26 Mile-a-Minute Weed

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PEST STATUS OF WEED

Nature of Damage

Mile-a-minute weed, *Polygonum perfoliatum* L., is an annual or perennial vine of Asian origin that infests nurseries, orchards, openings in forested areas, roadsides, and drainage ditches in the eastern United States. In natural areas, the plant displaces native vegetation.

Economic damage. This weed is a particular threat to forest regeneration (Stanosz and Jackson, 1991). In commercial forest areas where mile-a-minute weed has affected regeneration, costs ranging from about $60 to 500/ha are incurred for site preparation, weed management (e.g., herbicides, burning), and labor to replant seedlings (Charles Brown, pers. comm.). Unfortunately, in both commercial and natural regeneration areas, this weed is difficult to control with a single herbicide application due to prolonged persistence of seeds in the soil. Seeds are able to survive in the soil and germinate after as long as four years (Johnson, 1996; McCormic, pers. comm.). Also, seeds can germinate over a wide temperature range (4.4 to 20°C) after at least nine weeks of cold-wet stratification at 2°C (McCormick and Johnson, 1997). Plants growing along forest edges near regeneration areas are potential sources of seed (McCormick and Johnson, 1997). Mile-a-minute weed can invade apple orchards (Moul, 1948) and Christmas tree plantations (Lehtonen, 1994).

Disturbed areas such as railroad and utility rights-of-way, roadsides, and stream banks are ideal habitats for mile-a-minute weed. For example, along a power line right-of-way in Mineral County, West Virginia, mile-a-minute weed covered all other vegetation to a height of approximately 2 m (Fig. 1). The routine use of herbicides along power lines (treated every four years) creates open spaces and ideal conditions for this early successional species.

Figure 1. Mile-a-minute weed covering a power line right-of-way. (Photograph by Yun Wu.)

Mile-a-minute weed also infests recreational and residential areas, such as Rock Creek Park near Washington, D.C. (Fleming and Kanal, 1992), Frick Park and Schenley Park in Pittsburgh, Pennsylvania (*The Dominion Post* [Morgantown, West Virginia] 14 September 1999), and Valley Forge National Park in Valley Forge, Pennsylvania (Hartwig, 1995). The dense, prickly thickets formed by this weed are especially bothersome to tourists and their pets.

In eastern Asia where it originated, mile-a-minute weed is considered a harmful weed of agriculture (Kasahara, 1954; Barbora, 1972; Anon., 1978), a beneficial plant used as an herbal medicine (He *et al.*, 1984; Zhu, 1989; Sook and Myung, 1992; Yang and Kim, 1993; Hoque *et al.*, 1989), or an edible wild fruit (Bajracharya, 1980). Mile-a-minute weed is considered a harmful weed throughout Japan (Kasahara, 1954). In China, mile-a-minute weed is widely distributed but not considered to be a serious weed (Wang, 1990), but it may be a problem in less-intensively managed agricultural areas (Chen and Lin,

1989). Mile-a-minute weed is found at fewer sites in northern China than in southern China. It invades tea plantations and grows along cornfields in Henan Province in central China, where agricultural fields are intensively managed. It is distributed widely in southern China (e.g., Zhejiang, Fujian, Sichuan, and Guangxi provinces), where it grows along rivers and invades orchards.

Ecological damage. In the eastern United States mile-a-minute weed germinates in full sun in early spring. It grows rapidly and out competes native species (Moul, 1948; Hill *et al.,* 1981;*The New York Times*, 16 August 1994; Oliver, 1994). It also grows rapidly in areas where other weeds are killed by herbicides, for example in kudzu eradication areas in cities such as Washington, D.C. (*The New York Times*, 16 August 1994; Sue Salmons, pers. comm.). Gerlach-Okay (1997) investigated the changes in plant diversity on sites with and without mile-a-minute weed in Virginia. Plant diversity was reduced in the first year in plots with mile-a-minute weed, compared to controls. Loss of native plant species diversity from mile-a-minute weed affects wildlife species by reducing or eliminating their food plants and habitats (Oliver, 1994).

Geographical Distribution

In North America, the first recorded specimen was found near Portland, Oregon, in the 1890s, although establishment did not occur (Hickman and Hickman, 1977). In the late 1930s, mile-a-minute weed was found in Pennsylvania and Maryland. In 1954, a plant specimen was collected in British Columbia, although there was no report of establishment (Hill *et al.,* 1981; Park, 1986). By 1989, mile-a-minute weed infestations were reported in only three states – Pennsylvania, Maryland, and West Virginia (Mountain, 1989). By 1994, this plant was reported in eight states (Pennsylvania, Maryland, Ohio, West Virginia, Virginia, Delaware, New Jersey, and New York) and the District of Columbia (Lehtonen, 1994). Recently, the state of Connecticut was added to the list (Donna Ellis, pers. comm.) and the infestations are larger and expanding in all of the eight states and District of Columbia (Fig. 2). Fifteen additional states, all within Plant Hardiness Zones 6 and 7, have climates favorable for the propagation of mile-a-minute weed (Okay, 1997).

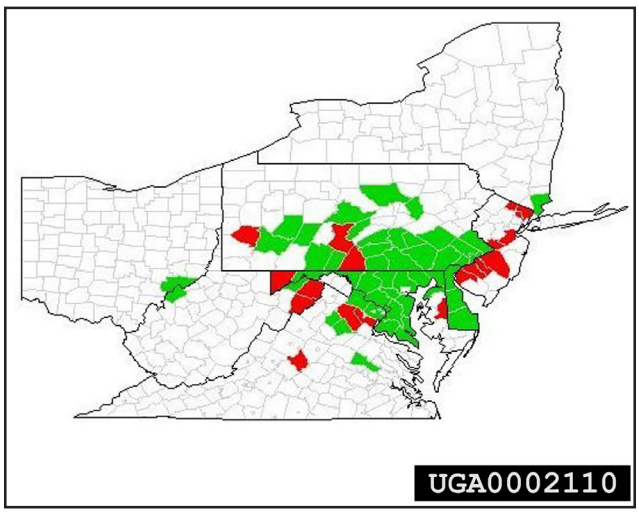

Figure 2. Current distribution of mile-a-minute weed by county in the eastern United States (red – before 1995, [Mountain, 1995]; green – after 1995). (Data prepared by Yun Wu; map by Gino Luzader.)

BACKGROUND INFORMATION ON PEST PLANT

Taxonomy

Synonyms of *Polygonum perfoliatum* L. include *Fagoparum perfoliatum* (L.) Rafine., *Chylocalyx perfoliatus* (L.) Hassk., *Echinocaulos perfoliatus* (L.) Meisn., *Echinocaulon perfoliatum* (L.) Hassk., *Tracaulon perfoliatum* (L.) Greene, *Persicaria perfoliata* (L.) H., *Ampelygonum perfoliatum* (L.) Roberty and Vautier, and *Truellum perfoliatum* (L.) Sojak (Steward, 1930; Park, 1986). Common names include mile-a-minute weed, devil's tearthumb, Giant climbing tearthumb, Asiatic tearthumb (Walker, 1976), and devil's tail tearthumb (Hartwig, 1995).

Mile-a-minute weed is in the family Polygonaceae (Cronquist, 1993), subfamily Polygonoideae (Vánky and Oberwinkler, 1994), tribe Polygoneae (Steward, 1930), subtribe Polygoninae (Vánky and Oberwinkler, 1994), genus *Polygonum* (Steward, 1930), and section Echinocaulon (Steward, 1930).

Biology

Plant height varies depending on where it grows. In open areas mile-a-minute weed forms a dense, tangled mat that covers everything including small trees and shrubs. Along forest edges, plants climb on trees and can reach 8 m in height.

The almost perfectly triangular-shaped leaves have long petioles and thin blades and grow alternately on the stem. They are bright green, 4 to 7 cm long and 5 to 9 cm wide, and the main veins and petioles are armed with recurved prickles. A pale green, saucer shaped sheath of 1 to 2 cm of diameter encircles the node (Fig. 3). Stems are green when young, red when aged and are armed with recurved prickles; stems become woody at the base. Inflorescences are spike-like clusters of 10 to 15 tiny flowers that are terminal in position or in the axils of the upper leaves. Inflorescences are up to 2 cm long and flowers are 1.5 mm across. Seeds consist of spherical, shiny-black achenes, covered by a white or pink perianth, which becomes blue and fleshy when mature. They form blueberry-like "fruits," each 5 mm in diameter, arranged in clusters. Annual plants have fibrous and shallow roots.

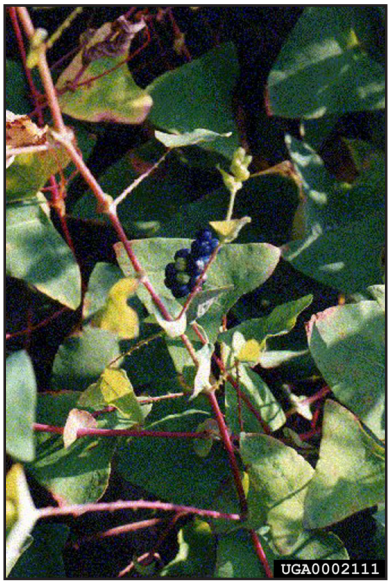

Figure 3. Mile-a-minute weed, *Polygonum perfoliatum* L. (Photograph by Yun Wu.)

The life cycle of mile-a-minute weed is varied, sometimes listed as an annual (Kasahara, 1954; He *et al*., 1984), other times as a perennial (Riefner, 1982; Zhu, 1989). It behaves like an annual in North America (Mountain, 1989; Cusick and Ortt, 1987; McCormick and Johnson, 1997). Mile-a-minute weed specimens have been collected from areas that are tropical (e.g., Hainan Province in China, Java in Indonesia, and Luzon in the Philippines) (Park, 1986), but it is not as abundant (Zi-de Jiang, pers. comm.). In the southern subtropical area of Yunnan Province in China, where frost does not occur and mild weather presents all year, mile-a-minute weed was observed to grow throughout the year. New roots grow from nodes on climbing stems and develop into new plants producing flowers and fruits. The main stems on these old plants were observed as thick as 1 cm in diameter, and were supported by a taproot. In the subtropical area of Guangzhou, China, mile-a-minute weed plants will die when the first frost appears in December, and seeds will start to germinate in late January or early February in the following year (Yun Wu and Zi-de Jiang, unpub.). Mile-a-minute weed is generally considered an annual plant that needs cold-wet stratification of seeds to break dormancy in temperate regions (Gerlach-Okay, 1997; Will Mountain, pers. comm.). In the northeastern United States, mile-a-minute weed will die during the first frost around late October or early November in Pennsylvania and West Virginia, and start to germinate in early to mid-March to April, although some plants may germinate late in the season (Mountain, 1989; McCormick and Johnson, 1997; Moul, 1948; Wu, unpub.). Flowering begins in June or early July and continues throughout the rest of the growing season (Reifner, 1982; McCormick and Johnson, 1997). Fruits are produced between early August and the first frost (Mountain, 1989). Seeds are dispersed by water, birds, and small mammals (Mountain, 1989; Gerlach-Okay, 1997), and by human activities.

Analysis of Related Native Plants in the Eastern United States

There are about 40 genera and 800 species of Polygonaceae (Buckwheat family) in the United States and Canada (Bailey and Bailey, 1976). They include 14 economically important plant species including those grown as human and animal food, such as *Fagopyrum* spp. (buckwheat) and *Rheum* spp. (rhubarb), and a few grown as ornamental plants such as *Coccoloba diversifolia* Jacq. (pigeon-plum), *C. uvifera* (L.) L. (sea grape), *Eriogonum crocatum* Davidson (saffron-buckwheat), *Eriogonum fasciculatum* Benth. (wild buckwheat), *Oxyria digyna* (L.) Hill (mountain sorrel), and *Polygonum amphibium* L. (water smartweed) (Table 1). The rest of the species are weeds and are a potential source of seed contamination (Germplasm Resource Information Network, 2001). There are 20 species designated as rare and endangered plants (Table 1) in six genera although most of them are in *Chorizanthe*, *Eriogonum*, and *Polygonella* (Germplasm Resource Information Network, 2001).

Table 1. Native or Economic Important Plants Related to *Polygonum perfoliatum* in Polygonaceae in the United States

Scientific Name (Common Name)	Economic Species	Endangered Species (USFWS)	Rare Plants (Center for Plant Conservation)	Native Species	Found in Eastern U.S.
Chorizanthe howellii Goodman (Mendocino spineflower)		X		X	
Chorizanthe orcuttiana Parry (Orcutt's spineflower)		X		X	
Chorizanthe pungens Benth. var. *hartwegiana* Reveal & Hardham (Hartweg's spineflower)		X		X	
Chorizanthe pungens Benth. var. *pungens* (Monterey spineflower)		X		X	
Chorizanthe robusta Perry (rubust spineflower)		X		X	
Chorizanthe valida S. Watson (Sonoma spineflower)		X		X	
Coccoloba diversifolia Jacq. (pigeon-plum)	ornamental			X	
Coccoloba uvifera (L.) L. (sea-grape)	erosion control/ornamental/ fruit			X	
Dodecahema leptoceras (A. Gray) Reveal & Hardham (slenderhorn spinyherb)		X		X	
Eriogorum apricum J. T. Howell (incl. var. *prostratum*) (lone buckwheat)		X		X	
Eriogonum argophyllum Reveal			X	X	
Eriogonum crocatum Davidson (saffron-buckwheat)	ornamental			X	
Eriogonum fasciculatum Benth. (wild buckwheat)	ornamental			X	
Eriogonum gypsophilum Wooton and Standl. (Seven River Hills buckwheat)		X		X	
Eriogorum kennedyi Porter ex. S. Wats. var. *austromontanum*Munz. & Johnston (Kennedy's buckwheat)		X		X	
Eriogorum longifolium Nutt. var. *gnaphalifolium*Gandog. (longleaf buckwheat)		X		X	
Eriogorum ovalifolium Nutt. var. vineum (Small) Nelson. (cushion buckwheat)		X		X	
*Eriogorum ovalifolium*Nutt. var. *williamsiae* Reveal (Williams' buckwheat)		X	X	X	
Rumex orthoneurus Rech. f.			X	X	
Rumex venosus Pursh (wild begonia)	weed			X	

Table 1. Native or Economic Important Plants Related to *Polygonum perfoliatum* in Polygonaceae in the United States (continued)

Scientific Name (Common Name)	Economic Species	Endangered Species (USFWS)	Rare Plants (Center for Plant Conservation)	Native Species	Found in Eastern U.S.
Eriogorum pelinophilum Reveal (clayloving buckwheat)		X	X	X	
Fagopyrum esculentum Moench (Japanese buckwheat)	bee plants/human or animal food			Intro.	X
Fagopyrum tataricum (L.) Gaertn. (tartary buckwheat)	human food/ animal food/weed			Intro.	X
Oxyria digyna (L.) Hill (mountain sorrel)	ornamental			X	X
*Oxytheca parishi*i Parry var. *goodmaniana* Ertter (Goodman's puncturebra)		X		X	
Polygonella basiramia (Small) Nesom & Bates (Florida jointweed)		X	X	X	
Polygonella macrophylla Small *Polygonella myriophylla* (Small) Horton (Small's jointweed)		X	X X	X X	
Polygonum amphibium L. (water smartweed)	ornamental weed			X	X
Polygonum arifolium L. (halberd-leaf tearthumb)				X	X
*Polygonum carey*i Olney (Carey's smartweed)		X		X	X
Polygonum cespitosum Blume (oriental ladysthumb)				X	X
Polygonum erectum L. (erect knotweed)	weed			X	X
*Polygonum hirsutum*Walt. (hairy smartweed)				X	X
*Polygonum hydropiperoides*Michx. (mild water-pepper)	weed			X	X
*Polygonum lapathifolium*L. (curlytop knotweed)				X	X
*Polygonum pensylvanicum*L. (Pennsylvania smartweed)	weed			X	X
*Polygonum punctatum*Elliott (dotted smartweed)	weed			X	X
Polygonum sagittatum L. (arrow-leaf tearthumb)	weed			X	X
Rheum rhabarbarum L. (garden rhubarb)	human food			Intro.	X
Rumex altissimus Wood (pale dock)	weed			X	X
Rumex hymenosepalus Torr. (canaigre)	tannin, dyestuff			X	

All information except the three introduced species from the Germplasm Resources Information Network (GRIN) (http: //www.ars-grin.gov/npgs/tax/index.html) and the Plant List of Accepted Nomenclature, Taxonomy, and Symbols (PLANTS) (USDA, NRCS) (http: //plants.usda.gov/plants/qurymenu.html).

Plants in the genus *Polygonum* are annual or perennial herbs, shrubs, or vines of moist habitats, and often grow as weeds in disturbed areas (Park, 1986). There are about 150 species in the genus *Polygonum* in the United States and Canada (Bailey and Bailey, 1976). The species in *Polygonum* are grouped into eight subgenera (called sections) (Steward, 1930). *Polygonum perfoliatum* belongs to the section Echinocaulon Meisn., which consists of 21 species. Of these, 15 are found in Asia (Park, 1986). Native species in the United States in this section include *Polygonum sagittatum* L. and *Polygonum arifolium* L. (Park, 1986). Other *Polygonum* species native to the United States mostly belong to a closely related section, Persicaria L. and include *Polygonum pensylvanicum* L., *Polygonum amphibium* L., *Polygonum lapathifolium* L., *Polygonum punctatum* Elliot, *Polygonum hydropiperoides* Michx., *Polygonum careyi* Olney, *Polygonum hirsutum* Walt., *Polygonum persicaria* L., and *Polygonum cespitosum* Blume. Another native species, *Polygonum erectum* L., belongs to section Avicularia Meisn. (Bailey and Bailey, 1976).

The North American species *P. sagittatum* and *P. arifolium* are chemically distinct from *P. perfoliatum*. In contrast, *Polygonum senticosum* (Meisn.) Fr. et Sav., a species distributed in eastern Asia, has morphological and chemical characteristics that are very similar to those of *P. perfoliatum*, including the complete absence of flavones (Park, 1986).

In contrast to *P. perfoliatum*, which mainly grows in moist, temperate woodlands, *P. pensylvanicum* mainly grows in nonforested areas within temperate deciduous forests, and *P. arifolium* and *P. punctatum* are aquatic plants (Baskin and Baskin, 1998), although, in the eastern United States, the four species were found to coexist on the same sites (Gerlach-Okay, 1997).

Plants of economic or ecological importance (including threatened and endangered species) in North America in the same family as mile-a-minute weed are listed in Table 1. Some widely distributed weeds (*Polygonum persicaria* L., *Polygonum convolvulus* L., *Polygonum hydopiper* L., *Polygonum aviculare* L., *Polygonum coccineum* Muhl. ex Willd., *Rumex acetosella* L., and *Rumex crispus* L.) are not listed because they are introduced species. *Polygonum orientale* L. is another introduced species that occurs in the eastern and midwestern portions of the United States.

HISTORY OF BIOLOGICAL CONTROL EFFORTS IN THE EASTERN UNITED STATES

Area of Origin of the Weed

Mile-a-minute weed is a widely distributed species of east Asia, including Japan, China, Korea, India, Indonesia, Bangladesh, Siberia, the Philippines, the Malay Peninsula, the Indochina Peninsula, Nepal, and Turkey (Steward, 1930; Fernald, 1950; Ohwi, 1965; and Guener, 1984).

Introduced into the United States from Japan in the late 1930s (Moul, 1948), mile-a-minute weed was found growing in a nursery in Stewartstown, York County, Pennsylvania. It was also introduced to the Glenn Dale Introduction Garden, Prince Georges County, Maryland from Nanjing, China at a similar time. It was eradicated from the introduction Garden (Moul, 1948), while the population in York, Pennsylvania became established and spread from the site.

Areas Surveyed for Natural Enemies

In 1996, the U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team (FHTET) initiated a project to determine the feasibility of using natural enemies to control mile-a-minute weed. Natural enemy surveys were conducted in the eastern United States and in China from 1997 through 2000. The survey areas in the eastern United States included Pennsylvania, Maryland, Delaware, West Virginia, and Virginia.

The survey areas in China included 18 provinces (Heilongjiang, Jilin, Liaoning, Inner-Mongolia, Hebei, Beijing, Tianjin, Henan, Shandong, Hubei, Hunan, Sichuan, Guangxi, Guangdong, Zhejiang, Fujian, Yunnan, and Guizhou) (Fig. 4).

Natural Enemies Found

Arthropods – eastern United States. One of the earliest surveys for natural enemies of mile-a-minute weed in the eastern United States was by Wheeler and Mengel (1984) who surveyed in southcentral Pennsylvania from 1981 through 1983. They recovered 34 species (five orders, 15 families) that developed on the weed and 12 species that fed on mile-a-minute weed only as adults. None of them appeared to cause significant damage to the weed. In 1998, Jim

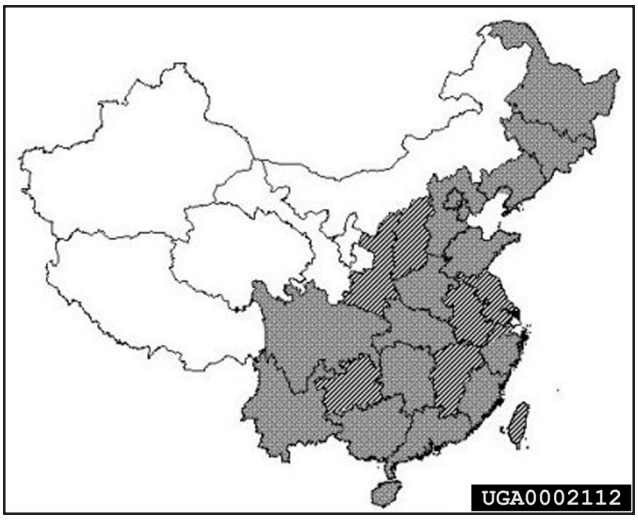

Figure 4. The distribution of mile-a-minute weed and natural enemy survey areas by province in China (brown – surveyed areas; gray – areas with weed, not yet surveyed). (Map by Ding Jian-qing.)

Fredericks (University of Delaware) surveyed selected sites in Pennsylvania and Delaware. The most abundantly recovered insect causing damage to mile-a-minute weed was adult Japanese beetles, *Popillia japonica* Newman, which caused significant defoliation. Other recovered insects appeared to cause no significant damage to the weed (Fredericks, 2001). The FHTET sponsored surveys at several sites in five states provided collections of natural enemies across a broad range of habitats. By the end of the 2000 field season, more than 1,500 arthropods were recovered from mile-a-minute weed representing 100 insect species in 50 families and seven orders although many have not been identified beyond the family level. Insects that attack the seeds or roots have not been recovered.

Arthropods – China. One hundred insect species in 32 families and seven orders were found associated with mile-a-minute weed (Jian-qing Ding, pers. comm.). Most of the insects collected in China fed on leaves, but stem borers, gall makers, and flower- and fruit-feeders also were recovered. No insects that attack the roots have been recovered. Of the 100 insect species recovered, several species appear to have potential for use as biological control agents, based on their distribution, host range, population density, and potential to damage the plant. These species are two geometrid moths, *Timandra griseata* Petersen (Fig. 5), and *Timandra convectaria* Walker (Lep.: Geometridae); a bug, *Cletus schmidti* Kiritschenko (Hem.: Coreidae); a weevil, *Homorosoma chinensis* (Col.: Curculionidae) (Fig. 6); and a sawfly, *Allantus nigrocaeruleus* (Smith) (Hym.: Tenthredinidae).

In addition to the above species, several others damaged mile-a-minute weed, but appear to have relatively broad host ranges based on the literature and would require detailed study to confirm their actual level of host specificity. These apparently polyphagous species were the stem borers *Pleuroptya ruialis* (Scopoli) and *Ostrinia scapulalis* (Walker) (Lep.: Pyralidae); the defoliators, *Smaragdina nigrifrons* (Hope) (Col.: Eumolpidae), *Gallerucida bifasciata* Motschulsky, and *Gallerucella* sp. (Joannis) (Col.: Chrysomelidae); and the noctuids *Trachae atriplicis* L. and *Agrogramma agnata* Staudinger (Lep.: Noctuidae).

Figure 5. *Timandra griseata* moth. (Photograph by Ding Jian-qing.)

Figure 6. *Homorosoma chinensis* adult. (Photograph by Ding Jian-qing.)

Specimens of all the species being considered as potential natural enemies for importation into quarantine facilities in the United States have been submitted to the USDA, ARS Systematic Entomology Laboratory for taxonomic confirmation.

Pathogens – United States and China. Fungal isolates were isolated from symptomatic mile-a-minute weed plants collected in the eastern United States and China. Symptoms associated with these agents included wilting or spotting of leaves and stems. Pathogenicity screening tests of these fungal isolates using various inoculation methods (a detached-leaf assay, a toothpick-insertion test [Fig. 7], or seedling-root dipping) have been conducted at the USDA, ARS, Foreign Disease-Weed Sciences Research Unit containment greenhouse facility in Frederick, Maryland. About 20 isolates caused symptoms in the detached-leaf assay, and two caused systemic symptoms or whole plant mortality when evaluated using the toothpick-insertion test (Wu *et al.*, 1999). Additional tests are planned as well as the continued development of procedures to identify isolates.

Figure 7. Toothpick-insertion test for pathogenicity of a fungal isolate on mile-a-minute weed plants and a control. (Photograph by Yun Wu.)

Host Range Tests and Results

Numerous preliminary host range tests for several natural enemies, including *T. griseata, H. chinensis*, and *Gallerucella* sp., were conducted in China on selected plant species within and outside of Polygonaceae. Additional host range tests were conducted in the United States for *T. griseata* and *H. chinensis* on several crop species within Polygonaceae.

In China, choice and no-choice tests were conducted on nearly 50 plant species for *T. griseata*. The results showed that larvae of this moth prefer mile-a-minute weed and did not attack other plants in choice tests. In no-choice tests, *T. griseata* larvae fed on *Polygonum thumbergii* Sieb. et Zucc., *P. lapathifolium*, *Polygonum bistorta* L., *Polygonum bungenum* Turcz., *P. hydropiper*, *Polygonum alpinum* All., *Rumex japonicus* Houtt., and *Fagopyrum dibotry* (D. Don) Itara. Additional host range testing conducted in the United States showed that larvae completely defoliated *P. perfoliatum* and two buckwheat species (*Fagopyrum esculentum* Moench. and *Fagopyrum tartaricum* [L.] Gaertn) in no-choice tests and were able to complete their life cycle to adults on all three host species. In choice tests, larval preferences for *F. esculentum, F. tartaricum,* and *P. perfoliatum* were equal (Price, 2001).

Choice and no-choice tests also were conducted in China on larvae and adults of the weevil *H. chinensis*. Forty plant species in 14 families were tested, of which 18 species were in the Polygonaceae. In both choice and no-choice tests, *H. chinensis* did not feed on the 22 species from 13 families outside of the Polygonaceae. In choice tests, using species within the Polygonaceae, the weevil did not attack any of 17 non-target test species. In no-choice tests, adult weevils did feed on *Rumex japonicus*, *P. lapathifolium*, and *P. lapathifolium* var. *lanatum*. Both adults and larvae fed on *Rheum altanicum* A. Los. and *P. bistorta* L.; but weevils did not oviposit or complete their life cycle on these plants. Weevils feeding on these species lived for 14 to 25 days as adults, and for 24 to 36 hours as larvae. Comparably, weevils feeding on mile-a-minute weed lived for 69 days as adults and for 216 hours as larvae, and completed their life cycle on mile-a-minute weed. In the United States, adult female *H.*

chinensis did not lay eggs on *F. esculentum* or *R. rhabarbarum* in no-choice tests but did on mile-a-minute weed. *H. chinensis* adults fed on *F. esculentum* and *R. rhabarbarum* in choice tests (Price, 2001).

BIOLOGY AND ECOLOGY OF NATURAL ENEMIES

Timandra griseata Petersen (Lepidoptera: Geometridae)

This insect is also known as *Calothysanis amata* (L.), *Calothysanis amataria* (L.), and *Timandra amataria* (L.) (Skou, 1986). It has two generations per year in Europe, with a flight period from mid-May until mid-September. In northern Europe, there is only one generation, with a flight period from late June to late July. In Europe, larvae feed on plants in the Polygonaceae (e.g., *Rumex* [dock, sorrel], *Polygonum* [knotgrass]) and the Chenopodiaceae (e.g., *Atriplex*). Pupation takes place in loosely woven cocoons between leaves, often on the host plants. The species is capable of overwintering either as a larva or pupa. This moth is widely distributed in Europe, Asia, and North Africa (Skou, 1986; West, 1986; Skinner, 1998). In China, larvae feed on leaves, young buds, and fruits of *P. perfoliatum.* When populations are high, larvae nearly destroy all the young leaves and buds on the plant.

Homorosoma chinensis (Wagner) (Coleoptera: Curculionidae)

No literature was found on this species, which has been recovered in Henan, Hunan, Hubei, and Heilongjiang provinces in China. Adults feed on flowers, buds, and young leaves of *P. perfoliatum*. Larvae attack buds and bore into stems prior to pupation (Fig. 8).

Cletus schmidti Kiritschenko (Hemiptera: Coreidae)

This bug is widely distributed in China. Both adults and larvae feed on the skin of the fruit, exposing the immature seeds, and adversely affecting reproduction of the weed. Preliminary host range testing results indicated that mile-a-minute weed is the major host of *C. schmidti.*

Figure 8. *Homorosoma chinensis* larva and its damage on a stem of mile-a-minute weed. (Photograph by Ding Jian-qing.)

RECOMMENDATIONS FOR FUTURE WORK

Surveys for natural enemies of mile-a-minute weed in China need to be completed for arthropods in Jiangsu, Jiangxi, and Anhui provinces, where mile-a-minute weed is widely distributed, and in southern China for plant pathogens.

Screening tests of exotic and native fungi isolated from mile-a-minute weed plants need to be completed. Fungi need to be identified and their host ranges estimated. Additional host range testing of *T. griseata* and *T. convectaria*, *H. chinensis*, *C. schmidti*, *Galerucella grisescens (Joannis),* and *A. nigrocaeruleus* need to be conducted in China and in the United States.

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