

**RELEASE, DEVELOPMENT AND ESTABLISHMENT OF
CHILOCORUS KUWANAE SILVESTRI FOR CONTROL OF *UNASPIS*
EUONYMI (COMSTOCK) IN TENNESSEE**

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ABSTRACT

Development and survival of the egg predator *Chilocorus kuwanae* (the Korean lady beetle) were higher on *Unaspis euonymi* than on eggs of *Chionaspis pinifoliae* or *Chionaspis salicisnigrae*. Although *C. kuwanae* may select a variety of ovipositional sites, females most often deposit a single egg under the test of a female scale insect. Eggs were found beneath *U. euonymi* tests in mid to late April, early July, and early to mid-October. Because the euonymus scale has three overlapping generations annually, an ample food supply is available to the Korean lady beetle. As such, inundative releases of the lady beetle into scale-infested areas may play an important role in the control of selected coccoid species in private as well as commercial plantings.

KEY WORDS: Diaspididae, *Unaspis euonymi*, *Chilocorus kuwanae*, biological control, Tennessee.

INTRODUCTION

Species of *Euonymus* are among the most preferred ornamentals planted in landscapes of homes and businesses and rank in the top 20 plants sold in Tennessee (Nash, 1992). Unfortunately, *Unaspis euonymi* (Comstock) is a serious pest of *Euonymus* spp., with infestations causing damage to the plant in the form of discoloration, die-back, and eventual death.

Because of the difficulty in controlling this pest, species of *Euonymus* have often been replaced with other ornamental plantings, and some nurseries have reduced or eliminated production of *Euonymus*. However, the Korean lady beetle (*Chilocorus kuwanae* Silvestri), an egg predator, was recently imported from Asia and has successfully controlled localized infestations of *U. euonymi* in several parts of the US (Drea and Hendrickson, 1988; Nalepa, 1992). In addition, the Korean lady beetle is known to feed on several other scale species including: *Ceroplastes japonicus* Green, *Chrysomphalus bifasciculatus* Ferris, *Hemiberlesia pitysophila* Takagi, *Parlatoria ziziphi* (Lucas), *Quadraspidiotus macroporanus* Takagi, *Q. perniciosus* (Comstock), and *U. yanonensis* (Kuwana) (Wu et al., 1989; Tachikawa, 1974; Yasumatsu, 1971). The objectives of this study were to evaluate the development and behavior of *C. kuwanae* and *U. euonymi* and to establish the predator on populations of euonymus scale in Tennessee.

MATERIALS AND METHODS

Field releases. From 1990 to 1993, 10 to 20 adult Korean lady beetles were placed in plastic cages ($n = 8-15$) in the laboratory and provided scale-infested euonymus cuttings (21–25.5 cm) every 3 days. A water vial plugged with cotton was placed in the cage to provide moisture. Both immatures and adults were used for initial field releases onto scale-infested plants.

A population of 180 scale-infested *E. japonica* Thunberg plants (20–30 cm high) was established in 1991 at the University of Tennessee, Knoxville Plant Science Farm, to be used as a food source for the predator. Plants were arranged in a block design with 5 blocks, each consisting of 4 rows with 9 plants/3.1 m row. Rows were 2 m apart, with each block separated by a 3.1-m alleyway. Ten adults and fifteen 3rd–4th instars of *C. kuwanae* were randomly released onto infested plants in each block.

Prey selection and development. All developmental stages of the Korean lady beetle were evaluated to determine prey preference and survivability on *Chionaspis salicisnigrae* (Walsh), *C. pinifoliae* (Fitch), and *U. euonymi*. Ten specimens of each instar were individually placed in a 9.5×1.2 cm petri dish along with 9 cm sheet of filter paper. A lady beetle adult was then placed in the center of the petri dish, ca. 4.5 cm from a cluster of 100 scale-insect eggs. The prey preference of each specimen was evaluated for *Chionaspis salicisnigrae*, *C. pinifoliae* or *U. euonymi*. Individuals were observed for 30 min and the following information was recorded: time to reach the food source, amount of time in contact with the food source and total amount of feeding time.

Ovipositional behavior. Fecundity was determined from observations on 33 adult females. Three cuttings of scale-infested euonymus plants, 21–25 cm long, were placed into a plastic container ($20 \times 10 \times 28$ cm). Five adult lady beetles were placed into the container and observed for ovipositional behavior. The number of eggs laid was recorded daily and the position of each egg was marked by placing a white dot (non-toxic paint) near the specimen to more easily observe eclosion.

Development of euonymus scale. Data were obtained from weekly collections of *U. euonymi* from plants located on the University of Tennessee's Knoxville campus. Plants varied in size from 0.75 to 1.5 m in height and from 0.5 to 0.75 m in width. Infested samples, ca. 10 cm long, were collected weekly in 1992. Ten viable specimens were removed from host material, processed, mounted on slides and examined microscopically to determine developmental stage.

RESULTS

Field releases

In June 1990, *C. kuwanae* were released at two sites (25 adults/site) onto heavily infested *E. japonica* in Knox County, TN. By September, fewer than 100 live adult scale insects were observed at the release sites. The plants once again began to produce extensive foliage; this phenomenon had not occurred during spring and summer. In 1992, 10–15 adult lady beetles were released at each of five sites (3 Knox, 1 Hamblen, and 1 Rutherford County). In 1993, 50 adults were released at each of four sites, two in middle and two in east Tennessee. The predator was recovered from one site in middle Tennessee in 1994.

Prey selection and development

A random searching pattern for the food source was observed in all developmental stages. In laboratory tests, male and female pairs, maintained in plexiglas cages, fed daily on or damaged 30 (10–92) female and 147 (52–309) male scale insects over a 29-day period. *C. kuwanae* has been reported to feed on 1340–2610 specimens of *H. pitysofila* in China and 44–1085 *U. yanonensis* in Japan (Yasumatsu, 1971). No differences in the amount of time required to find the food sources were observed. However, once the potential food source was discovered, all stages fed longer (15 to 720 times) on eggs of the euonymus scale than of either *C. pinifoliae* or *C. salicisnigrae*. Specimens were unable to develop to adulthood on either pine needle scale or willow scale eggs. A constant increase in the number of euonymus eggs consumed was recorded for the various stages of the Korean lady beetle. In laboratory observations on 25 first instars (<24 h old), a constant increase in weight gain was recorded from 0.0009 (0.0001–0.005) g for first instars to 0.0078 (0.005–0.015) g for adults. Adult size was 3.5 (2.9–4.3) mm length and 2.9 (2.7–3.2) mm width.

Ovipositional behavior

Korean lady beetle fecundity increased as prey consumption increased, which may in part explain the dramatic impact on scale-infested plants. The most preferred ovipositional site for *C. kuwanae* female eggs (0–6/site) was under female scale tests (69%) of *U. euonymi*. Occasionally, eggs were laid within the cast exuviae of other lady beetles. The survival rate of the eggs to first instar was higher for those deposited under the scale test than for other ovipositional sites. This increase in survivability may be due to the protection from desiccation and predation conferred by the female tests. Other ovipositional sites on plants infested with *U. euonymi* included advantageous roots (10%), cut ends of branches (16%), and undersides of leaves (5%). Two mated females produced 45 and 65 eggs, respectively, over a 25-day period under laboratory conditions. Egg eclosion occurred 4–6 days after oviposition.

Development of euonymus scale

In eastern Tennessee, the euonymus scale overwinters as adult females and has three overlapping generations per year. Females undergo three developmental stages, the mobile crawler stage followed by the sessile second and adult stages. Males have additional prepupal and pupal stages before development into the mobile adult stage. Males died within 48 h after emergence. Females deposited eggs beneath their tests in mid to late April, early July, and early to mid-October. Adults were present in early June, mid-August, and early November. The three time periods for crawler presence were May, late July to early August, and mid-October to mid-November.

The goal of this project is to release and establish the Korean lady beetle across the state to reduce and maintain the euonymus scale at acceptable levels. Small scale field evaluations in 1990–1992 have demonstrated the potential effectiveness of the Korean lady beetle against the euonymus scale in Tennessee. Such biological control agents offer a sustainable, alternative means of area-wide, long-term pest suppression that is environmentally safe, economical, and compatible with other control tactics.

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