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## HERBIVOROUS INSECT FAUNA OF MILE-A-MINUTE WEED, *PERSICARIA PERFOLIATA* (POLYGONACEAE), IN JAPAN

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The mile-a-minute weed, *Persicaria perfoliata* (L.) H. Gross (Polygonaceae), was first established in the United States in Pennsylvania and Maryland in the 1930s (Wu et al. 2002), and has been placed on noxious weed lists in several states of the United States because of the damage it causes in infested orchards, nurseries, and horticultural crops (Oliver & Coile 1994; Wu et al. 2002). Because of its rapid growth, the weed readily invades forests or forest edges (Wu et al. 2002). In addition, the weed's thorny vines impede movement of wildlife and interfere with human activities (Okay 1997). By 2003, the plant was found in 8 states (Delaware, Maryland, New York, Ohio, Pennsylvania, Virginia, West Virginia, and Connecticut) and the District of Columbia (Lamont & Fitzgerald 2000; Price 2001). Fifteen additional states are currently at risk of becoming infested with this weed (Okay 1997). In the southern United States, mile-a-minute weed could behave as a perennial plant (Stevens 1994; Ding et al. 2000). Recently, mile-a-minute weed was targeted for biological control.

Several natural enemies of mile-a-minute weed have been recognized in China (Ding et al. 2004), but little information is available on other potential biological control agents from other regions of the plant's large native range (Ohwi 1965; Satake et al. 2000). We examined the weed in Japan because parts of Japan are in the native range of mile-a-minute weed (Ohwi 1965) and those areas are a good climatic match to the northeastern United States, where release of natural enemies is intended (Reardon, unpublished data). Here we report the results of a survey made in 2004 and 2005 of the herbivorous insect fauna of mile-a-minute weed of Japan.

We selected our survey locations in Japan using data from the National Census on River Environments (1993-1999). We surveyed 15 sites, mainly in Kinki district (Table 1). Although most sites were sampled only once, in 2004, one site (Yawata city, Kyoto) was sampled several times over the course of the season. In 2005, we sur-

veyed 1 site in Kinki district several times. Sample sites were distributed over 10 Prefectures and samples were collected between Apr and Nov.

For thorny vines of mile-a-minute weed sprawling on other vegetation, sweep net sampling was not feasible. Instead, timed visual searches were used as the sample unit (15 min per sample, 2 to 6 samples per site on a given sample date). Insects detected were captured for identification. Larvae were reared to adults on mile-a-minute weed in the laboratory (25°C, a photoperiod of 16: 8 L: D).

We collected 50 herbivorous insect species (Table 2) on mile-a-minute weed: 11 Lepidoptera (22%), 26 Hemiptera (52%), 3 Orthoptera (6%), 9 Coleoptera (18%), and 1 Hymenoptera (2%). Of the total (except 4 species with unknown hosts), 30 species were clearly polyphagous and 10 were specialists on other plant families; these species clearly were not potential biological control agents. Six species appeared to be potential Polygonaceae specialists: (1) Two hemipterans, the bug *Coptosoma parvipictum* Montandon (Pataspidae) (Tomokuni, 1993), found frequently at the Yawata city site, and the aphid *Trichosiphonaphis ishimi-kawae* (Shinji) (Aphididae) (Moritsu 1983), which was found in both years at many sites; (2) two lepidopterans, *Timandra apicirosea* (Prout) (Geometridae) and *Oligonyx vulnerata* (Butler) (Noctuidae) (Inoue et al. 1982), of which *T. apicirosea* was frequently found, whereas *O. vulnerata* was rarely collected; (3) one sawfly, *Allantus luctifer* Smith (Tenthredinidae) (Asahina et al. 1965), found in both years at many sites; and (4) one beetle, *Rhinoncomimus latipes* Korotyaev (Curculionidae) (Colpetzer et al. 2004a,b) (Table 2).

*Rhinoncomimus latipes* was collected in 2004 at the Yawata site from May to Oct, with peak abundance in late-Jun and mid-Sep and was collected at 6 sites (Yawata, Matsuobashi, Ishiyama, Kizu, Sendai, and Sapporo). Larvae of *T. apicirosea* were observed from May to Sep and it was collected at 9 sites (Azuchi, Kizu, Matsuobashi, Taki-

TABLE 1. THE PERIODS AND LOCATIONS OF SURVEY SITES IN 2004 AND 2005.

| Site (Prefecture)         | Survey period |          | River or lake near the site                              |
|---------------------------|---------------|----------|----------------------------------------------------------|
|                           | 2004          | 2005     |                                                          |
| Within Kinki district     |               |          |                                                          |
| Azuchi (Shiga)            | Aug           | Aug.     | Biwa Lake                                                |
| Hirakata (Osaka)          | —             | Apr-Sep  | Yodo river                                               |
| Ishiyama (Shiga)          | Oct           | Jun-Oct  | Daido river                                              |
| Kizu (Kyoto)              | May           | May-Sep  | Kizu river                                               |
| Matsuobashi (Kyoto)       | Jul           | Apr-Aug  | Katsura river                                            |
| Takiyama (Hyogo)          | Sep           | Jun.-Oct | Ina river                                                |
| Yasu (Shiga)              | —             | Sep-Nov  | Yasu river                                               |
| Yawata (Kyoto)            | May-Oct       | May-Oct  | Uji river (the junction of Uji, Kizu, and Katsura river) |
| Outside of Kinki district |               |          |                                                          |
| Hachioji (Tokyo)*         | Sep           | Aug      | Aki river                                                |
| Haijima (Tokyo)*          | —             | Aug      | Tama river                                               |
| Kagoshima (Kagoshima)     | Oct           | Jun-Oct  | Usogi river and Kenkou river                             |
| Sapporo (Hokkaido)*       | —             | Aug      | Yubari river                                             |
| Sendai (Miyagi)*          | —             | Aug      | Natori river                                             |
| Shizuoka (Shizuoka)*      | Sep           | Aug      | Abe river                                                |
| Tochigi (Tochigi)*        | Sep           | Aug      | Kinu river                                               |

\*Surveyed once a year.

yama, Yawata, Haijima, Kagoshima, Sendai, and Tochigi). The sawfly *A. luctifer* was collected mainly as eggs or larvae and was observed at 10 sites (Azuchi, Hirakata, Ishiyama, Matsuobashi, Takiyama, Yasu, Yawata, Hachioji, Haijima, and Shizuoka). Eggs of *A. luctifer* were inserted in or around leaf midrib veins and at the Yawata site peak egg abundance occurred in May and Jul.

Of the 6 specialist herbivores encountered, *R. latipes* appears to be the most promising agent to control mile-a-minute weed (Colpetzer et al. 2004a, b). Two other species encountered, *A. luctifer* and *T. apicirosea*, appear less promising. A congener of *T. apicirosea*, *Timandra griseata* Peterson (Lepidoptera: Geometridae) from China, previously has been rejected as a biological control agent because it developed on common buckwheat, *Fagopyrum esculentum* Moench (Polygonaceae) and tartary buckwheat, *Fagopyrum tartaricum* Gaertn (Polygonaceae) (Price et al. 2003). The aphid *T. ishimikawae*, a Polygonaceae specialist, was abundant but switches hosts seasonally, using species of Caprifoliaceae in winter (Moritsu 1983). Therefore, this aphid would only establish where both necessary Polygonaceae and Caprifoliaceae hosts grow near each other. The remaining Polygonaceae specialists, *C. parvictum* and *O. vulnerata*, were not abundant in our samples, and may have limited impact on mile-a-minute weed in Japan. However, it is possible their densities might increase after the introduction to the United States if their own natural enemies limit their Japanese densities.

Two leaf beetle species, *Lema diversa* Baly and *L. concinnipennis* Baly, that are oligophagous for Polygonaceae and that are common in China (Ding et al. 2004) have been reported from Japan (Hayashi et al. 1984), but were not collected in this survey. Although seed feeding species are known in China (Ding et al. 2004), none was collected in Japan.

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#### SUMMARY

*Persicaria perfoliata* is an annual plant of Asian origin, which is a serious invader of native and orchard plant communities in the eastern USA. Based on a 2-year survey of herbivores of

TABLE 2. HERBIVOROUS INSECTS ASSOCIATED WITH *P. PERFOLIATA* IN JAPAN.

| Order/Family          | Species                                          | Number of sites  |    |      |    | Host range     |
|-----------------------|--------------------------------------------------|------------------|----|------|----|----------------|
|                       |                                                  | 2004             |    | 2005 |    |                |
|                       |                                                  | Y <sup>1,3</sup> | OY | K    | OK |                |
| Orthoptera            |                                                  |                  |    |      |    |                |
| Pyrgomorphidae        | <i>Atractomorpha lata</i> (Motschoulsky)         | 2                | 3  | 0    | 0  | G <sup>2</sup> |
| Acrididae             | <i>Acrida cinerea</i> (Thunberg)                 | 1                | 0  | 0    | 0  | OS             |
|                       | <i>Patanga japonica</i> (Bolivar)                | 1                | 0  | 0    | 0  | G              |
| Hemiptera-Heteroptera |                                                  |                  |    |      |    |                |
| Tingidae              | <i>Corythucha marmorata</i> (Uhler)              | 3                | 1  | 4    | 0  | OS             |
| Coreidae              | <i>Cletus rusticus</i> Sätl                      | 2                | 0  | 1    | 0  | OS             |
|                       | <i>Homoeocerus unipunctatus</i> (Thunberg)       | 2                | 0  | 1    | 0  | OS             |
| Lygaeidae             | <i>Hygia (Colpura) lativentris</i> (Motschulsky) | 0                | 0  | 1    | 0  | G              |
|                       | <i>H. (Hygia) opaca</i> (Uhler)                  | 2                | 0  | 0    | 0  | G              |
|                       | <i>Riptortus clavatus</i> (Thunberg)             | 0                | 0  | 1    | 0  | G              |
|                       | <i>Tropidothorax cruciger</i> (Motschulsky)      | 0                | 1  | 0    | 0  | ?              |
|                       | <i>T. belogolowi</i> (Jakovlev)                  | 0                | 1  | 0    | 0  | ?              |
|                       | <i>Nysius plebeius</i> (Distant)                 | 0                | 0  | 1    | 0  | G              |
|                       | <i>Togo hemipterus</i> (Scott)                   | 1                | 0  | 0    | 0  | G              |
| Malcidae              | <i>Chauliops fallax</i> Scott                    | 3                | 0  | 0    | 0  | OS             |
| Miridae               | <i>Adelphocoris triannulatus</i> (Sätl)          | 0                | 0  | 1    | 0  | G              |
|                       | <i>Charagochilus angusticollis</i> (Fallén)      | 2                | 0  | 0    | 0  | G              |
|                       | <i>Eurystylus coelestialium</i> (Kirkaldy)       | 0                | 0  | 1    | 0  | G              |
| Pataspidae            | <i>Coptosoma parvipictum</i> Montando            | 8                | 0  | 1    | 0  | PS             |
|                       | <i>Megacopta punctatissima</i> (Montandon)       | 0                | 0  | 1    | 0  | OS             |
| Pentatomidae          | <i>Carbula humerigera</i> (Uhler)                | 0                | 0  | 0    | 1  | G              |
|                       | <i>Dolycoris baccalum</i> (Linnaeus)             | 0                | 0  | 2    | 0  | G              |
|                       | <i>Eysarcoris lewisi</i> (Distant)               | 0                | 0  | 0    | 1  | G              |
| Hemiptera-Homoptera   |                                                  |                  |    |      |    |                |
| Aphididae             | <i>Trichosiphonaphis ishimikawae</i> (Shinji)    | 12               | 6  | 8    | 4  | PS             |
| Aphrophoridae         | <i>Aphrophora maritima</i> Matsumura             | 1                | 1  | 0    | 0  | OS?            |
|                       | <i>Gargara genistae</i> Fabricius                | 0                | 1  | 0    | 0  | G?             |
| Deltocephalidae       | <i>Nephotettix cincticeps</i> Uhler              | 0                | 1  | 0    | 0  | OS?            |
|                       | <i>Phlogotettix cyclops</i> Mulsant et Rey       | 1                | 0  | 0    | 0  | ?              |
| Penthimiidae          | <i>Penthimia nitida</i> Lethierry                | 1                | 0  | 0    | 0  | G              |
| Ricaniidae            | <i>Orosanga japonicus</i> Melichar               | 0                | 0  | 0    | 1  | G              |
| Lepidoptera           |                                                  |                  |    |      |    |                |
| Arctidae              | <i>Hyphantria cunea</i> Drury                    | 0                | 0  | 0    | 1  | G              |
| Geometridae           | <i>Timandra apicirosea</i> (Prout)               | 9                | 5  | 5    | 4  | PS             |
| Gracillariidae        | <i>Calybites phasianipennella</i> Hübner         | 3                | 0  | 3    | 3  | G              |
| Lymantriidae          | <i>Cifuna locoples confuse</i> (Bremer)          | 0                | 1  | 0    | 0  | G              |
|                       | <i>Orgyia thyellina</i> Butler                   | 0                | 0  | 0    | 2  | G              |
| Noctuidae             | <i>Helicoverpa armigera</i> (Hübner)             | 0                | 0  | 2    | 0  | G              |
|                       | <i>Herminia innocens</i> Butler                  | 0                | 0  | 1    | 0  | G              |
|                       | <i>Oligonyx vulnerata</i> (Butler)               | 0                | 0  | 1    | 0  | PS             |
|                       | <i>Trachea atriplicis gnama</i> Butler           | 1                | 0  | 1    | 1  | G              |
|                       | <i>Viminia rumicis</i> (Linnaeus)                | 1                | 1  | 1    | 0  | G              |
| Tortricidae           | <i>Adoxophyes honmai</i> Yasuda                  | 2                | 1  | 0    | 0  | G              |
| Hymenoptera           |                                                  |                  |    |      |    |                |
| Pamphiliidae          | <i>Allantus luctifer</i> Smith                   | 7                | 4  | 7    | 3  | PS             |

<sup>1</sup>Y: Yawata, OY: Outside of Yawata, K: Kinki district, OK: Outside of Kinki district.

<sup>2</sup>G: Generalist, PS: Polygonaceae specialist, OS: Other plant family specialist,?: unknown.

<sup>3</sup>In 2004, we assessed mile-a-minute weed in Yawata 12 times and at 9 sites outside of Yawata. In 2005, we assessed mile-a-minute weed at 8 sites within Kinki district and at 7 sites outside of Kinki district. Insects collected were identified and their host ranges checked with Orthopterological Society of Japan (2006), Tomokuni (1993), Asahina et al. (1965), Hayashi et al. (1984), Uéno et al. (1985), Inoue et al. (1982), and Moritsu (1983).

TABLE 2. (CONTINUED) HERBIVOROUS INSECTS ASSOCIATED WITH *P. PERFOLIATA* IN JAPAN.

| Order/Family  | Species                                    | Number of sites  |    |      |    | Host range |
|---------------|--------------------------------------------|------------------|----|------|----|------------|
|               |                                            | 2004             |    | 2005 |    |            |
|               |                                            | Y <sup>1,3</sup> | OY | K    | OK |            |
| Coleoptera    |                                            |                  |    |      |    |            |
| Attelabidae   | <i>Apoderus erythrogaster</i> Vollenhoven  | 1                | 0  | 0    | 1  | G          |
|               | <i>Euops splendidus</i> Voss               | 1                | 0  | 2    | 0  | G          |
| Chrysomelidae | <i>Aulacophora nigripennis</i> Motschulsky | 1                | 0  | 0    | 1  | G          |
|               | <i>Ophraella communis</i> LeSage           | 0                | 1  | 1    | 0  | OS         |
| Curculionidae | <i>Rhinoncomimus niger</i> Korotyaev       | 12               | 3  | 4    | 1  | PS         |
|               | <i>Eugnathus distinctus</i> Roelofs        | 1                | 0  | 0    | 0  | OS         |
| Scarabaeidae  | <i>Anomala rufocuprea</i> Motschulsky      | 1                | 0  | 2    | 1  | G          |
|               | <i>Mimela splendens</i> Gyllenhal          | 0                | 0  | 1    | 0  | ?          |
|               | <i>Popillia japonica</i> Newman            | 7                | 1  | 4    | 1  | G          |

<sup>1</sup>Y: Yawata, OY: Outside of Yawata, K: Kinki district, OK: Outside of Kinki district.

<sup>2</sup>G: Generalist, PS: Polygonaceae specialist, OS: Other plant family specialist,?: unknown.

<sup>3</sup>In 2004, we assessed mile-a-minute weed in Yawata 12 times and at 9 sites outside of Yawata. In 2005, we assessed mile-a-minute weed at 8 sites within Kinki district and at 7 sites outside of Kinki district. Insects collected were identified and their host ranges checked with Orthopterological Society of Japan (2006), Tomokuni (1993), Asahina et al. (1965), Hayashi et al. (1984), Uéno et al. (1985), Inoue et al. (1982), and Moritsu (1983).

this plant in Japan, a suite of herbivorous insects were collected. Six species, including 1 bug, 1 aphid, 2 moths, 1 sawfly, and 1 beetle, are considered as specialists on Polygonaceae.

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