

Distribution of Natural Enemies of *Euonymus* Scale, *Unaspis euonymi* (Comstock), in Virginia¹

D. K. Jefferson, P. B. Schultz and M. D. Bryan²

Hampton Roads Agric. Res. & Ext. Ctr.
Virginia Beach, VA 23455-3363 USA

J. Entomol. Sci. 30(2): 273-278 (April 1995)

ABSTRACT The colonization of *Chilocorus kuwanae* (Silvestri) (Coleoptera: Coccinellidae) and *Cybocephalus nipponicus* (Endrody-Younga) (Coleoptera: Nitidulidae), introduced predators of euonymus scale, *Unaspis euonymi* L., was evaluated on evergreen euonymus scale, *Euonymus japonica* L., by regional and statewide surveying. This study determined the statewide distribution of the native parasites of euonymus scale, *Aspidiotiphagus* spp. and *Encarsia* spp. (Hymenoptera: Aphelinidae). Highest recovery incidences were from 18 of the 41 survey sites on 25 May. The survey established the survival and dispersal of *C. kuwanae* in metropolitan areas of Virginia with recoveries in 8 of the 12 cities.

KEY WORDS *Unaspis euonymi*, *Chilocorus kuwanae*, euonymus scale, parasites.

Euonymus scale, *Unaspis euonymi* (Comstock) (Homoptera: Diaspididae), is a serious pest of ornamental shrubs in the United States. It attacks a number of hosts including species in *Euonymus*, *Pachysandra*, and *Celastrus* with euonymus being its primary host. Symptoms of initial infestation are yellow or white spotting on the foliage. Heavier infestation includes encrustation of the stems by the females and a whitened foliage by the males that results in defoliation and subsequent plant death.

Euonymus ranked twelfth in a survey of the 20 most commonly used landscape plants (Holmes and Davidson 1984). It exhibits a wide variety of growth forms including ground covers, climbing vines, and both evergreen and deciduous shrubs. Selections of *E. japonicus* (Thunb.) and *E. fortunei* (Turcz.) have resulted in variegated cultivars that are popular in urban landscapes.

Euonymus scale was apparently introduced from Asia (Drea and Carlson 1987). It overwinters as mature females on the stem and leaf veins of the host plant. Eggs are deposited in early spring beneath the female. In Virginia, the eggs hatch in May, with a second generation developing in August. Dennis (1969) reported control was obtained with several insecticides, but observed that no effective method of biological control had been found.

¹ Accepted for publication 19 December 1994.

² Nat. Biol. Cntrl. Lab., USDA, APHIS, Niles, MI 49120.

Natural enemies reportedly have been collected from euonymus scale. Gill et al. (1982) reported the predaceous mite *Hemisarcoptes malus* (Schimer) (Acari: Hemisarcoptidae) and the aphelinid parasite *Aspidiotiphagus citrinus* (Crawford) (Hymenoptera: Aphelinidae) in Maryland. In addition to *Aspidiotiphagus* sp., Kosztarab (1963) reported *Prospaltella* sp. (Hymenoptera: Aphelinidae), another predaceous mite, *Thyreophagus entomophagus* (Laboulbene) (Acari: Acaridae), and unidentified predaceous mites in the families Phytoseiidae and Tarsonemidae in Ohio. Kosztarab and Kozár (1988) listed nine parasite species from Central Europe. *Encarsia* spp. (Hymenoptera: Aphelinidae) have also been found in *U. euonymi* infestations (Bryan, personal communication). A few members of the Cecidomyiidae, particularly the genus *Lestodiplosi*, also feed on scale (Harris 1990). Additionally, Neuroptera in the families Raphidiidae, Coniopterygidae and Chrysopidae prey on scale insects (Drea 1990). These species have been ineffective as biological control agents leading to the need for further foreign exploration.

The U. S. Department of Agriculture, Agricultural Research Service (USDA, ARS) undertook exploration for potential biological control agents of euonymus scale in the native range in Asia, and beginning in 1984, imported and established two coleopterous predators from Korea: *Chilocorus kuwanae* (Silvestri) (Coleoptera: Coccinellidae), and *Cybocephalus* prob. *nipponicus* (Endrody-Younga) (Coleoptera: Nitidulidae) (Drea and Carlson 1987, Drea and Carlson 1988, Hendrickson et al. 1991).

In 1987, colonies of both species were released in Virginia, *C. kuwanae* at the Hampton Roads Agric. Res. & Ext. Ctr. (AREC), Virginia Beach, and *C. nipponicus* in a residential site in Virginia Beach. In 1991, the USDA Animal and Plant Health Inspection Service (APHIS), in cooperation with the Virginia Department of Agriculture and Consumer Services (VDACS), initiated a program for biological control of euonymus scale. Release stock was obtained from workers at the USDA ARS Beneficial Insects Research Laboratory, Newark, DE. This material was collected at local sites in Delaware and is of probable Korean origin. In 1992, colonies of *C. kuwanae*, collected from the Virginia Beach colonization site, were released in Henrico, Clarke, Roanoke, Fairfax, and Spotsylvania counties of Virginia. In 1993, *C. kuwanae* was released in Loudoun, Campbell, Pittsylvania, and Prince George counties. The objective of the study was to determine the natural enemy complex of euonymus scale by surveying for *C. kuwanae*, *C. nipponicus* and native parasites initially in Virginia Beach, and subsequently in all metropolitan areas of Virginia.

Materials and Methods

Natural enemy distribution, 1992. In 1992, 25 landscape sites in Virginia Beach with euonymus plantings, were sampled monthly from May to August. Sites were located within a 16-km radius of the Hampton Roads AREC and harbored medium to high euonymus scale populations. The original sites were located using 1991 survey data from the Euonymus Scale Biological Control Project, of USDA, APHIS (Schultz, unpublished data). In cases where scale populations had been eliminated by pesticide application, alternate sites were selected by searching for nearby euonymus infested with living scale.

Sampling at each of the locations was accomplished by two methods. The first method involved sampling for parasites and slow-moving predators. This was achieved by removing a 10-cm terminal section of twig from each compass quadrant of the scale-infested section of the euonymus plant. Leaves were removed and the twig was placed in a culture tube with a cotton plug. The second method consisted of sampling for larger, faster moving predators. The predators were removed from the plant by either beating or shaking the branches over a collection sheet (0.8 × 0.8 m). Plant debris was placed in 500-ml cartons. Samples were returned to the laboratory and the scales on each twig were counted. Predators, such as *C. kuwanae* larvae and other large insects, were removed. Culture tubes and cartons were then placed in darkness at 23°C and 60% RH to allow the parasites to emerge. After four weeks the dead parasites were removed from the culture tubes, sorted, counted, and representative samples were sent to the USDA, APHIS laboratory in Niles, MI for identification. Sites where natural enemies were recovered were recorded.

Natural enemy distribution, 1993. In 1993, the survey was expanded into a state-wide study to include 41 sites in 10 counties and two incorporated, independent cities. Areas were surveyed primarily in metropolitan areas, where euonymus plantings would likely be found. A maximum of six sites per locality was selected, but was dependent on the ability to locate euonymus plantings. Survey methods were the same as those used in the previous year with sampling twice per month between May and August.

Results and Discussion

Natural enemy distribution, 1992. The indigenous natural enemies *Aspidiotiphagus* spp. and *Encarsia* spp. (Hymenoptera: Aphelinidae) were recovered from twig samples. Of the 25 Virginia Beach sites sampled, *Aspidiotiphagus* spp. or *Encarsia* spp. were collected from 11 sites. Of the predators, *C. kuwanae* was collected at nine sites, and *C. nipponicus* was collected at its initial release site. The greatest distance between the release site and *C. kuwanae* recovery sites was approximately 10 km.

Natural enemy distribution, 1993. As in the 1992 survey, *Aspidiotiphagus* spp. and *Encarsia* spp. were found. These two genera were collected in all 10 counties and the two independent cities surveyed. The highest incidence of parasites were found on 25 May in 7 of the 12 localities (18 of the 41 sites) (Table 1), whereas, none was found on the 12 July sampling. Other recoveries ranged from 22-39% of the sampling sites. Variation in the results from each sampling period is likely due to changes in the relative abundance of third-instar euonymus scale from which the parasites emerged.

Of the 12 localities sampled, *C. kuwanae* was recovered from eight, which were distributed throughout the metropolitan regions of the state. The highest incidence of *C. kuwanae* was recovered from 11 of 36 sites (31%) on 10 August, with 12 of 41 (30%) sites on May 25 (Table 1). Other recoveries ranged from 16-24%. Interestingly, the locations of recovery sites of *C. kuwanae* were not consistent throughout the season. Several sites were negative on August samples, despite recoveries early in the season. Both euonymus scale and its natural enemies would be susceptible to cultural or chemical control strategies that would drastically

Table 1. Survey for *Chilocorus kuwanae* and aphelinid parasites in Virginia, 25 May 1993.

| City | Number of sites | County | Sites positive for <i>C. kuwanae</i> | Sites positive for <i>Aspidiotiphagus</i> or <i>Encarsia</i> |
|-----------------|-----------------|------------------|--------------------------------------|--|
| Mechanicsville | 1 | Hanover | 1/1 | 0/1 |
| Richmond | 4 | Henrico | 1/4 | 1/4(A*) |
| Fredericksburg | 5 | Stafford | 2/5 | 4/5(A) |
| Leesburg | 6 | Loudoun | 0/6 | 1/6(A) |
| Blandy Farm | 3 | Clarke | 1/3 | 2/3(A) |
| Charlottesville | 4 | Albemarle | 2/4 | 3/5(A) |
| Roanoke | 3 | Roanoke | 0/3 | 3/3(A) |
| Lynchburg | 4 | Campbell | 0/4 | 1/4(A) |
| Danville | 3 | Pittsylvania | 0/3 | 0/3 |
| Emporia | 2 | Greensville | 2/2 | 1/2(E) |
| Chesapeake | 1 | Independent City | 0/1 | 0/1 |
| Virginia Beach | 4 | Independent City | 3/4 | 2/4(A,E) |
| TOTALS | 41 | | 12/41 (30%) | 18/41(44%) |

*A = *Aspidiotiphagus* sp., E = *Encarsia* sp.

decrease insect populations. Renovation pruning is a common practice with large shrubs such as euonymus. While this practice is recommended during plant dormancy, it is in fact often conducted by property owners and landscapers during the growing season. Environmental fluctuations and changes in population densities could result in decreases of natural enemies at particular sites.

The establishment of *C. kuwanae* in Virginia was expected because it has become established at sites in both Maryland and North Carolina (Drea and Carlson 1987, Nalepa et al. 1993). What was unusual was the sporadic natural spread within metropolitan areas. While follow-up monitoring of a *C. kuwanae* release in Richmond, VA, had negative results, large numbers were collected from a site 15 km distant. Even though euonymus and euonymus scale were not distributed uniformly throughout the landscape, *C. kuwanae* had little difficulty finding new food sources. Similar unanticipated recoveries of *C. kuwanae* were made in Charlottesville and Norfolk, VA in 1992 and 1993, and of *C. nipponicus* in Fredricksburg, VA in 1993.

Conclusion. Survey results indicated natural and introduced parasites and predators occurred on euonymus scale populations throughout metropolitan areas of Virginia. This study determined the statewide distribution of the native aphelinid parasites *Aspidiotiphagus* spp. and *Encarsia* spp. The survey established the survival and

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