EGG DISTRIBUTION AND SAMPLING OF *DIAPREPES ABBREVIATUS* (COLEOPTERA: CURCULIONIDAE) ON SILVER BUTTONWOOD

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ABSTRACT

Taylor's power law and Iwao's patchiness regression were used to analyze spatial distribution of eggs of the Diaprepes root weevil, *Diaprepes abbreviatus* (L.), on silver buttonwood trees, *Conocarpus erectus*, during 1997 and 1998. Taylor's power law and Iwao's patchiness regression provided similar descriptions of variance-mean relationship for egg distribution within trees. Sample size requirements were determined. Information presented in this paper should help to improve accuracy and efficiency in sampling of the weevil eggs in the future.

Key Words: Diaprepes root weevil, eggs, within-plant distribution

RESUMEN

Se utilizaron la ley de Taylor y la regresion de Iwao para analizar la distribución de los huevos del picudo Diaprepes, *Diaprepes abbreviatus* (L.) en arboles de botón plateado, *Conocarpus erectus*. Los estudios fueron realizados durante 1997 y 1998. Tanto la ley de Taylor como la regresion de Iwao dieron resultados similares en cuanto a la relacion de la varianza y el promedio para la distribución de huevos del picudo en los arboles. Se determinaron los requerimentos del tamaño del número de muestras. En un futuro, la informacion que se presenta en este artículo puede ayudar a mejorar la eficiencia del muestreo de huevos de este picudo.

Translation provided by the authors.

The Diaprepes root weevil, *Diaprepes abbreviatus* (L.) (Coleoptera: Curculionidae) is an important pest of citrus, ornamentals, and root crops in Florida (Woodruff 1964; Simpson et al. 1996). Injury caused by the Diaprepes root weevil is a result of larval feeding of the roots as well as leaf feeding by adults. The biology of the insect has been studied since the early 1930s (Wolcott 1933, 1936), followed by other biological studies (e.g., Beavers & Selhime 1975; Lapointe & Shapiro 1999; Quintela et al. 1998; Rogers et al. 2000; Lapointe 2001). Female weevils oviposit on foliage by gluing their eggs between leaves. Neonates fall to soil surface and eventually become established in the soil until adulthood (Wolcott 1933). Previous research on the dynamics of the Diaprepes root weevil has been conducted primarily on citrus (i.e., Quintela et al. 1998; Nigg et al. 1999) but few studies address its damage and distribution on other host plants (Mannion et al. 2003). For example, damage on ornamental plants caused by adult feeding reduces considerably the marketability of the crop. Additionally, ornamentals may act as reservoirs of eggs and larvae (Mannion et al. 2003).

Some information is available on the distribution of adults of the Diaprepes root weevil among citrus trees (Nigg et al. 1999, 2001, 2002; McCoy & Simpson 1994) but no information is available on the distribution of eggs. The objectives of this study were to determine within-plant spatial dispersion of the *Diaprepes* eggs in silver buttonwood, *Conocarpus erectus* L. var. *sericeus* Fors., an ornamental plant, and to report numerical sampling plans for the egg stage of the Diaprepes root weevil.

MATERIALS AND METHODS

Within-Plant Sampling

The study was conducted during 1997 and 1998 in a 1 ha field-grown ornamental nursery in Homestead, Miami-Dade County, Florida. The field contained a mixture of ornamental plant species. Many of them are considered hosts of *D. abbreviatus* (silver buttonwood, *Conocarpus erectus* L. var. *sericeus* Fors.; green buttonwood, *C. erectus* (L.); live oak, *Quercus virginiana* Mill; dahoon holly, *Ilex cassine* L.) (Mannion et al.

2003). Five silver buttonwood trees and five dahoon holly trees were selected randomly, and each tree was divided into three strata: upper, middle, and lower, approx. 2.7-3.9, 1.4-2.6, and 0.2-1.3 m from the ground, respectively. Five 40-50-cm-long branches per stratum per tree were randomly selected monthly and all leaves counted per branch. The number of egg masses present per branch was recorded. Means and variances of counts of eggs were calculated for each tree stratum. Periodically egg samples were held in 5-mL vials for hatching, and larvae were reared and identified (Quintela et al. 1998).

Statistical Analysis

The statistical distribution of counts of eggs in relation to sampling unit was examined with Taylor's (Taylor 1961) power law and Iwao's (Iwao 1968) patchiness regression. Taylor's power law expresses the functional relationship between the variance (s^2) and the mean (μ) as $(s^2) = a\mu^b$. The coefficient a and the exponent b are estimated by a linear regression of log s^2 on log x where s^2 and x are the sample variance and the sample mean, respectively. The parameter b is a measure of aggregation, and the parameter a is a scaling factor related to the sampling procedure, and sample unit employed. The Iwao patchiness regression relates mean crowding $[m^* = x + (s^2/x) - 1]$ and x by simple linear regression as $m^* = \alpha + \beta x$. The intercept α is an index of contagion and the slope β is a measure of aggregation as the exponent b in the Taylor power law (Iwao 1968).

The coefficients from Taylor power law regression were used to determine sample size requirements necessary for estimating population means for each plant species with fixed levels of precision. Precision was defined as $D = s_x/x$, where s_x is the standard error of the mean. Estimators with standard errors of 10 and 25% were chosen for this study. The number of samples necessary to estimate the mean with fixed precision was determined by solving for $n = ax^{(b-2)}/D^2$ where a and b are coefficients obtained from Taylor power law regression.

Results and Discussion

Buttonwood is a low-branching evergreen tree with terminal clusters of leaves and sylleptic branches that are formed on vigorous shoots, providing a renewal of leaves through the year (Tomlinson 1980). The average number of leaves per branch was 191.0 ± 7.79 and 82.0 ± 24.65 during the spring and winter, respectively. Therefore, we inspected an average of 1,245-3,000 leaves for the 5 sampled trees during each sampling date. Only Diaprepes root weevil adults, not other weevils, were observed in either silver buttonwood and dahoon holly. All emerging larvae from collected eggs were identified as *D. abbreviatus*. There was no relationship between leaf abundance per branch and number of egg masses (F = 2.09, df = 19, P < 0.16, r^2=0.10). The highest numbers of egg masses in silver buttonwood occurred from Jan to Apr 1997 and Jan to Mar 1998 . Less than 2 egg masses per branch were recorded from May through Oct 1997 and from Apr to Oct 1998 (Fig. 1). No eggs were recorded during Nov and Dec. Higher numbers of egg masses (mean ± SE = 2.4 ± 0.14) were recorded in silver buttonwood than in dahoon holly (0.010 ± 0.0095) (F = 69.46; df = 1, 378; $Pr > F$ = 0.0001). Therefore, it appears that silver buttonwood is more favorable for oviposition than dahoon holly.

Within-Tree Sampling

The mean egg mass count per branch for each tree stratum provided information on the reliability of each stratum as a potential sampling unit. More egg masses (mean ± SE = 2.9 ± 0.39) per branch were found on the upper stratum than on the lower one (1.8 ± 0.23) (F = 3.5, df = 261, P < 0.05), however, the number of egg masses in the upper stratum was not different from the middle (2.1 ± 0.23). Estimates of indices of dispersion were calculated for silver buttonwood as shown in Table 1. Both the Taylor's power law regression and Iwao patchiness regression provided similar coefficients of determination (r^2) for egg masses in silver button wood; r^2 = 0.94 and r^2 = 0.92, respectively. According to Taylor's power law, egg masses were aggregated within canopy strata when they are deposited in silver button wood (a = 0.34, b = 1.21, r^2 = 0.98). A significant difference was detected for the b value by Student t-test. Both Taylor's power law regression and Iwao patchiness regression indices indicated aggregated spatial pattern in the upper (b = 1.33; _ = 1.55) and middle canopies (b = 1.09; β = 1.15),

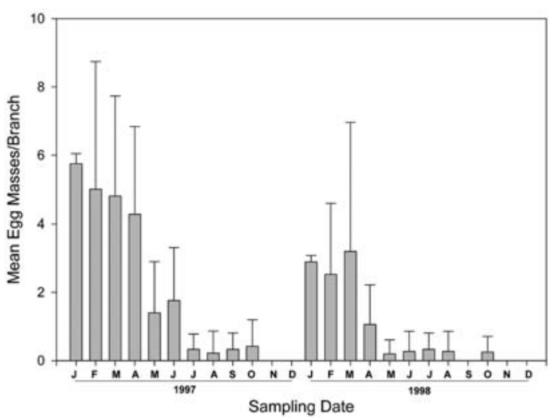

Fig. 1. Seasonality of oviposition of *D. abbreviatus* in silver buttonwood, 1997-1998 in Homestead, FL.

TABLE 1. WITHIN-TREE DISPERSION STATISTICS FOR EGG MASSES OF *DIAPREPES ABBREVIATUS* ON SILVER BUTTONWOOD.

	Iwao's patchiness regression			Taylor's power law		
Tree Stratum	α	β	r^2	log *a*	*b*	r^2
Upper	-0.25	1.55	0.96	0.37	1.33	0.94
Middle	0.22	1.09	0.66	0.31	1.15	0.88
Lower	0.16	0.82	0.47	-0.15	0.86	0.62
Common	0.03	1.28	0.92	0.34	1.21	0.94

whereas a random spatial pattern ($b < 1$) was recorded from the lower canopy ($b = 0.82$; $\beta = 0.86$) ($t = 3.44$, $df = 20$, $P = 0.003$).

Sample size curves for fixed levels of precision for sampling Diaprepes root weevil eggs in silver buttonwood are shown in Fig. 2. Mean sample sizes needed for a precision level of 0.25 were 19 branches for silver buttonwood when the average egg mass is near 0.20 egg masses per branch. When egg mass densities were low, numerous samples are required to estimate egg mass density with a degree of precision of 0.10.

It appears that in silver buttonwood more eggs are deposited during winter and early spring than at other times of the year. According to Schroeder and Sutton (1977) and Lapointe (2001), Diaprepes root weevils prefer to deposit eggs on more mature and expanded citrus leaves. Silver buttonwood is a bushy type tree. Silver buttonwood hardened mature leaves are present throughout the canopy. Mature leaves of silver buttonwood in the upper and middle canopy strata are flatter than mature leaves in the lower canopy stratum, which tend to curve inward and are regularly covered with sooty mold.

Sampling procedures for egg masses will depend on the host plant species. According to Taylor's power law, eggs are aggregated in their spatial patterns for silver buttonwood. The cause of aggregation of the Diaprepes root weevil egg masses in silver buttonwood could be attributed

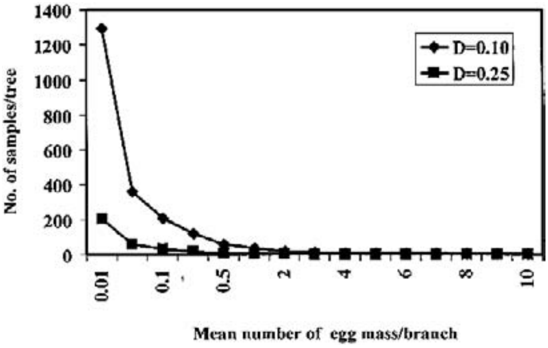

Fig . 2. Sample size requirements for branch samples of silver buttonwood of *Diaprepes* weevil eggs for precision levels of 0.10 and 0.25.

to the active aggregation of adults in the upper and middle stratum of the canopy (D.A., unpublished data). Dispersion of pest populations is an important aspect of population biology because it is a result of the interaction between individuals and their habitat (Sevacherian & Stern 1972). Knowledge of this dispersion allows a better understanding of the relationship between an insect and its environment, and provides basic information for interpreting spatial dynamics, designing efficient sampling programs for population estimation and pest management (Sevacherian & Stern 1972). The numerical sampling approach and the options for estimating densities of r^2 eggs should provide guidance for monitoring Diaprepes root weevil infestation in silver buttonwood in Florida. More studies are needed to determine Diaprepes root weevil egg mass distribution in other host plants.

ACKNOWLEDGMENTS

We thank D. Hall (USDA/ARS, Ft. Pierce, FL), J. Jacas, and R. Litz (UF-TREC, Homestead, FL) for helpful review of this manuscript. This study was supported by T-STAR 1998 grant to JEP.

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