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PREY PREFERENCE BY *DELPHASTUS CATALINAE* (COLEOPTERA: COCCINELLIDAE) ON *BEMISIA ARGENTIFOLII* (HOMOPTERA: ALEYRODIDAE): EFFECTS OF PLANT SPECIES AND PREY STAGES

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ABSTRACT

Plant species and insect stages were studied for their effects on feeding by predator *Delphastus catalinae* (Horn) (Coleoptera: Coccinellidae) on the silverleaf whitefly (*Bemisia argentifolii* Bellows and Perring) (Homoptera: Aleyrodidae). To study the influence of plant species, immature whitefly prey were presented simultaneously to starved predator adults on leaf cuttings of five different plant species: cotton (*Gossypium hirsutum* L.), tomato (*Lycopersicon esculentum* Miller), hibiscus (*Hibiscus rosa-sinensis* L.), cowpea (*Vigna unguiculata* [L.], Walpers ssp. *unguiculata*), and collard (*Brassica oleracea* var. *acephala* DC). Percentage predation over 24 h was significantly highest on cotton, followed in rank order by collards, cowpea, tomato, and hibiscus. Different predation rates may have been caused by differential response to volatile secondary compounds released by the leaf cuttings. Host stage preference was studied by presenting individual adult predators with equal numbers of prey (200 per replicate) in three aggregate life stages: eggs, small nymphs (1st to 3rd instars) and large nymphs (4th instar to pupae). Adults consumed significantly higher numbers of eggs in a 24-h predation period compared with small or large nymphs. These findings suggest that among the plant species tested, *Delphastus catalinae* may be most effective on early-season cotton or immediately after whitefly infestation when eggs are predominant.

Key Words: silverleaf whitefly, predation, tomato, vegetables, hibiscus, cotton

RESUMEN

Las especies de plantas y las estadias de insectos fueron estudiados para sus efectos en la alimentación del depredador *Delphastus catalinae* (Horn) (Coleoptera: Coccinellidae) sobre la mosca blanca (*Bemisia argentifolii* Bellows y Perring) (Homoptera: Aleyrodidae). Para estudiar la influencia de las especies de plantas, las inmaduras de la mosca blanca presas fueron presentadas a los adultos depredadores habrientos sobre esquejes de hojas de cinco especies diferentes de plantas: algodón (*Gossypium hirsutum* L.), tomate (*Lycopersicon esculentum* Miller), hibiscus (*Hibiscus rosa-sinensis* L.), caupí o garbanzo (*Vigna unguiculata* [L.], Walpers ssp. *unguiculata*), y hoja de col (*Brassica oleracea* var. *acephala* DC). El porcentaje de depredación por un período de 24 h fue significativamente el mas alto en algodón, seguido en el orden del mas alto hasta el mas bajo por la hoja de col, caupí, tomate y *Hibiscus*. Las diferencias en las tasas de depredación pueden ser causadas por sus respuestas diferenciales a los compuestos de volátiles secundarios liberados de los esquejes de hojas. La preferencia de la estadia de hospedero fue estudiada al presentar a los individuos de adultos depredadores un número igual de presas (200 por replica) en tres estadias de vida agregadas: huevos, ninfas pequeñas (1º a 3º estadia) y ninfas grandes (4º estadia a pupario). Los adultos consumieron significativamente mas huevos en un periodo de depredación de 24 h, comparados con las ninfas pequeñas o grandes. Estos hallazgos sugieron que entre las especies de plantas probadas, *Delphastus catalinae* puede ser lo mas efectivo en algodón en el principio de la estación o inmediatamente después de la infestación de mosca blanca cuando los huevos son predominantes.

Delphastus catalinae (Horn) (Coleoptera: Coccinellidae) is a promising predator for biological control against whiteflies (Simmons & Legaspi 2004), especially under greenhouse conditions (Liu 2005). Development, survivorship and fecundity were studied in the laboratory against the silverleaf whitefly, *Bemisia argentifolii* Bellows and Perring (Homoptera: Aleyrodidae) (= *B. tabaci* Gennadius Biotype B) (Liu 2005). In that study, it was reported that mean adult longevity was

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146.6 d, net reproductive rate (R_0) was 276.8, gross reproductive rate (*GRR*) was 325.1, generation time (*T*) was 35.6 d, doubling time (*DT*) was 4.8 d and intrinsic rate of increase (r_m) was 0.158. These parameters suggest that the beetle is capable of regulating *B. argentifolii* and other whiteflies under greenhouse conditions (Liu 2005). In a previous study, Hoelmer et al. (1993) reported adult longevity of 60.5 d for females and 44.8 d for males of *D. pusillus* (LeConte) (= D. catalinae) at 28°C. Number of prey *B. argentifolii* consumed by adult predators decreased with prey age: 167.1 eggs or 11.6 early 4th instars per day. In an applied biological control program, *Delphastus* may persist without augmentation efforts only in large populations of *Bemisia* because of the need for large numbers of eggs in its diet (Hoelmer et al. 1993).

In laboratory studies with ornamental plants, predation efficacy of *D. catalinae* was compared against *Coleomegilla maculata lengi* Timberlake (Coccinellidae) feeding on the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) (Aleyrodidae) (Lucas et al. 2004). Adult and 4th instar *C. maculata* were more efficient predators of whitefly nymphs and eggs on glabrous fuchsia (*Fuchsia hybrida* Voss cv "Lena Corolla"). However, *D. catalinae* adults were more efficient on pubescent poinsettia plants (*Euphorbia pulcherrima* Willd ex Klotzch cv "Dark Red Annette Hegg"). In comparison with *Nephaspis oculatus* (Blatchley) (Coccinellidae), *D. catalinae* displayed faster rates of movement, but smaller searching areas in their larval stages when feeding on *B. argentifolii* on hibiscus (Liu & Stansly 1999). However, the adults searched in similar patterns and *D. catalinae* did so more quickly as compared with the other predators. *Nephaspis oculatus* also consumed prey more slowly. Furthermore, lower and higher temperature extremes for 24-h survival of both adult and immature *D. catalinae* were found to be about 0 and 40°C, respectively (Simmons & Legaspi 2004). At 25°C, adult *D. catalinae* can survive almost 6 mo at 25°C (50% survived 3.4 mo.); this has implications for commercial shipment and survival of mild winters (Simmons & Legaspi 2004). In exclusion cage experiments, *D. catalinae* caused 55% and a 67% decreases in densities of *B. argentifolii* in two field seasons (Heinz et al. 1999). However, open field evaluations on cotton showed no significant effects of releases of 3.5 or 5.5 *D. catalinae* beetles per plant.

In this study, we investigated the effects of cotton, vegetable and ornamental plant species on predation by *D. catalinae* on immature stages of *B. argentifolii*. We also determined preferences for different lifestages of whitefly prey.

Materials and Methods

Performance on Plant Species

Adult *Delphastus catalinae* of undetermined age and sex were starved before they were individually confined for 24 h in a 150-mm plastic Petri dish lined with filter paper. As a source of water, a damp cotton ball was placed in a small dish in the test arena. Dishes used for the predation study contained a circular leaf section of each plant species that was previously infested with *B. argentifolii*. When necessary, additional cuttings were added to present ≈50 whitefly nymphs and eggs per plant species. Leaf cuttings were glued on to a filter paper lining a dish (150 × 25 mm) and placed within the same dish. Five plant species were used: cotton (*Gossypium hirsutum* L. var "DP 458 B/R"®), tomato (*Lycopersicon esculentum* Miller cv "Burbank") (Pennington Seed Inc., Madison, GA), hibiscus (*Hibiscus rosa-sinensis* L.) (Espositos Nurseries, Tallahassee, FL), cowpea (*Vigna unguiculata* [L.] Walpers, cv "Mississippi Silver") (Cross Seed Company, Charleston, SC), and collard (*Brassica oleracea* ssp. *acephala* DC, cv "Georgian") (Cross Seed Company, Charleston, SC). Each Petri dish comprised one replicate; each treatment was replicated 10 times (treatments × replicates = 5 × 10). One adult predator was released in the center of each Petri dish and allowed to feed for 24 h. After the 24-h exposure, the predator was removed from each dish and the number of remaining eggs and nymphs were recorded. This experiment was conducted in a ThermoForma growth chamber (ThermoForma, Marietta, OH) maintained at 26°C, 60% RH and 14L: 10D photoperiod.

Host Stage Preference

Collard greens (cv "Georgian") were grown in pots containing MetroMix 200, (Scotts-Sierra Horticulture Products Co. Marysville, OH). A maximum of 4 leaves per potted plant were covered with an organza bag (16 cm × 20 cm) to prevent whitefly infestation. All other leaves were removed. Oviposition sites on the plant were restricted by securing only one leaf between two cardboard sheets (15 cm × 15 cm) and foam (1.27 cm). Ten circular holes were previously bored in the underside cardboard with a No. 10 cork borer. The cardboard was held in place with a 9-gauge wire frame and binder clips. The plant stem was covered with aluminum foil. The plants were placed in screened cages (61 × 61 × 61 cm). Approximately 200-300 adult whiteflies were released into each cage and allowed a 24-h oviposition period. Infestations were staggered to assure adequate numbers of each lifestage: eggs, small (1st-3rd instars) and large nymphs (4th-pupae) at the time of the experiment. Leaf cuttings containing ≈200 prey items of each stage were made with the cork borer and they were placed in a feeding arena (150 × 25 mm dish lined with filter paper). Each leaf cutting was glued to the filter paper to reduce wilting time. A single starved (8-h starvation period) adult *D. catalinae* was placed in the

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center of each arena and allowed 24 h to feed. Each dish was secured with a rubber band. After the 24-h exposure, the predators were removed and the numbers of remaining prey were recorded by lifestage (eggs, small and large nymphs). The experiment was replicated 10 times. These tests were conducted in a ThermoForma growth chamber under conditions described as above.

Data Analysis

Predation on different plant species was analyzed as a One-Way ANOVA on percentage of whitefly hosts eaten. Data were transformed by the arcsine transformation prior to analysis but are presented as untransformed means (Sokal & Rohlf 2003). Predation on different host stages was analyzed as a One-Way ANOVA on numbers of prey eaten. When treatment effects were significant, means were separated by Tukey's HSD (P = 0.05). All analyses were performed with Systat 10.2 (Systat Software Inc., Point Richmond, CA).

RESULTS AND DISCUSSION

Performance on Plant Species

The proportions of whitefly hosts consumed were significantly different among plant species (F = 25.22; df = 4, 45; P < 0.01; R^2 = 0.69). Predation was significantly highest on cotton, followed in rank order by collard, cowpea, tomato, and lowest on hibiscus and ranged from 98.6% to 46.1% (Fig. 1). Previous studies have shown that different plant species can have profound effects on predation rates. In *Serangium parcesetosum* Sicard (Coccinellidae) feeding on *B. argentifolii* (Legaspi et al. 1996), predation was highest on cucumbers, followed by tomato and cantaloupe, and lowest on hibiscus, which are similar to the results presented here. In the predatory stinkbug *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae) feeding on 4th instar *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae), attack rates were higher and handling times shorter on sweet pepper and eggplant, compared with tomato (De Clercq et al. 2000). Lower predator performance on tomato was attributed to the presence of glandular trichomes and allelochemicals (De Clercq et al. 2000). The architecture of host plant leaves may affect predation rates, such as that in the lady beetle *Propylea quatuordecimpunctata* (L.) (Coccinellidae) feeding on the Russian wheat aphid, *Diuraphis noxia* (Mordvilko) (Aphididae) (Messina & Hanks 1998). Lower predation rates on broad-leaved crested wheatgrass, *Agropyron desertorum* (Fisher ex Link) Schultes was attributed to the presence of refuges such as rolled leaves, compared with the slender-leaved Indian ricegrass, *Oryzopsis hymenoides* (Roemer & Schultes) Ricker (Messina et al. 1997). Moreover, predation rates may be af-

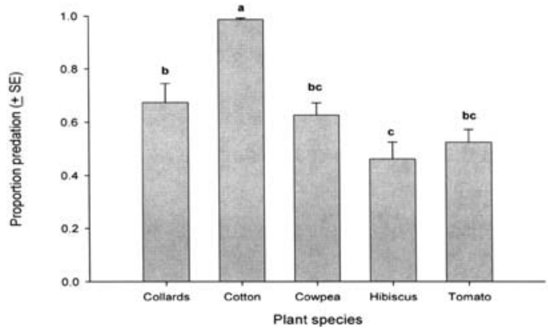

Fig. 1 Proportion of predation in 24 h (mean ± SE) by *Delphastus catalinae* on *Bemisia argentifolii* on different host plants. Bars with common letters are not significantly different (Tukey HSD; P = 0.05).

fected by interactions between different biotic and abiotic factors. In *Macrolophus pygmaeus* Rambur (Hemiptera: Miridae) feeding on green peach aphids, *Myzus persicae* (Sulzer) (Homoptera: Aphididae), predation rates were higher in darkness than in a light environment, and differences were more marked on pepper plants rather than eggplant (Perdikis et al. 2004).

Host Stage Preference

Total numbers of each host stage were not significantly different at the start of the experiment; about 200 prey items of eggs, small and large nymphs were presented to individual predators at the start of the feeding period (F = 0.029; df = 2, 27; P = 0.972; R^2 = 0.002), thereby permitting analysis on numbers of prey eaten (rather than percentages). Higher numbers of eggs were consumed in the 24-h predation period, compared with small or large nymphs (F = 84.933; df = 2, 27; P < 0.01; R^2 = 0.863) (Fig. 2). Predators are known to display different prey-preference responses when presented with various life stages of a prey. In some studies, adult prey was preferred over the egg stage. When eggs of Colorado potato beetle *Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae) and aphids (*M. persicae*) were presented to *C. maculata* in equal numbers, females did not prefer either prey at low densities, but preferred aphids at high densities (Hazzard & Ferro 1991). Other studies have shown preferences for the egg stage of prey. For example, the phoretic mite, *Macrocheles peregrinus* Krantz (Acari: Macrochelidae) feeding on the horn fly, *Haematobia irritans exigua* De Meijere (Diptera: Muscidae), showed a strong preference for eggs of other dipterans (Roth et al. 1988). *Coleomegilla maculata lengi* neonates displayed strong preferences for conspecific eggs, even in the presence of essential prey and benefited from such cannibalistic behavior (Gagne et al. 2002). When presented

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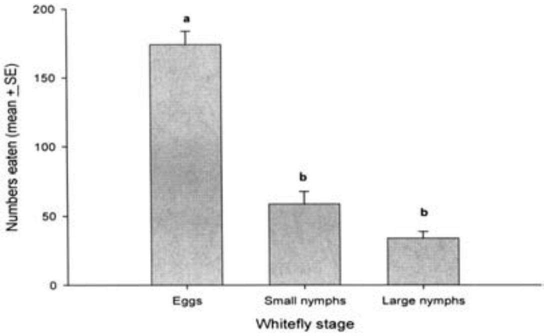

Fig. 2. Host stage preference by adult *Delphastus catalinae*. Mean numbers of whitefly prey eaten in 24 h. Bars with common letters are not significantly different (Tukey HSD; $P = 0.05$).

with a choice between younger or older eggs, *C. maculata lengi* larvae displayed preferences for younger eggs of *Trichoplusia ni* (Hübner) (Noctuidae) (Roger et al. 2001). Finally, lifestage preferences may change with predator specificity. Blackwood et al. (2001) tested 13 species of phytoseiid mites for preferences between eggs and larvae of the two-spotted spider mite, *Tetranychus urticae* Koch (Arachnida: Acari: Tetranychidae), and found that oligophagous, specialized spider mite predators generally displayed a preference for eggs, whereas more polyphagous, generalist predators showed no prey-stage preferences.

In this study, we found that the proportions of whitefly eggs and nymphs consumed were highest on the cotton disks, followed by collards, cowpea, and tomato, and lowest on hibiscus. The collard and cowpea had glabrous leaves while the leaves from the other plant species in this study had trichomes. Because this study was not performed with whole plants, the effects of leaf structure (e.g., trichomes, refuges) were not likely to be strong factors affecting predation rates. More likely is the possibility that *D. catalinae* responded differentially to volatile secondary compounds released by the plant leaf cuttings. *Delphastus catalinae* adults displayed a strong preference for *B. argentifolii* eggs followed by small, then large nymphs, despite their presence in equal numbers in the feeding arena. The data suggest that in an applied biological control context, *D. catalinae* adults are most likely to be effective against *B. argentifolii* in cotton and early in the season for other crops, or when the egg stage is most abundant.

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References Cited

Blackwood, J. S., P. Schausberger, and B. A. Croft. 2001. Prey-stage preference in generalist and specialist phytoseiid mites (Acari: Phytoseiidae) when offered *Tetranychus urticae* (Acari: Tetranychidae) eggs and larvae. Environ. Entomol. 30: 1103-1111.

De Clercq, P., J. Mohaghegh, and L. Tirry. 2000. Effect of host plant on the functional response of the predator *Podisus nigrispinus* (Heteroptera: Pentatomidae). Biol. Contr. 18: 65-70.

Gagne, I., D. Coderre, and Y. Mauffette. 2002. Egg cannibalism by *Coleomegilla maculata lengi* neonates: preference even in the presence of essential prey. Ecol. Entomol. 27: 285-291.

Hazzard, R. V., and D. N. Ferro. 1991. Feeding responses of adult *Coleomegilla maculata* (Coleoptera: Coccinellidae) to eggs of Colorado potato beetle (Coleoptera: Chrysomelidae) and green peach aphids (Homoptera: Aphididae). Environ Entomol. 20: 644-651.

Heinz, K. M., J. R. Brazzle, M. P. Parella, and C. H. Pickett. 1999. Field evaluations of augmentative releases of *Delphastus catalinae* (Horn) (Coleoptera: Coccinellidae) for suppression of *Bemisia argentifolii* Bellows & Perring (Homoptera: Aleyrodidae) infesting cotton. Biol. Contr. 16: 241-251.

Hoelmer, K. A., L. S. Osborne, and R. K. Yokomi. 1993. Reproduction and feeding behavior of *Delphastus pusillus* (Coleoptera: Coccinellidae), a predator of *Bemisia tabaci* (Homoptera: Aleyrodidae). J. Econ. Entomol. 86: 322-329.

Legaspi, J. C., B. C. Legaspi, Jr., R. K. Meagher, Jr., and M. A. Ciomperlik. 1996. Evaluation of *Serangium parcesetosum* (Coleoptera: Coccinellidae) as a biological control agent of the silverleaf whitefly (Homoptera: Aleyrodidae). Environ. Entomol. 25: 1421-1427.

Liu, T. X. 2005. Life history and life table analysis of the whitefly predator *Delphastus catalinae* (Coleoptera: Coccinellidae) on collards. Insect Sci. 12: 129-135.

Liu, T. X., and P. A. Stansly. 1999. Searching and feeding behavior of *Nephaspis oculatus* and *Delphastus catalinae* (Coleoptera: Coccinellidae), predators of *Bemisia argentifolii* (Homoptera: Aleyrodidae). Environ. Entomol. 28: 901-906.

Lucas, E., C. Labrecque, and D. Coderre. 2004. *Delphastus catalinae* and *Coleomegilla maculata lengi* (Coleoptera: Coccinellidae) as biological control agents of the greenhouse whitefly, *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae). Pest Mgmt. Sci. 60: 1073-1078.

Messina, F. J., and J. B. Hanks. 1998. Host plant alters the shape of the functional response of an aphid predator (Coleoptera: Coccinellidae). Environ. Entomol. 27: 1196-1202.

Messina, F. J., T. A. Jones, and D. C. Nielson. 1997. Host-plant effects on the efficacy of two predators attacking Russian wheat aphids (Homoptera: Aphididae). Environ. Entomol. 26: 1398-1404.

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PERDIKIS, D. C., D. P. LYKOURESSIS, AND L. P. ECONOMOU. 2004. Influence of light-dark phase, host plant, temperature, and their interactions on the predation rate in an insect predator. Environ. Entomol. 33: 1137-1144.

ROGER, C., D. CODERRE, C. VIGNEAULT, AND G. BOIVIN. 2001. Prey discrimination by a generalist coccinellid predator: effect of prey age or parasitism? Ecol. Entomol. 26: 163-172.

ROTH, J. P., A. MACQUEEN, AND D. E. BAY. 1988. Predation by the introduced phoretic mite, *Macrocheles peregrinus* (Acari: Macrochelidae), on the buffalo fly, *Haematobia irritans exigua* (Diptera: Muscidae), in Australia. Environ Entomol. 17: 603-607.

SIMMONS, A. M., AND J. C. LEGASPI. 2004. Survival and predation of *Delphastus catalinae* (Coleoptera: Coccinellidae), a predator of whiteflies (Homoptera: Aleyrodidae), after exposure to a range of constant temperatures. Environ. Entomol. 33: 839-843.

SOKAL, R. R., AND F. J. ROHLF. 2003. Biometry: The Principles and Practice of Statistics in Biological Research. W. H. Freeman, NY.

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