POPULATION DYNAMICS OF TWO SPECIES OF *GREENIDEA* (HEMIPTERA: APHIDIDAE) AND THEIR NATURAL ENEMIES ON *PSIDIUM GUAJAVA* (MYRTACEAE) AND *FICUS BENJAMINA* (MORACEAE) IN CENTRAL MEXICO

MANUEL DARÍO SALAS-ARAIZA[1], ROBERT W. JONES[2], ALEJANDRO PEÑA-VELASCO[1], OSCAR ALEJANDRO MARTÍNEZ-JAIME[1] AND EDUARDO SALAZAR-SOLÍS[1]
Departamento de Agronomía, División Ciencias de la Vida, Universidad de Guanajuato, Mexico
dariosalasaraiza@hotmail.co

Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro, Juriquilla, Queretaro, Mexico

ABSTRACT

Greenidea psiidi van der Goot and *Greenidea ficicola* Takahashi (Hemiptera: Aphididae), are Asiatic species that feed on guava, *Psidium guajava* and *Ficus* spp.; both of these aphids were reported as exotic pests in Florida in 2002 and in Mexico in 2003. The present study characterized the population dynamics of both aphid species and their natural enemies on guava and ornamental figs in the Bajio region of Central Mexico. This report represents the first record of *G. psiidi* on *Ficus* sp. in Mexico and the first report of the presence of both species in the state of Guanajuato. *Greenidea psiidi* and *G. ficicola* were detected on guava in Mar 2007 and on fig trees during the same year in Apr near Irapauto, Guanajuato. Populations of both alate and apterous forms of *G. psiidi* in Apr were greater on guava than on fig trees ($W = 119.0$; $P = 0.0122$), which coincided with new vegetative growth after leaf loss in winter on guava. In Apr populations of apterous forms of both species were significantly greater than winged forms on both guava and figs. No correlation was found between temperature changes and population densities of aphids. The indigenous predators, *Chrysoperla comanche* Banks, *Chrysoperla exotera* (Navás) and *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), fed readily on the aphids and were found on both guava and fig trees, although densities of all 3 species were in greater numbers on *Ficus*. The combined population densities of the 3 predators had a positive correlation with that of *G. ficicola* ($r = 0.74$), with a best fit found with a quadratic model of simple regression: y (densities of *Chrysoperla* spp.) = $1.2479x^2 - 4.3073x + 9.6493$, and $R^2 = 0.703$. Nine species of coccinelid beetles (Coleoptera: Coccinellidae) were identified, the most common being of the genus *Scymnus*. Results suggest that non-deciduous ornamental fig trees may serve as reservoirs of beneficial insects for deciduous guava trees. Results from the present study provide basic biological data to aid in management of these 2 exotic species of *Greenidea* on guava in central Mexico.

Key Words: guava, aphids, *Greenidea*, *Psidium guajava*, *Ficus benjamina*

RESUMEN

Greenidea psiidi van der Goot y *Greenidea ficicola* Takahashi (Hemiptera: Aphididae), son de origen asiático, en 2002 fueron reportados como plaga exótica en Florida y en México en 2003. En el presente estudio, se describe la dinámica poblacional de estas dos especies de áfidos y sus enemigos naturales en guayaba y *Ficus* en la región de El Bajío en el centro de México. Es el primer reporte de *G. psiidi* en *Ficus* spp. en México y el primer reporte de ambas especies en el estado de Guanajuato. *Greenidea psiidi* y *G. ficicola* fueron observadas en guayaba desde marzo y en *Ficus* desde mediados de abril, en el área de estudio. Las poblaciones de áfidos alados y ápteros de *G. psiidi* fueron más altas en abril en guayaba que en *Ficus* ($W = 119.0$; $P = 0.0122$), esto coincide con los nuevos brotes después de que el árbol de guayaba pierde las hojas. Las poblaciones de las formas ápteras de ambas especies fueron significativamente mayores que las formas aladas tanto en guayaba como en *Ficus*. No se encontró correlación entre la temperatura y las poblaciones de áfidos. Los enemigos naturales *Chrysoperla comanche* Banks, *Chrysoperla exotera* (Návas) y *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), se alimentan de estos áfidos y fueron encontrados tanto en guayaba como en *Ficus*, aunque la densidad de las tres especies fueron más altas en *Ficus*. Las poblaciones combinadas de las tres especies de depredadores presentaron una correlación positiva con la especie *G. ficicola* ($r = 0.74$), lo cual se explica con la ecuación cuadrática de regresión simple: y (densidades de *Chrysoperla* spp.) = $1.2479x^2 - 4.3073x + 9.6493$, donde el coeficiente $R^2 = 0.703$. Se identificaron nueve especies de Coccinellidae, siendo el más común el género *Scymnus*. Estos resultados sugieren que los árboles de *Ficus* cuyo follaje es perenne, puede servir como refugio de insectos benéficos para los árboles de guayaba, cuyo há-

bito es caducifolio. Los resultados de esta investigación aportarán conocimientos sobre la biología de estas especies exóticas de áfidos lo que ayudará en el manejo de la plaga en huertas de guayaba en la región central de México.

Translation provided by the authors.

Mexico contributes 25% of the world production of guava (*Psidium guajava* L.; Myrtaceae), of which the states of Michoacan, Aguascalientes, and Zacatecas of the central Altiplano region are the principal producers (González-Gaona et al. 2002). In 2008, the exotic aphid pests, *Greenidea psidii* van der Goot and *Greenidea ficicola* Takahashi were observed on guava and ornamental fig trees, *Ficus benjamina* (L.), in the central Altiplano state of Guanajuato (Salas-Araiza, unpublished data). There is concern among producers and agricultural researchers of central Mexico that these new pests may pose a threat to guava production in Mexico.

The genus *Greenidea* Schouteden belongs to the subfamily Greenideinae within the Aphididae and includes approximately 45 species (Pérez Hidalgo et al. 2009). The natural distribution of the genus is Asiatic and species are found to favor young foliage of plants of the families, Fagaceae, Betulaceae, Juglandaceae, Myrtaceae, Rosaceae, and Rubiaceae (Blackman & Eastop 1994). The presence of *Greenidea* in the New World may be the result of importation of infested ornamental fig trees which are widely commercialized throughout the world, and they have been implicated as vehicles for the introduction of exotic pests (O'Donnell & Parrella 2005).

Greenidea psidii was first discovered in the New World in1916 on guava and its relative, *Psidium cattleianum* Sabine in Brazil (Noemberg-Lazzari et al. 2006). Halbert (2004) reported that *G. ficicola* was collected in Florida in 2002, and together with *G. psidii* were found to feed on guava and ornamental fig trees (*Ficus benjamina* (L.)). Pérez Hidalgo et al. 2009 reported the presence of *G. psidii* in Costa Rica in 2009. The first reports of *Greenidea* in Mexico come from Peña-Martínez et al. (2003), who recorded *G. psidii* feeding on guava in the states of Hidalgo, Morelos, Guerrero, and the Federal District, and *G. ficicola* feeding on ornamental fig trees in the state of Guanajuato, Mexico. Trejo-Loyo et al. (2004) reported *G. ficicola* occurs on Myrtaceae in Cuernavaca, Morelos. Although further data is lacking, it is probable that both *G. psidii* and *G. ficicola* are widely distributed in Mexico.

The biology of species of *Greenidea* on guava and other host plants is poorly known (Halbert 2004; Sousa-Silva et al. 2005; Noemberg-Lazzari et al. 2006). Northfield et al. (2008) noted that many insect pests feed on alternative host plants and that the understanding of the relationships of pest populations on wild hosts with those on cultivated hosts is crucial in the development of management strategies. The objective of the present study was to determine the population dynamics of *Greenidea psidii*, *G. ficicola* and their natural enemies on *Psidium guajava* and *Ficus benjamina* in the state of Guanajuato, Mexico. The data generated from this study will help evaluate the importance of these aphids within the pest complex attacking guava in the Bajío Region, as well as aid in the development of integrated pest management strategies.

Materials and Methods

The study site was conducted at the experimental field station of the Division of Life Sciences of the University of Guanajuato at the Ex-Hacienda El Copal (101°01'01"N, 20°49'49"O) at 1,750 masl in the municipality of Irapuato, Guanajuato, Mexico. The region has a mean annual precipitation of 750 mm, a mean temperature of 19°C and mean relative humidity of 56% (INEGI 2009). Two orchards, 1 guava (*P. guajava*), and the other ornamental figs, (*F. benjamina*) were chosen for the study sites.

All trees were 10 years old and the 2 orchards were separated by approximately 1 km. Weekly samples were made of aphids (alate and apterous forms) and predators (adults of Coccinellidae and larvae of Chrysopidae) from 10 trees of each host species. For each tree, samples consisted of 20 beats of a 1-m wooden rod on the branches of the trees, from which insects fell onto a 1-m^2 beating sheet. All insects on the sheet were collected and placed in a labeled vial with 70% alcohol. The sample period was from 23 Mar to 22 Jun 2007 which corresponded to the early spring growth period of leaves of guava and to the reproductive activity of aphids. Samples were not taken on subsequent dates because aphids had ceased reproductive growth and individuals were virtually undetectable. All material from each tree was preserved in individual vials containing 70% alcohol, with a corresponding label and brought to the laboratory.

The collected specimens were identified in the Entomology Laboratory of University of Guanajuato, with a compound and stereo microscope. Aphids were mounted for species determination following techniques given by Peña-Martínez (1995). The keys of Blackman & Eastop (1994, 2000) were used for species identification of aphids. For the neuropteran and coccinellid predators, the keys of López-Arroyo et al. (2008) and Gordon (1985) were used, respectively. Meteoro-

logical data was obtained from a weather station maintained at the study site located 200 m from the orchards. All identified specimens were deposited in the Entomological Collection "Leopoldo Tinoco Corona" of the University of Guanajuato.

Data were analyzed with the statistical software program SAS (SAS 1995). Abundance measures were calculated for *G. psiidi and G. ficicola* and the various predator species on guava and figs. Due to non-linearity of data determined by the Shapiro-Wilks test, mean comparisons of aphid and predator numbers between hosts and among samples dates were made with Mann-Whitney non-parametric procedures. In addition, correlation analyses were conducted between population numbers of aphids with those of the various predators and also with climatic variables (temperature and precipitation).

Results and Discussion

Species of *Greenidea* in Guava and Figs

Both *G. psidii* and *G. ficicola* were present on guava and the ornamental fig, *F. benjamina* (Figs. 1, A, B, C). This is the first report of *G. psiidi* on the widely planted *F. benjamina* from Mexico, and for this species for the state of Guanajuato. Although the habitual host for *G. ficicola* is *Ficus* spp. (Noemberg-Lazzari et al. 2006), Halbert (2004) reports that this aphid species also occurs on guava, as confirmed in the present study. Although the apparent habitual hosts of *G. psidii* is guava, and that of *G. ficicola* is *Ficus* spp., it is unclear how populations on the habitual and other infrequent host plants interact and which of the infrequent hosts can maintain viable, reproductive populations in the absence of the habitual host plants.

Both species of *Greenidea* were aggregated on new shoots and leaves of their hosts, a feeding preference previously reported by Pérez Hidalgo et al. (2009). On guava, *G. psiidi* and *G. ficicola* were present on new leaf buds and on either side of young leaves, whereas on *F. benjamina* they were found principally on the underside of young leaves. The preference by aphids for new plant growth is a common behavior in aphids. Gould et al. (2007) state that certain stages of aphids have preferences for specific tissues of host plants. For example, *Chaitophorus populicola* Thomas, preferably feeds on new growth with diverse and high levels of amino acids. These authors also note that high sugar levels and low amino acid concentration in leaves increases the production of winged individuals.

Population Dynamics of *Greenidea psidii* and *Greenidea ficicola*

Both *G. psiidi* and *G. ficicola* were first recorded on guava trees in late Mar 2007, although the abundance of *G. psiidi* was notably greater during Mar and early Apr. This appearance and population growth coincided with the emergence of new shoots and leaves on guava, the timing of which corresponds to that described by Damián-Nava et al. (2004). Colonizing alate aphids are often attracted to specific volatiles of host plants (Chapman et al. 1981; Nottingham et al. 1991; Powell & Hardie 2001). Because *G. psiidi* and *G. ficicola* are found initially on young shoots and leaves, it is probable that initial alate colonizers are attracted to volatiles associated with new growth of guava plants.

It important to note that the 2 tree species studied have marked differences in leafing patterns and the appearance of new growth. Guava is deciduous, with complete leaf loss occurring generally in Nov with new growth beginning in Mar in the study area. This is in contrast to *F. benjamina* which is a non-deciduous tree that produces new growth apparently in response to environmental factors. However, both *G. psiidi* and *G. ficicola* appeared first on guava, and then on *F. benjamina* (Fig. 1, A, B, C), although foliage was available on the latter host throughout winter months. These data suggest that *G. psiidi* and *G. ficicola* first colonize and establish on guava and then later move to *F. benjamina*. This behavior was expected for *G. psiidi* for which guava is considered a habitual host, but not for *G. ficicola* which *Ficus* is considered the habitual host. Further study is needed to establish the initial colonization behavior of these 2 species and whether the behaviors are the result of greater attractiveness of guava in comparison to *F. benjamina* and/or the leaf quality of *F. benjamina* is inadequate until late Apr.

The peak abundance of both species (alate and apterous forms) occurred in mid and late Apr (7.5 and 6.0 aphids/sample, for *G. psiidi* and *G. ficicola*, respectively) (Fig. 1, A, B). The densities of *G. psiidi* were greater on guava than on *F. benjamina* during the first 5 sample periods, and significantly so at peak densities during the third week of Apr ($w = 119.0$; $P = 0.0122$; Fig. 1, A).

By mid May, densities of *G. psiidi* and *G. ficicola* were barely detectable, and remained at very low densities through late Jun. These low densities are presumably the result of the maturation of leaves and the deterioration of the physical and nutritional requirements for these species (Fig. 2, A).

The appearance and abundance of alate forms in relation to apterous forms of *G. psiidi* and *G. ficicola* followed patterns expected from observations reported by Noemberg-Lazzari et al. (2006). Alates were found in very low numbers initially on both guava and *F. benjamina* and differences between the 2 forms were not significantly different until the third week of Apr (Fig. 2, B, C). At that time, the abundance of apterous forms in-

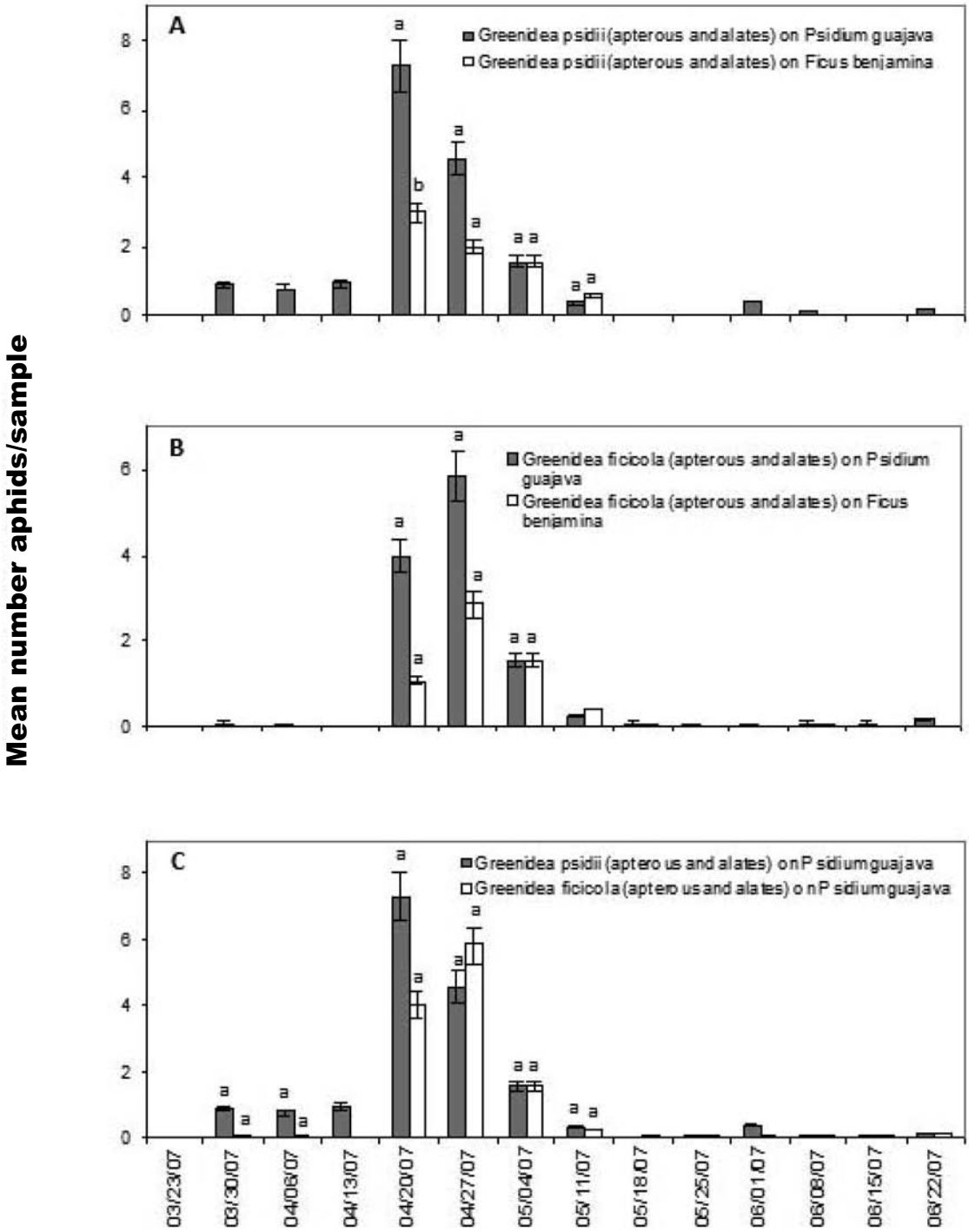

Fig. 1. Population dynamics of apterous and alate forms of *Greenidea* on 14 samples dates in Irapuato, Guanajuato, México. Means with the same letter not significantly different based on Mann-Whitney non parametric test (**A:** 04/20/07, w = 119.0, P =0.0122).

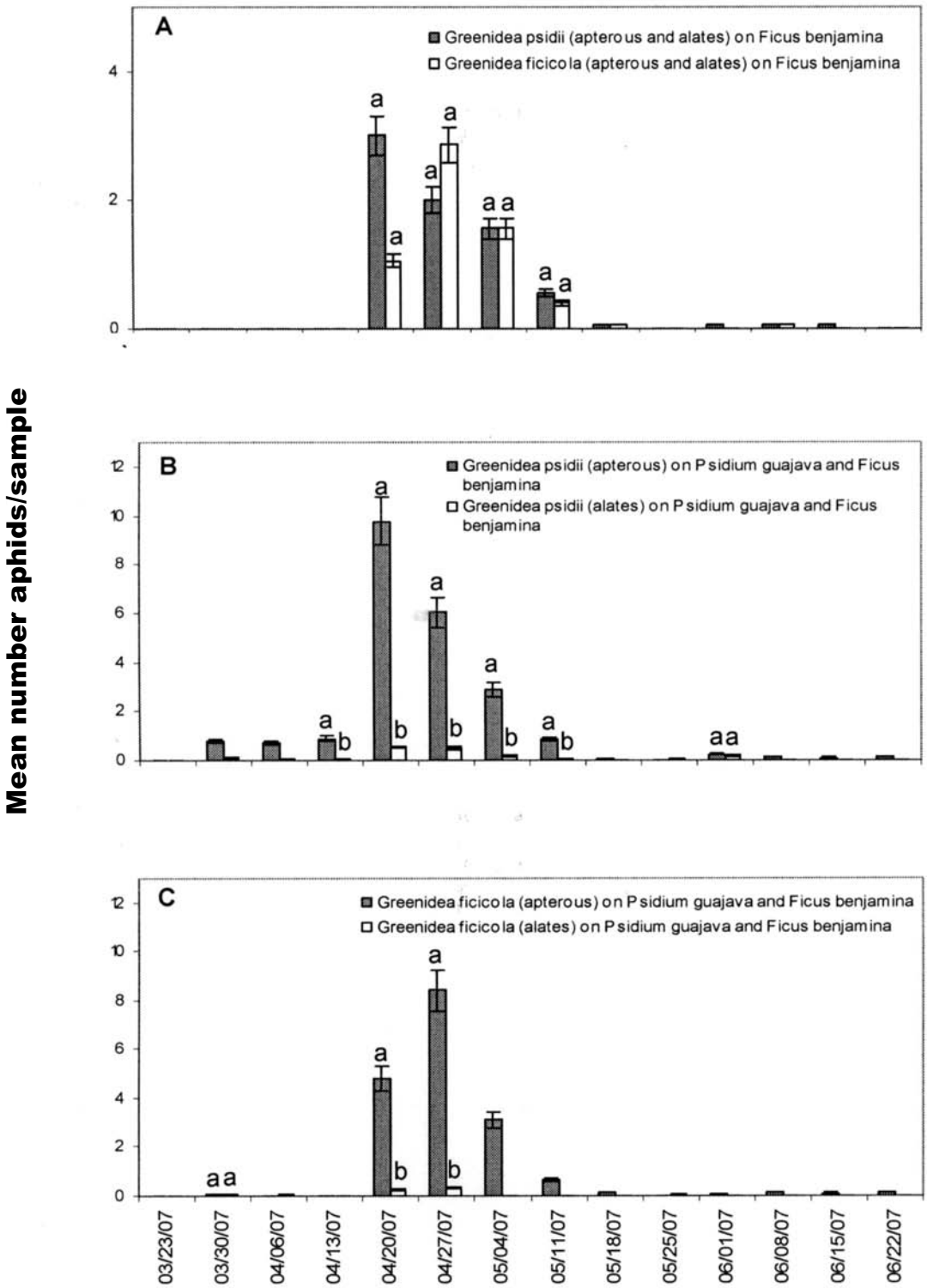

Fig. 2. Population dynamics of apterous and alate forms of *Greenidea* on 14 samples dates in Irapuato, Guanajuato, Mexico. 2007. Means with same letter not significantly different based on Mann-Whitney non parametric test (**B:** 04/13/07, w = 138.5, P = 0.0179; 04/20/07, w = 100.5, P = 0.002; 04/27/07, w = 35.0, P = < 0.001; 05/04/07, w = 88.0, P = < 0.0003; 05/11/07, w = 118.0, P = 0.0037; **C:** 04/20/07, w =127.5, P = 0.016; 04/27/07, w = 17, P = < 0.0001).

creased considerably (16-18 fold) for both species. Significant differences between the abundance of alate and apterous forms of *G. psiidi* on guava and *F. benjamina* were found from mid Apr through mid May (Fig. 2, B). Alate forms were also most abundant during this period, and continued to be found into Jun. It is assumed that many of these alate individuals dispersed from guava and *F. benjamina* when leaf and shoot quality declined after Apr. No correlation was found between the mean ambient temperature nor mean precipitation with the population changes of *G. psiidi* and *G. ficicola* on guava and *F. benjamina* (r = 0.15 for temperature; r = -0.21 for precipitation for *G. psidii*; r =0.16 for temperature; and r = -0.18 for precipitation for *G. ficicola*), This was expected given that there was little change in either temperature or precipitation during the sample period (Fig. 3). Even with greater temperature variation, however, little correlation would be expected given that temperature is often not a principal factor in aphid population growth. For example, Desneux et al. (2006) reported that temperature was not positively correlated with population densities of *Aphis glycines* Matsumura on soybeans**,** and some species, such as *Schizaphis graminum* (Rondan) on wheat produce more nymphs at lower temperatures (Pendleton et al. 2009). Differences in precipitation also were probably not an important factor in the changes in populations that were observed because the only noteworthy change in precipitation occurred between the last two samples. Although precipitation has been observed to physically dislodge aphids from plants and increase infection by pathogens (Nielson & Barnes 1961), in our study precipitation occurred primarily in Jun, and thus well after populations had already declined in late May. It could be argued that the life cycle of *G. psiidi* and *G. ficicola* is adapted to avoid the unfavorable effects of the seasonal rains by completing their life cycle during the dry season. However, Noemberg-Lazzari et al. (2006) reported that in Brazil both species are present year round (*G. psiidi* on guava and *G. ficicola* on *Ficus* sp.), suggesting that the life cycle of the 2 insects is facultative and probably dependant more on host quality than on specific seasonal variations in climate.

Natural Enemies

Chrysopidae. Three species of Chrysopidae (Neuroptera) were identified on guava and *F. benjamina*: (1) *Chrysoperla comanche* (Banks), (2) *Chrysoperla exotera* (Návas), and (3) *Chrysoperla carnea* (Stephens). The most abundant species was *C. comanche* and the present work represents the first report of this species for the state of Guanajuato. This chrysopid is cited by Ramírez-Delgado et al. (2006) as the predominant species in pecans and grapes in the states of Coahuila and Durango, suggesting that it is one of the most important aphid predators of the central highlands of northern Mexico.

The combined populations of the 3 species of *Chrysoperla* were present from 20 Apr 2007 to 15 Jun 2007 in guava and ficus. *Chrysoperla* was first recorded on *F. benjamina* on 20 Apr of 2007 (Fig. 4, A). In both guava and *F. benjamina,* an increase of individuals of *Chrysoperla* spp. coincided with an apparent increase in the populations of the apterous forms for both aphid species on 20 Apr 2007 (Fig. 1, A, B, C). Populations of the

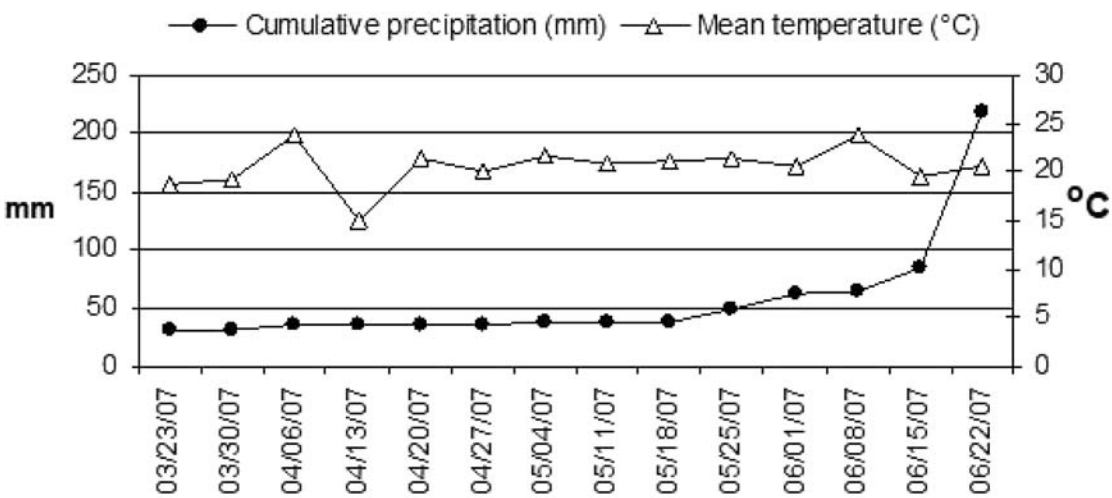

Fig. 3. Mean temperature (°C) and cumulative precipitation (mm) at El Copal, Irapuato, Guanajuato, México, 2007.

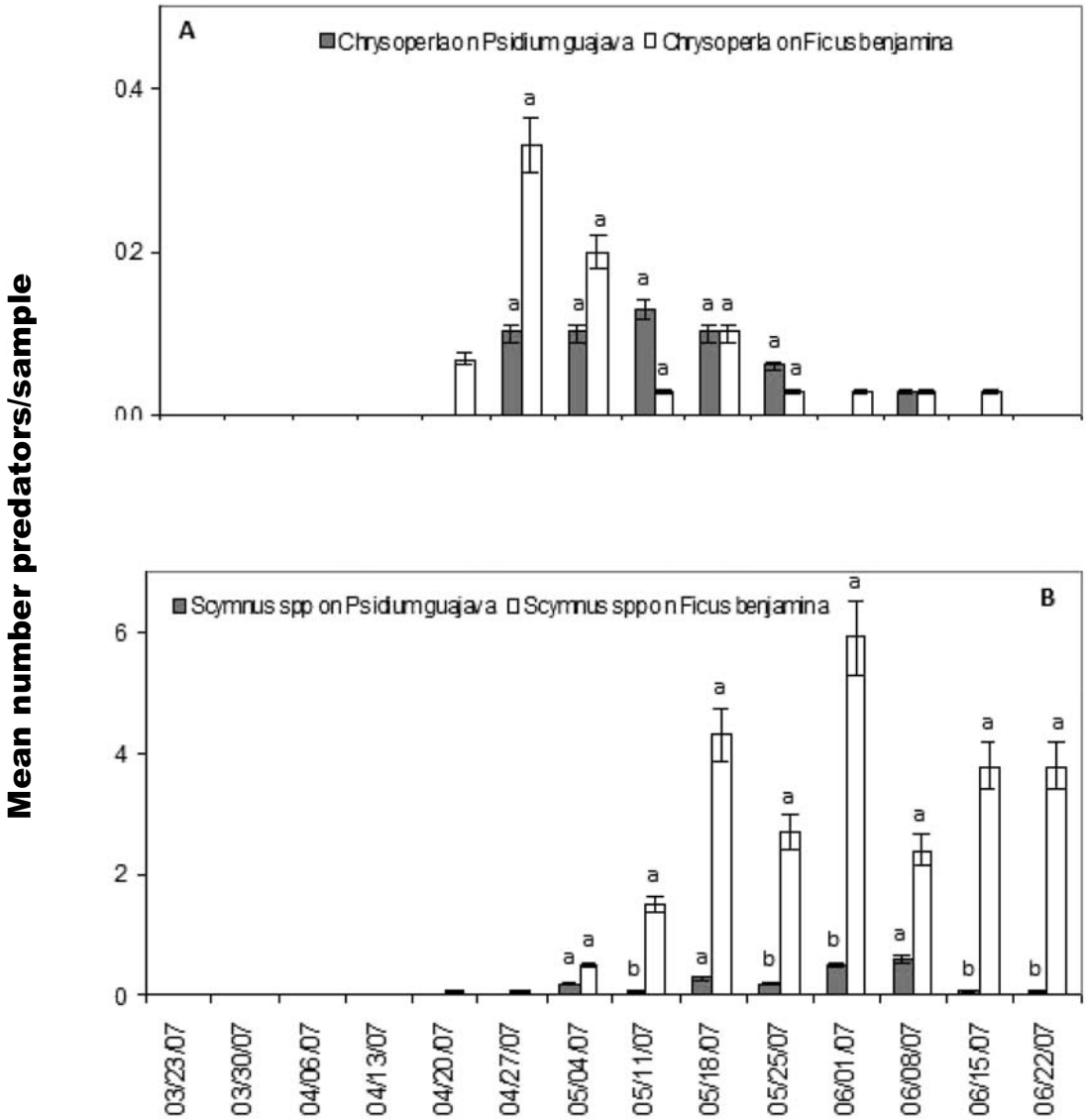

Fig. 4. Population dynamics of the combined totals of 3 species of *Chrysoperla* and S*cymnus* spp on 14 sample dates in Irapuato, Guanajuato, Mexico. 2007. Means with the same letter are not significantly different based on the Mann-Whitney non parametric test (**B:** 05/11/07, w =77.5, P = 0.016; 05/25/07, w = 92.0, P = < 0.001; 06/01/07, w = 95.0, P = < 0.001; 06/15/07, w = 83.0, P = < 0.006; 06/22/07, w = 83.0, P = < 0.006).

combined densities of *Chrysoperla* spp. peaked first on *F. benjamina* on 27 Apr 2007 (0.32 individuals/sample) and later on guava on 11 May 2007 (0.15 individuals/sample). Densities of these predators gradually decreased from mid-May to mid Jun.

Combined populations of the 3 species of *Chrysoperla* were positively correlated with populations of *G. ficicola* (r = 0.74) on guava and *F. benjamina* and the relationship defined by y (densities of *Chrysoperla* spp.) = $1.2479x^2 - 4.3073x + 9.6493$, grade 2 polynomial with R^2 = 0.703 (Fig. 5). This suggests that there was a numerical response in the populations of *Chrysoperla* species in conjunction with density changes in *G. ficicola*. There was no apparent correlation found between populations of *G. psiidi* with *Chrysoperla* on either guava or *F. benjamina*.

Coccinellidae. Species of Coccinellidae (Coleoptera) on guava and *F. benjamina* were: *Hippo-*

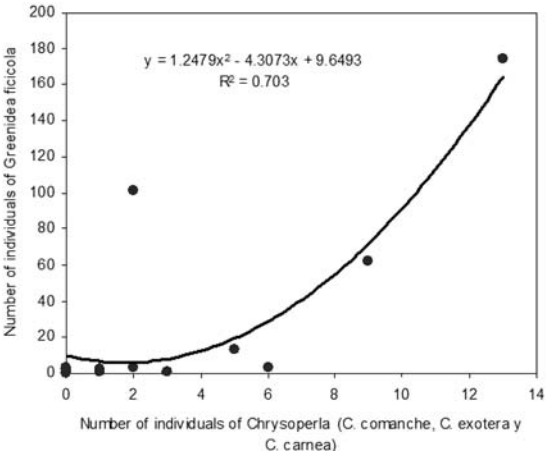

Fig. 5. Correlation and simple regression model between number of individuals of *Greenidea ficicola* and number of individuals of 3 species of *Chrysoperla* on 14 sample dates in Irapuato, Guanajuato, México, 2007.

damia convergens Guérin-Méneville, *Harmonia axyridis* Pallas, *Zoglobra* spp., *Coccinella* spp., *Olla v-nigrum* (Mulsant), *Cycloneda sanguinea* L., *Stethorus* spp., *Hyperaspis quadrioculata* (Motschulsky), and *Scymnus* spp. On *F. benjamina*, *Scymnus* spp. were the most abundant with 167 total individuals found compared with 126 captured in guava. Individuals of *Scymnus* spp. first appeared in *F. benjamina* on 20 Apr 2007 and began increasing by 11 May 2007, reaching a maximum abundance on 1 Jun 2007 of approximately 6 individuals/sample and maintained densities of 2.5-4 individuals/sample until the end of the sample period. The overall population densities of *Scymnus* spp. was higher on *F. benjamina* than on guava (11.9 *vs* 9 individuals/sample, respectively), and on 5 of the 10 sample dates, and these predators had significantly higher densities on *F. benjamina* than on guava (Fig. 4, B). Results suggest that other prey present on *F. benjamina* were more important in maintaining *Scymnus* spp. than the *Greenidea* species because these predators appeared after major populations peaks of *Greenidea*, and increased after mid-May in the virtual absence of these aphids.

Aphid mummies were not observed in the present study and there are no reports of parasitism of *Greenidea* suggesting that predators are the principal insect biological control agents of *Greenideae* in the region. Although *F. benjamina* was a host plant of *Greenidea,* both aphid species were found first on guava, and then reached higher densities on guava than on *F. benjamina*. However, following aphid colonization, chrysopid and coccinelid predators developed greater densities on *F. benjamina.* These data suggest that *F. benjamina* is more important as a refuge for natural enemies of the pest aphids in the region, than as an alternative host plant from which *Greenidea* colonizes guava. The movement of predators from one host to another is well documented, in particular for aphidophagous generalists such as chrysopids and coccinellids (Sloggett et al. 2008).

The following study lays the groundwork for the management of *Greenidea psidii* and *G. fisicola* in guava in the region. Indigenous predators were found to readily feed on *G. psiidi* and *G. ficicola* and are apparently an important component in reducing densities of the pests. Further work is needed to study in detail the colonization behavior of *G. psiidi* and *G. ficicola* in relation to guava and other hosts, and to investigate methods to optimize the action of native predators on these aphids.

Referenced Cited

Blackman, R. L., and Eastop, V. F.1994. Aphids on the World's Trees. An Identification and Information Guide. CAB International, Oxon. 8+988 pp and 16 plates

Blackman, R. L., and Eastop, V. F. 2000. Aphids on the World's Crops: An Identification Guide. John Wiley & Sons. New York. 466 pp.

Chapman, R. F., Bernays, E. A., and Simpson, S. J. 1981. Attraction and repulsion of the aphids *Cavariella aegopodii,* by plant odors. J. Chem. Ecol. 7: 881-889.

Damián-Nava, A., González-Hernández, V. A., Sánchez-García, P., Peña-Valdivia, C. B., Livera-muñoz, M., and Brito-Guadarrama, T. 2004. Crecimiento y fenología del guayabo (*Psidium guajava* L.) cv. "Media China" en Iguala, Guerrero. Rev. Fitotec. Mexicana 27(4): 349-358.

Desneux. N., O'Neil. R. J., and Yoo, H. J. S. 2006. Suppression of population growth of the soybean aphid, *Aphis glycines* Matsumura, by predators: The identification of key predators and the effects of prey dispersion, predators abundance, and temperature. Environ. Entomol. 35(5): 1342-1349.

Gordon, R. D. 1985. The Coccinellidae (Coleoptera) of America North of Mexico. J. New York Entomol. Soc. 93(1): 1-912

Gould, G. G., Jones, C. G., Rifleman, P., Pérez, A., and Coleman, J. S. 2007. Variation in eastern cottonwood (*Populus deltoides* Bartr.) phloem sap content caused by leaf development may affect feeding site selection behavior of the aphid, *Chaitophorus populicola* Thomas (Homoptera: Aphididae). Environ. Entomol. 36(5): 1212-1225.

Halbert, S. E. 2004. The genus *Greenidea* (Rhynchota: Aphididae) in the United States. Florida Entomol. 87(2): 159-163.

INEGI. 2009. Instituto Nacional de Estadística Geografía e Informática. Información Geográfica. Mapa de Climas. (3 January 2009) (http://mapaserver.inegi.org.mx/geografía/español/ estados/gto/clim.cfm?c=444&e=07)

López-Arroyo, J. I., De León-Hernández, T., Ramírez-Delgado, M., and Loera-Gallardo, J. 2008. Especies de *Chrysoperla* (Neuroptera:

Chrysopidae) presentes en México, pp. 69-80 *In* M. D. Salas-Araiza y E. Salazar-Solís [eds.], Entomófagos en el Control de Plagas Agrícolas en México. Primera Edición. Universidad de Guanajuato, Guanajuato. Gto. 90 pp.

NIELSON, M. W., AND BARNES, O. L. 1961. Population studies of the spotted alfalfa aphid Arizona in relation to temperature and rainfall. Ann. Entomol. Soc. America. 54(3): 441-448.

NOEMBERG-LAZZARI, S. M., ZONTA-DE CARVALHO, R. C., CARDOSO, J. T., AND CALADO, D. C. 2006. First record of *Greenidea psidii* van der Goot and comparison with *Greenidea ficicola* Takahashi (Hemiptera: Aphididae) in Brazil. Zootaxa 1235: 63-68.

NORTHFIELD, T. B., PAINI, D. R., FUNDERBURK, J. E., AND REITZ, S. R. 2008. Annual cycles of *Frankliniella* spp. (Thysanoptera: Thripidae) thrips abundance on North Florida uncultivated reproductive hosts: predicting possible sources of pest outbreaks. Ann. Entomol. Soc. America 101(4): 769-778.

NOTTINGHAM, S. F., HARDIE, J., DAWSON, G. W., HICK, A. J., PICKETT, J. A., WADHAMS, L. J., AND WOODCOCK, C. M. 1991. Behavioral and electrophysiological responses of aphids to host and nonhost plant volatiles. J. Chem. Ecol. 17: 1231-1242

O'DONNELL, CH. A., AND PARRELLA, M. P. 2005. Host suitability of selected *Ficus* species for *Thrips palmi* (Thysanoptera: Tripidae). Florida Entomol. 88(1): 97-98.

PADILLA-RAMÍREZ, J. S., GONZÁLEZ-GAONA, E., REYES-MURO, L., AND MAYEK-PÉREZ, N. 2007. Producción de fruto e índices productivos en árboles de guayabo. Agric. Téc. México 33(2): 191-196.

PENDELTON, B. B., PALOUSEK COPELAND, A. L., AND MICHELS, JR., G. J. 2009. Effect of biotype and temperature on fitness of greenbug (Hemiptera: Aphididae) on sorghum. J. Econ. Entomol. 102(4): 1624-1627.

PEÑA MARTÍNEZ, R. 1995. Colecta y montaje de áfidos (Homoptera: Aphididae). Curador Entomológico y Acarológico No. 2:9-14.

PEÑA-MARTÍNEZ, R., VILLEGAS-JIMÉNEZ, N., REYES-BARRÓN, L., PADILLA-BADILLO, G., AND HALBERT, S. 2003. Dos nuevas plagas potenciales en México (Homoptera: Aphididae: Grenideinae). Entomología Mexicana 3: 411-415.

PÉREZ HIDALGO, N., VILLALOBOS-MULLER, W., AND MIER-DURANTE, P. 2009. *Greenidea psidii* (Hemiptera: Aphididae: Greenideinae) new invasive aphid in Costa Rica. Florida Entomol. 92(2): 396-398.

POWELL, G., AND HARDIE, J. 2001. The chemical ecology of aphid host alternation: How do return migrants find the primary host plant? Appl. Entomol. Zool. 36: 259-267.

RAMÍREZ-DELGADO, M., LÓPEZ-ARROYO, J. I., NAVA-CANBEROS, U., GONZÁLEZ-HERNÁNDEZ, A., AND MERCADO-HERNÁNDEZ, R. 2006. Diversidad y fluctuación poblacional de especies de Chrysopidae en frutales del norte de México. Entomología Mexicana 5 (1): 480-485.

SAS. 1995. User's guide for linear models. SAS Institute Inc. Cary, North Carolina.

SLOGGETT, J. J., ZEILSTRA, I., AND OBRYCKI, J. J. 2008. Patch residence by aphidophagous ladybird beetles: Do specialists stay longer? Biol. Control 47: 199-206.

SOUSA-SILVA, C. R., BROMBAL, J. C., AND ILHARCO, F. A. 2005. *Greenidea ficicola* Takahashi (Hemiptera: Greenideidae), a new aphid in Brazil. Neotrop. Entomol. 34(6): 1023-12024.

TREJO-LOYO, A. G., PEÑA-MARTÍNEZ, R. AND VILLEGAS-JIMÉNEZ, N. 2004. Afidofauna (Hemiptera: Aphididae) de Cuernavaca, Morelos, México. Folia Entomol. Mexicana 43(2): 191-202.