Suitability of Five Horticulturally Important Armored Scale Insects as Hosts for an Exotic Predaceous Lady Beetle[1]

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Abstract

Chilocorus kuwanae (Sylvestri) was imported from Korea to the United States for release against the euonymus scale (*Unaspis euonymi* (Comstock)). Field observations suggest that *C. kuwanae* feeds on a number of other armored scale insects, including white peach scale (*Pseudaulacaspis pentagona* (Targionni-Tozzeti)) and obscure scale (*Melanaspis obscura* (Comstock)). However, such observations have not been rigorously examined under controlled conditions. Our laboratory investigations indicate that *C. kuwanae* survives and reproduces well on San Jose scale (*Quadraspidiotus perniciosus* (Comstock)), in addition to euonymus scale. Fecundity was reduced in adults fed white peach scale. Few larvae survived to adulthood when fed oleander scale (*Aspidiotus nerii* (Bouche)). Adults failed to reproduce on obscure scale; none of the larvae fed this host survived to the pupal stage.

Index words: *Chilococrus kuawanae*, biological control, integrated pest management, armored scale insects

Significance to the Nursery Industry

Armored scales are among the more serious pests of commercially grown landscape trees and shrubs. Heavily infested plants are unsightly and die back if control measures are not applied. With concerns over pesticide use increasing among homeowners, landscapers, and nurserymen, alternative control measures for armored scale insects are being investigated. *Chilocorus kuwanae* is known to feed on euonymus scale, however, little is known regarding its ability to survive, develop, and reproduce on other economically important armored scales such as white peach, oleander, obscure, and San Jose scales.

Introduction

Chilocorus kuwanae (Silverstri) was released at the National Arboretum in Washington, DC in 1984 where it became established on several infested shrubs including, *Euonymus europaea* L., *E. hamiltoniana* Wallich var. *nikoensis*, and *E. kiautschovica*. All were heavily infested with euonymus scale (*Unaspis euonymi* (Comstock)) (1). *Chilocorus kuwanae* has previously been associated with several important scale pests of landscape trees and shrubs, including San Jose scale (*Quadraspidiotus perniciosus* (Comstock), and white peach scale (*Pseudaulacaspis pentagona* (Targionni-Tozetti)) (2). In Maryland, Staines et al. (3) (1990) reported *C. kuwanae* feeding on a number of armored scale species including the obscure scale (*Melanaspis obscura* (Comstock)).

One of our research objectives is to establish *C. kuwanae* in landscape plantings to help control important armored scale pests. In two separate laboratory experiments we examined the performance of *C. kuwanae* larvae and adults fed economically important armored scale species. Larval survivorship, development, and growth were determined for *C. kuwanae* utilizing euonymus scale, San Jose scale, oleander scale (*Aspidiotus nerii* (Bouche)), and obscure scale as hosts. Oleander scale is a subtropical species that feeds on a wide variety of plants, often causing economic damage (4). Patterns of adult reproduction were evaluated for *C. kuwanae* fed euonymus scale, San Jose scale, obscure scale and white peach scale.

Materials and Methods

A colony of *C. kuwanae* was maintained in laboratory culture on San Jose scale reared on a factitious host, butternut squash, *Cucurbita moschata* (Duchesne) Poir. var. Butternut, and on euonymus twigs infested with euonymus scale in petri plates. Both were kept in a growth chamber at 25°C (77°F). Euonymus twigs were changed every 7 days and the squash replaced as needed. Newly hatched *C. kuwanae* larvae were collected daily and placed in petri plates containing several twigs infested with overwintering euonymus scale or overwintering obscure scale at a rate of 5 larvae per plate. Scale viability was assessed by examining the infested surface of plant samples in the field. Only those with a high density of viable scales were used for the experiment. The ends of each cut twig were dipped in hot beeswax to reduce moisture loss. Each plate contained a moistened sponge fragment to further reduce desiccation. Five *C. kuwanae* larvae were also placed on a San Jose scale-infested squash and on an oleander scale-infested Russett potato. Squashes and potatoes were kept in 53 × 36 × 20 cm (21 × 14 × 8 in) ventilated plastic containers and changed as needed, depending on initial scale density. Petri plates were examined every other day for larval survival and development. All pupae were weighed. Larvae on euonymus and obscure scales were moved with a fine paintbrush to fresh host material every 4 days. There were 26 replicates of euonymus scale, 11 of San Jose scale, 8 of obscure scale, and 10 of oleander scale.

Received for publication May 4, 1992; in revised form November 30, 1992.

[1]**Support for this project provided by the Horticultural Research Institute**, International Society of Arboriculture Research Grant Program, and Competitive Grant Program of the Maryland Agricultural Experiment Station. Scientific article No. A6395 Contribution No. 8582 of the Maryland Agricultural Experiment Station.

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In addition to assessing the performance of immature beetles on various hosts, we were interested in determining how suitable the different scales were as prey for adult beetles. Therefore, we attempted to estimate fecundity of *C. kuwanae* fed different scales. Fecundity could not be measured by counting eggs since *C. kuwanae* adults oviposit under scale covers. Instead, fecundity was estimated by counting the number of first instar beetle larvae found in a petri dish after adult beetles consumed scales and laid eggs for a period of 7 days.

To estimate fecundity, newly eclosed adult males and females were paired and placed in petri dishes containing different species of scales, or on squash (San Jose scale) or potatoes (white peach scale). Euonymus and obscure scales were offered to beetles as overwintering females on twigs and white peach and San Jose scales were offered as third instar males and females. Scales of each species were changed every 7 days and the previously exposed scales were retained for a period of 30 days in a growth chamber of 25°C (77°F). The previously exposed scales were checked every other day for 30 days for hatching larvae of *C. kuwanae*. The fecundity of each female beetle used in the experiment was estimated by counting its progeny for a period of 63 days (9 wks) or until the beetle died or failed to produce offspring for two consecutive weeks. When a male beetle died, it was replaced with one from a colony. If no larvae were obtained from a pair of beetles within 30 days, the beetles were dissected to confirm that they were male and female. Beetles that were incorrectly paired were excluded from the analysis. The fecundity study contained the following number of replicates: 10 euonymus scale, 9 San Jose scale, 7 white peach scale, and 4 obscure scale.

Results and Discussion

We examined several parameters of performance for beetles fed different species of scales. Data gathered on larval mortality did not conform to the assumptions necessary for parametric analysis; therefore, a Kruskall-Wallis test was used to compare the mortality of *C. kuwanae* larvae on different scale hosts. Larval mortality differed significantly among the four species tested ($P < 0.05$) (Fig. 1) (5). Mortalities of larvae fed euonymus scale (43%) and San Jose scale (38%) were significantly lower than those fed obscure (100%) and oleander scales (92%). Despite earlier reports of an association between *C. kuwanae* and *M. obscura*, it is clear that *C. kuwanae* cannot survive and complete development on obscure scale (3). We found no records reporting oleander scale as a host for *C. kuwanae*. It appears that this species is a poor host and should not be considered a target for releases.

Data on all other life history parameters of the beetle did conform to the assumptions for parametric analysis and analysis of variance was used for subsequent parameters. Statistically significant differences were observed in the number of days to pupation for the larvae fed different hosts (ANOVA, $P < 0.05$) (Fig. 2). Average development times were 20.6, 19.3, and 25.2 days for euonymus scale, San Jose scale, and oleander scale, respectively. None of the larvae placed with obscure scale survived to the pupal stage. San Jose and euonymus scales were the most suitable hosts, in terms of development time. Rapid larval development might reduce mortality of this vulnerable stage (6). Pupal weight did not differ significantly among the three hosts from which adults emerged (Fig. 3).

Adults fed white peach scale produced 10.2 offspring per week and hence this host does not appear as suitable as San Jose or euonymus scales (Fig. 4). Obscure scale did not support reproduction of *C. kuwanae* (Fig. 4). Due to highly variable reproduction among pairs, there were no significant differences in reproduction among beetles fed euonymus, San Jose, or white peach scale (ANOVA, $P > 0.05$). Except for obscure scale, there was no significant difference in the

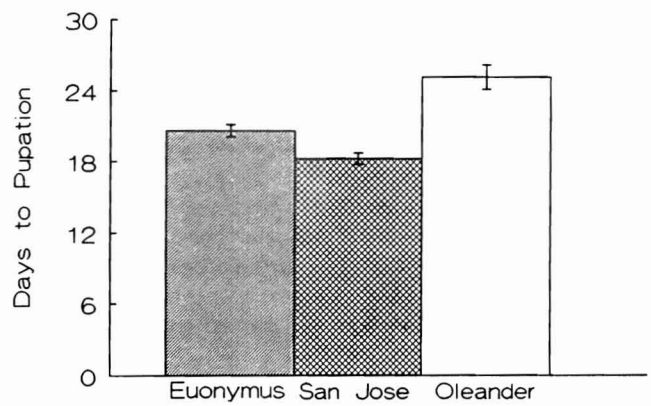

Fig. 2. Average number of days to pupation of *Chilocorus kuwanae* larvae fed three species of armored scales. Bars represent means and vertical lines represent standard errors.

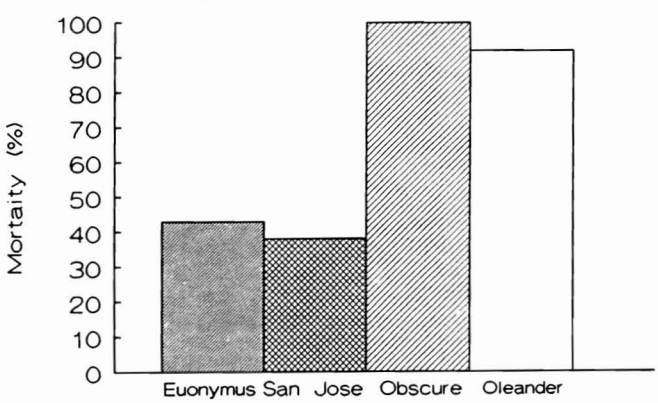

Fig. 1. Average mortality of *Chilocorus kuwanae* larvae fed four species of armored scales.

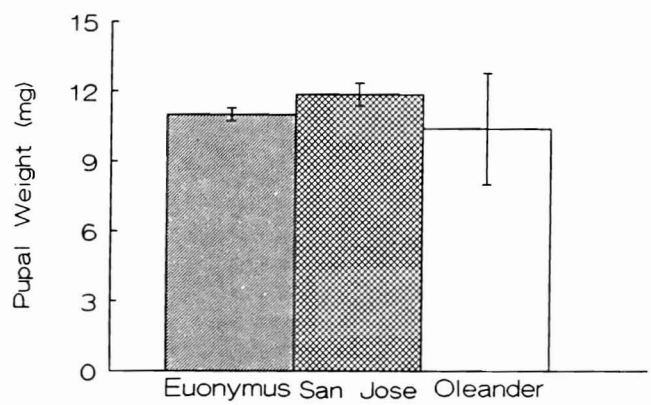

Fig. 3. Average weight of *Chilocorus kuwanae* pupae from larvae fed three species of armored scales. Bars represent means and vertical lines represent standard errors.

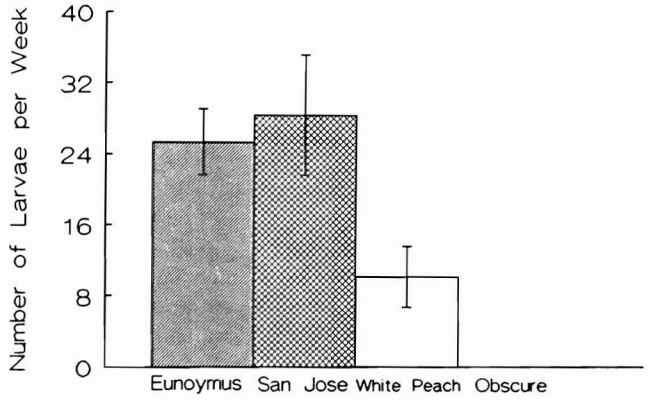

Fig. 4. Average number of larvae produced each week by adult *Chilocorus kuwanae* fed four species of armored scales. Bars represent means and vertical lines represent standard errors.

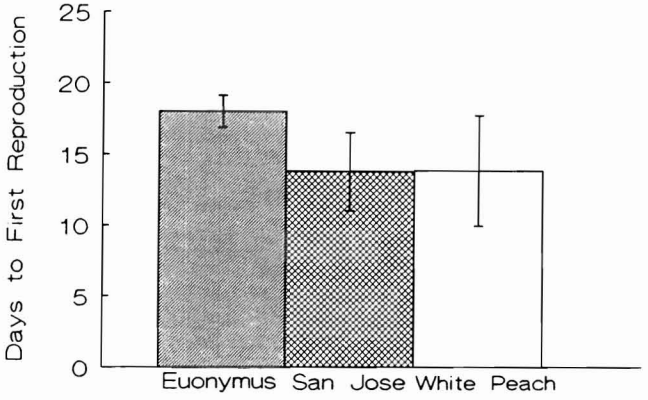

Fig. 5. Average number of days to first reproduction of adult *Chilocorus kuwanae* fed three species of armored scales. Bars represent means and vertical lines represent standard errors.

age of first reproduction when *C. kuwanae* consumed San Jose, euonymus, or white peach scale (Fig. 5).

In conclusion, a successful biological control agent must first be able to survive well and reproduce on its intended host. Laboratory studies indicate that euonymus scale and San Jose scale are equally suitable hosts for *C. kuwanae* with respect to survivorship and reproduction. White peach scale was intermediate in supporting reproduction of *C. kuwanae*. We were unable to gather information on its ability to support survival of immature *C. kuwanae*. Therefore, our knowledge of the suitability of this species as a host for *C. kuwanae* remains incomplete. Obscure scale, although listed among hosts on which *C. kuwanae* has been observed feeding, proved to be an unsuitable host under laboratory conditions and supported neither survival or reproduction. The same inference can be drawn for oleander scale. This species supported larval development of *C. kuwanae* very poorly. No data were gathered on the suitability of Oleander scale to support reproduction. These laboratory studies were useful in providing baseline information on the host range of an exotic predator potentially beneficial to the nursery and landscape maintenance industries. However, assessment of this beetle using San Jose, euonymus, and white peach scale under field conditions must be conducted to further evaluate the efficacy of this biological control agent for use in nursery and landscape settings.

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