Forest Service to undergo evaluation for biological control because of the ineffectiveness of chemical control to eradicate infestations.

MAM varies in height depending on its habitat (MAM 2005). Vines grow very quickly in forest areas, reaching anywhere from six to eight meters high, shading other plants, and reducing their ability to photosynthesize (Hudson 2004); this is shown in Figure 1(B). In other, more open areas, mile-a-minute forms dense mats carpeting the ground and small shrubs. It has light green, triangular leaves armed with downward pointing barbs on their underside. One unique feature is the cup-shaped, leafy structures called ocreas. These ocreas, that surround the stem at undefined intervals, are where flower buds, and later flowers and fruits emerge (Gerlach-Okay 2004). The stems of early plants are green and turn red as the plant ages through the season. Starting in mid-summer, mile-a-minute produces a fruit resembling blueberries, which begins as

a white immature berry and slowly matures to a blue berry until the first frost arrives, usually mid-October in New Jersey.

Figure 1(A). Mile-a-minute with both mature and immature berries.

Figure 1(B). Mile-a-minute climbing over trees and other tall vegetation.

The seeds, requiring a cold period before germination, germinate in full sun in early spring (Hough-Goldstein 2005). However, studies have shown that mile-a-minute can tolerate partial shade. It is the characteristic of early germination which allows mile-a-minute to out-compete native plants for soil nutrients. Each plant can produce anywhere from 50 to 100 seeds that can remain in the seed bank for up to three years (Hudson 2004). Most of them germinate the following year, while some are spread by birds and water. With the help of *Rhinoncomimus latipes* (Coleoptera: Curculionidae), it is my hope that researchers will start to see a decline in the mile-a-minute population.

R. latipes is a stem feeding weevil which is black and about two millimeters long. Adult weevils eat small holes in the mile-a-minute leaves while the larvae bore into the stem, completely develop, exit the stem, and drop to the floor for pupation (Hough-Gouldstein 2005). Larval feeding by this weevil has the potential to kill small mile-a-minute plants and reduce seed production by adult plants (Flanders 2004). The life cycle of the weevil is about 26 days and females can lay approximately three eggs per day.

R. latipes spends most of the day feeding on the capitula, or flower heads, leaves, and ocreas. While the females prefer to feed mainly on the capitula, which are an important source of protein needed for egg production, the males prefer the leaves and ocrea (Colptzer et al. 2004). This biological control agent is host-specific to only mile-a-minute weeds and does not pose any threats to the biological resources of the United States. Tests have shown that these weevils do not lay eggs or undergo larval development on any other plant species (Flanders 2004).

Photo by Amy Diercks

Figure 2. Adult weevil covered in orange film from mile-a-minute plant.

MATERIALS AND METHODS

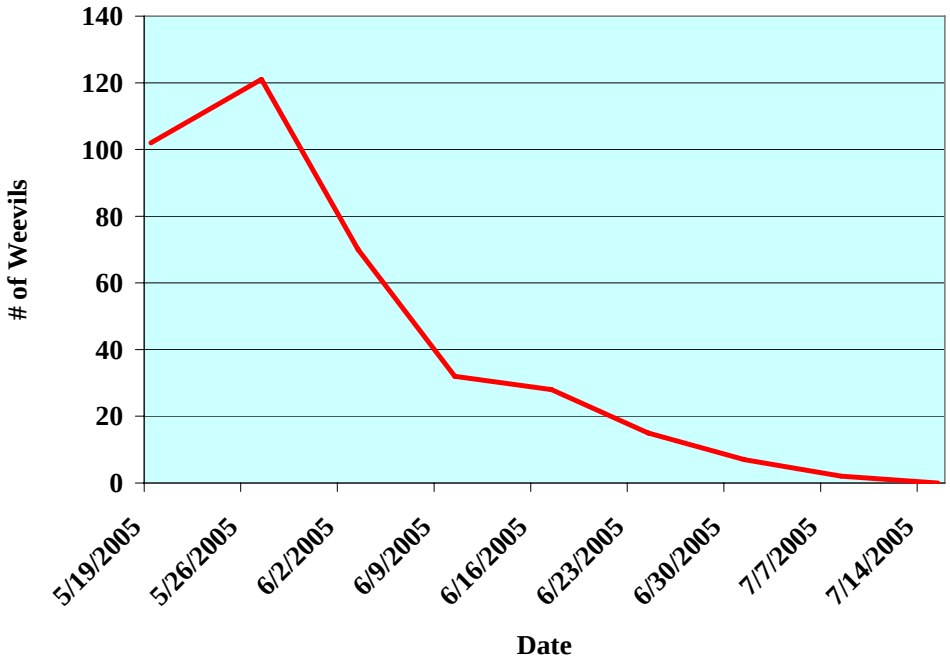
A small site with a limited population of mile-a-minute was selected at Washington Crossing State Park in Hopewell, New Jersey, in May of 2005. This site was selected to evaluate the effectiveness of the weevils on a small infestation of mile-a-minute. Two quadrats, a control and a release, each 2m², were set up in different areas of the park. Each site was partially shaded and contained approximately the same population of mile-a-minute. A 2 meter by 2 meter piece of PVC pipe was used to set up the quadrats. Thin, white string was used to outline the quadrats and orange flags were placed in the four corners of both quadrats. 652 weevils were introduced into the release site only and the exact plant they were released on was flagged using blue tape.

Each week the 20 tallest plants in each site were measured and their heights were recorded. As the summer progressed and the berries started to develop, both immature and mature berries were counted and recorded. Every week in the release site the percentage of feeding damage was recorded for each of the 20 tallest plants. Also, the distance the weevils traveled from the release site was determined along with the total number of weevils found in the release quadrat in five minutes. Other species of plants, their percent cover, and weather conditions were also noted weekly.

RESULTS

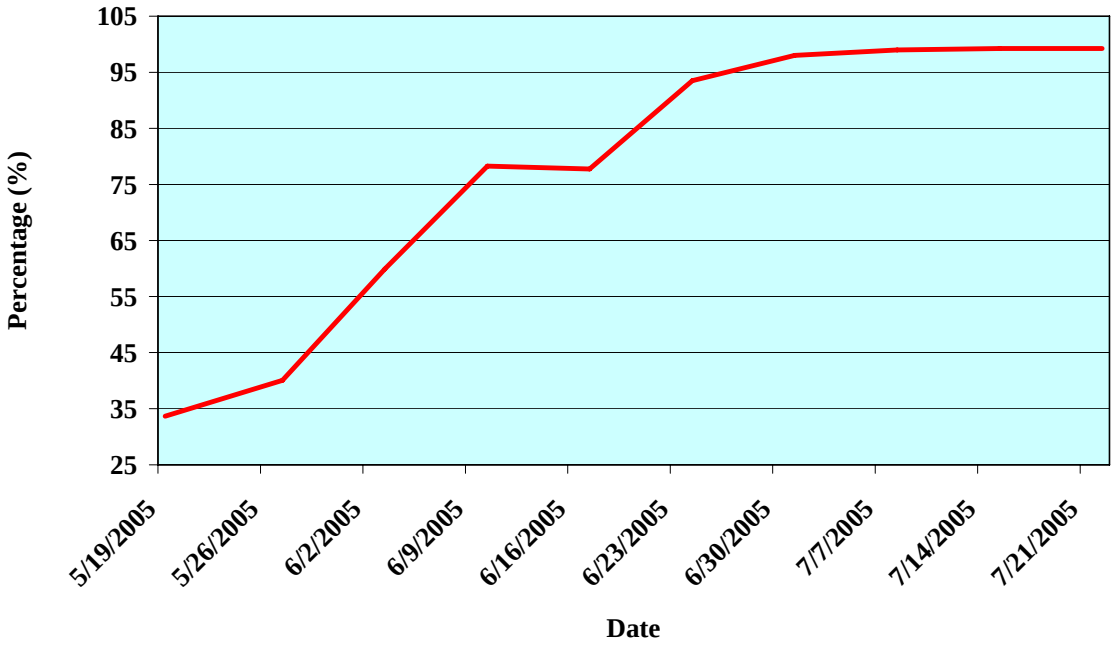
A total number of 652 weevils were released at Washington Crossing State Park in early May 2005. The weevils were first evaluated two weeks after the release was made, then weekly thereafter. The number of weevils observed per week is shown in Figure 3. As the summer progressed, the population of weevils in the release site declined because the weevils were spreading to surrounding areas to feed on more mile-a-minute. The furthest distance the weevils were found to have traveled from the release site was 13.5 meters. It was calculated that the weevils were moving from the release site at a rate of 0.8 meters/week.

Figure 3. Number of Weevils Found in the Release Site



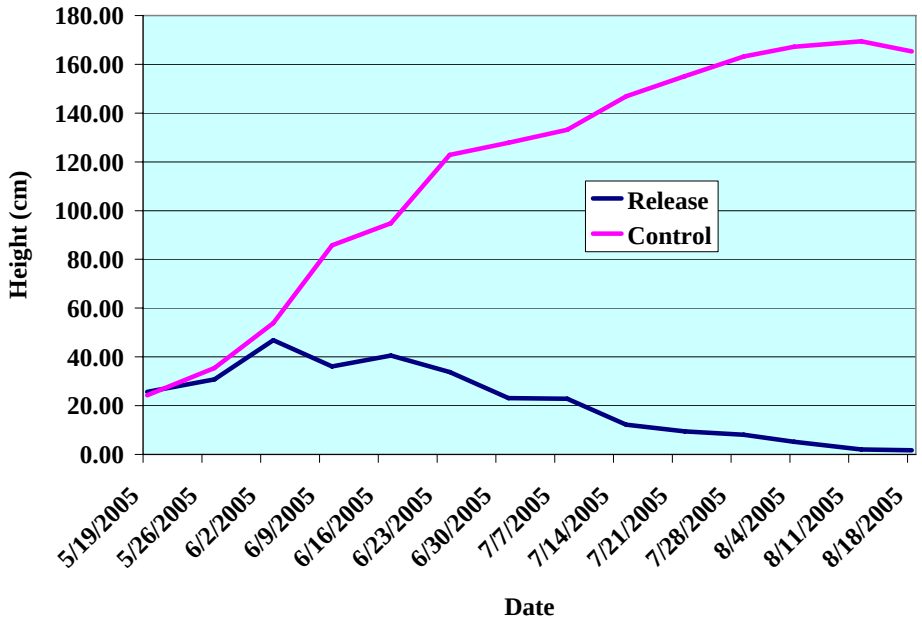
By the end of July the population of weevils had completely dispersed from the release site leaving the mile-a-minute weeds over 95 percent defoliated. The weevils took advantage of all the mile-a-minute available where they were initially released before spreading to other areas to feed. Figure 4 shows the percent defoliation each week.

Figure 4. Percent Defoliation in Release Site



By late August all of the mile-a-minute plants within the release site were gone. When comparing the heights of the release plants to the heights of the control plants there was a significant difference. These heights can be observed in Figure 5. The plants in the control site were much taller and healthier than the plants in the release site thanks to the feeding damage done by the weevils.

Figure 5. Average Height of Mile-a-Minute



At Washington Crossing State Park, berry production did not occur until early September, which was about a month later than expected. This was probably caused by certain weather conditions or the presence of another invasive species such as Japanese stilt grass. The data from Washington Crossing showed no record of berry production in the release site since all the plants had been eliminated. Without the production of berries, the weed cannot reproduce causing a decline in the next year's population.

Japanese stilt grass possibly played a role in the decline of mile-a-minute at the control site. Throughout the course of the summer the populations of mile-a-minute and Japanese stilt grass in the control were about the same. However, given the environment, the partial shade and open forest area did not seem to be an ideal habitat for the mile-a-minute. Since the mile-a-minute had no trees or other vegetation to climb, for most of the summer it established a dense mat on the forest floor along with the Japanese stilt grass. However, it was observed that towards the end of the summer and the beginning of fall the mile-a-minute plants were rapidly disappearing in the control site. Eventually, all the mile-a-minute was gone leaving only the Japanese stilt grass.

DISCUSSION

Over the years mile-a-minute has invaded and taken over a variety of habitats. In commercial forest areas where mile-a-minute has affected forest regeneration, costs ranging from about $60 to $500/ha are incurred for site preparation, weed management, and labor to replant seedlings (Wu 2002). However, this weed is very difficult to control with a single herbicidal treatment because of the seeds' ability to persist in the soil for up to four years (Hough-Gouldstein 2004). Indeed, this weed tends to grow very rapidly in areas where other weeds, such as kudzu, have been killed by herbicides (Wu 2002).

By 1996, researchers surmised that using natural enemies, instead of herbicides, would be more effective in controlling the production of mile-a-minute. The U. S. Department of Agriculture Forest Service started a project to determine if this idea was promising (Wu 2002). There were many such areas established in China and the eastern United States between 1997 and 2000 to survey natural enemies of mile-a-minute. During this time, a moth from China, *Timandra*

griseata, was selected as a promising agent (Wu 2002). The larvae of this moth caused complete defoliation and preferred to feed on mile-a-minute over other plants. However, when the moth was tested in the United States, given a host range of three buckwheat species including mile-a-minute, the larvae stage completely defoliated the mile-a-minute and the other two species (Wu 2002). *T. griseata* appeared to have a relatively broad host range which was not acceptable if this species was going to be introduced into the United States because of the potential for more harm than good.

Eventually *R. latipes* was selected as the best candidate for the job. Releases finally began in the United States in July of 2004, after the weevil was evaluated under quarantine for some time. However, whenever a new biological control project commences there are two initial steps that need to be taken in order to give an indication of the potential effectiveness of the project. The beneficial, *R. latipes*, must be tested in both high- and low-pest populations of MAM by inundating these areas with weevils. Most mile-a-minute populations where *R. latipes* has been released are found in areas that are heavily infested. This project was initiated to test a small area of mile-a-minute where the population was not completely out of control. The data obtained from Washington Crossing State Park, during the summer of 2005, presented some interesting conclusions.

Since the population of mile-a-minute within the release and control sites was not very high, the number of weevils released in the release site proved to be effective in controlling the population by completely wiping out all of the plants. Throughout the summer a steady decline in plant height and increase in feeding damage was observed in the release site.

Toward midsummer increasing numbers of weevils and feeding damage were observed in surrounding areas of mile-a-minute. This led to the conclusion that the weevils were in fact slowly spreading over a considerable distance, 0.8 meters per week, in order to find more mile-a-minute on which to feed. Their movement throughout the summer will be a critical issue in determining their effectiveness. Without the progression of *R. latipes* the weevils have a slim chance of becoming an effective biological control agent.

Eventually all the plants within the release site were eliminated, and, as a result, berries were never produced. The reduced berry production will lead to decreased germination next season in the quadrat. If there continues to be a reduced berry population each season, there will be lower populations of mile-a-minute. However, since no terminal damage was observed in the field, evidence of reproduction has not yet been found. Once the new season starts it will be imperative to recover weevils in the field, leading to the conclusion that *R. latipes* did in fact reproduce.

Observations of the control site led to inferences. The mile-a-minute was in a partially shaded, partially open area which was not the ideal habitat for the weed. Also, the extremely dry summer led to a delay in berry production and overall development. Towards the end of the summer, the mile-a-minute population was slowly declining, but since there were no weevils present there had to be some other factor affecting the population. As a result of insufficient light and the lack of tall vegetation, mile-a-minute was out-competed by Japanese stilt grass by early fall. This shows that mile-a-minute needs a certain amount of sunlight and nourishment to be able to take over an area.

The project will be continued during the summer of 2006. Further data will be obtained and more accurate conclusions drawn. It is my hope that evidence of terminal damage will be obtained demonstrating reproduction. The goal of the project is to observe a decline in the mile-a-minute population over the seasons and with any luck this goal will be achieved.

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