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A DISTRIBUTION AND ESTABLISHMENT PROGRAM FOR *CHILOCORUS KUWANAE* (SILVESTRI) (COLEOPTERA: COCCINELLIDAE) IN THE UNITED STATES

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Abstract.—*Chilocorus kuwanae,* a coccinellid predator of euonymus scale, *Unaspis euonymi* (Comstock) (Homoptera: Diaspididae), was introduced from Korea (1984) and Japan (1985) into the United States. The beetle was released in 25 states in the eastern half of the country and became established in nine states (CN, DE, MA, MD, MI, NC, NJ, OH, PA) and the District of Columbia.

Key Words: Insecta, Coccinellidae, *Chilocorus kuwanae,* euonymus scale, *Unaspis euonymi,* biological control, predator, *Aprostocetus neglectus,* Euonymus plants

Euonymus scale, *Unaspis euonymi* (Comstock) (Homoptera: Diaspididae), is a serious pest of many species of ornamental trees and shrubs in the United States (Gill et al. 1982). In the absence of adequate controls, this insect can attain populations severe enough to cause complete defoliation and death of the host plant (Johnson and Lyon 1988). Even moderate infestations impair photosynthesis and reduce growth (Cockfield and Potter 1987). The pest is a nuisance to homeowners because insect-damaged shrubs are unsightly and require pesticide treatments or removal. Some attractive but scale-susceptible species or varieties of *Euonymus,* an ornamental shrub or tree, are no longer produced by nurserymen since the plants require frequent chemical pest control (Drea and Hendrickson 1988). A biological control method for euonymus scale could reopen markets for these *Euonymus.*

The Agricultural Research Service (ARS), USDA, initiated a Small Farms Research Project in the early 1980's for control of scale pests, one of which was euonymus scale. Since *U. euonymi* is believed to be Oriental in origin, the assistance of the ARS Asian Parasite Laboratory, Seoul, Republic of Korea (ROK) was requested to obtain natural enemies attacking the scale in Korea. Several species of parasites and predators of *U. euonymi* were collected by the laboratory personnel, including the coccinellid *Chilocorus kuwanae* (Silvestri). Specimens of this beetle were shipped to the ARS quarantine facilities at the Beneficial Insects Research Laboratory, Newark, Delaware. After clearance from quarantine, the beetle was sent to the ARS Beneficial Insects Laboratory, Beltsville, Maryland, for additional studies, culture, and release (Drea and Carlson 1987).

Methods and Materials

From 1984 to 1986 411 adult *C. kuwanae* were received from the laboratory in Korea.

Initially these specimens were used to establish laboratory cultures. F_1 adults, larvae, and a small number of eggs from these cultures were released at the U.S. National Arboretum, Washington, D.C., on *Euonymus europaeus* L. in 1984. Color photographs of the predators can be found in Hendrickson and Drea (1988).

The predator became established at the Arboretum. By 1985 this primary release site had become a natural insectary and served as the main source of living material for laboratory cultures and for subsequent distribution of the predator to secondary release sites in MD, DE, PA, NJ and DC.

Populations of beetles at these locations increased rapidly. For example, in Swarthmore, PA, a single shrub, ca. 2.5 m diam., provided 7135 beetles in the year following the initial release of 84 *C. kuwanae* adults on the shrub. During the period 1985 to 1989 a total of 16,157 beetles were collected and redistributed from the primary and secondary sites. Ultimately, beetles were released directly or sent to cooperators in 24 states (AL, AR, CN, DE, FL, GA, KS, KY, MA, MD, MI, MO, NC, NH, NY, OH, OK, PA, VA, RI, TN, TX, VT, WV) and DC. In 1986, nine specimens of *C. kuwanae,* collected by one of us (MR) in Japan, were cultured at Beltsville and 53 specimens were supplied to the New Jersey Department of Agriculture, Trenton.

To determine the success of the project by 1989, questionnaires requesting information relating to the outcome of releases made at various locations throughout much of the eastern United States, were mailed to cooperators in June and reported in this study.

Results and Discussion

By 1987, the scale populations had been reduced to a very low level at the Arboretum, the primary release site (Drea and Carlson 1987). By 1989 the scale insects were almost absent from the trees and the coccinellid was difficult to find.

All cooperators replied to the questionnaire. From their replies and personal field observations we determined that *C. kuwanae* was established in CN, DC, DE, MA, MD, MI, NC, NJ, OH, and PA for one or more years (Fig. 1). In some areas, insufficient time had elapsed since release to determine winter survival.

Releases made in Texas failed to establish. One of us (MR) obtained 2311 adult, larval and pupal stages of *C. kuwanae* from Maryland and Delaware sites in 21 consignments from August 1987 to September 1989. These were released on euonymus scale at numerous sites in Austin, Bryan, College Station, and Dallas/Ft. Worth. Only a few cast larval skins were found and by July 1990 only one adult was recovered. Release sites in Texas were ant-free and *C. kuwanae* adults readily fed on the abundant scale insects. *Chilocorus kuwanae* adults were observed to feed and remain alive for 10 days in branch sleeve cages following colonization. Failure to establish may be related to climatic conditions, especially heat. Surveys are now being conducted to determine overwinter survivalship and reproduction of adult *C. kuwanae* released in October, 1989. The release date was selected to initially circumvent high summer temperatures and to study the potential colonizations of the beetle at lower temperature.

An example suggesting the importance of heat in preventing establishment of this predator occurred in Delaware. Five releases of *C. kuwanae* totalling 60 individuals were made in 1986 and 1987 on 22 small specimens (less than 30 cm high) of a prostrate, variegated variety of *Euonymus fortunei,* infested with euonymus scale, growing on the grounds of the Beneficial Insects Research Laboratory, Newark, DE. The beetles never remained on the plants more than 2 or 3 days and failed to establish. These plants were individually isolated and surrounded by bare soil. Heat rising from the exposed soil on sunny days may have

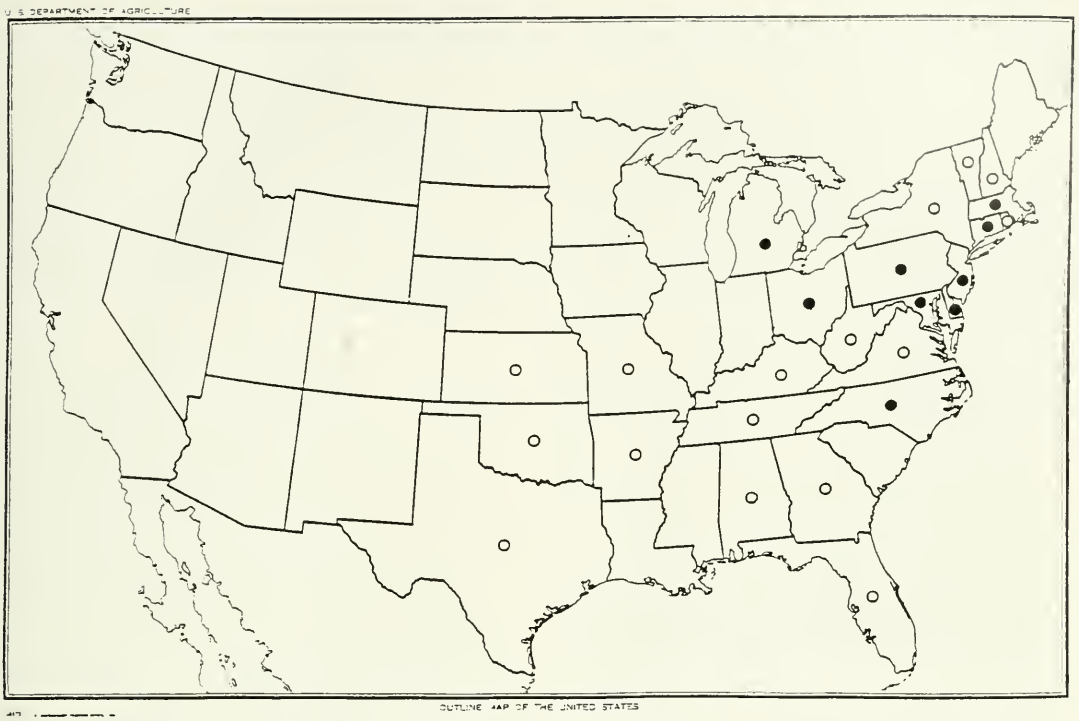

Fig. 1. Distribution of *Chilocorus kuwanae* in eastern United States. A solid circle indicates establishment, an open circle represents one or more releases without confirmed establishment in that state.

repelled the predators. In contrast, beetles became established on an extensive groundcover planting of the same species at Swarthmore, PA, that had no bare soil to reflect heat.

The presence of ants may be another consideration when selecting release sites for the coccinellid. At some locations in DE, MD, and PA, the beetles failed to establish, or if established, failed to develop populations high enough to control the scale over a several year period. These shrubs or trees were always ant infested. There were numerous ants tending honeydew producers such as aphids and planthoppers. The ants repeatedly stung larvae and pupae of *C. kuwanae* and removed stung individuals from the shrubs. Ant species on shrubs were identified as *Camponotus nearcticus* Emery, *C. ferrugineus* (F.), *Formica pallidefulva* Latreille, *Lasius alienus* (Foerster) and *Tapinoma sessile* (Say) (Hymenoptera: Formicidae).

Larvae of *C. kuwanae,* collected from study sites in Delaware and Maryland during 1988 and 1989, were parasitized by *Aprostocetus neglectus* (Domenichini) (Hymenoptera: Eulophidae: Tetrastichinae). The identifier, John LaSalle, noted that this species is known from Europe, the Middle East and North Africa where it is a parasite of coccinellid larvae and pupae. The parasite was previously unknown from North America.

No parasites have been reared from adults of *C. kuwanae* originating from field sites in the U.S. To eliminate the possibility of further distributing *A. neglectus,* only adult *C. kuwanae* are utilized for new field colonizations.

Our best estimate of the rate of movement by *C. kuwanae* was determined from

adults reared from pupae collected by R. D. Gordon in Bowie, MD in August, 1989. Specimens probably dispersed from our closest colonization sites at either Beltsville Agricultural Research Center, Maryland, a distance of ca. 11 km in 5 years, or from the U.S. National Arboretum, Washington, DC, a distance of ca. 19 km in 6 years. It appears that the rate of movement is about 2–3 km per year.

The use of cooperators for disseminating the beetle has greatly enhanced the slow rate of natural dispersal. As a result of this effort, *C. kuwanae* has become established in nine states and the District of Columbia during the six year period from 1984 to 1989. We are hopeful that additional cooperator assistance and future involvement of the Animal and Plant Health Inspection Service, USDA, will result in the collection and wide dissemination of the predator throughout the U.S.

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