New Record of Predation on Adult Diaprepes abbreviatus (Coleoptera: Curculionidae) by Euthyrhynchus floridanus and Podisus maculiventris (Heteroptera: Pentatomidae)

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NEW RECORD OF PREDATION ON ADULT *DIAPREPES ABBREVIATUS* (COLEOPTERA: CURCULIONIDAE) BY *EUTHYRHYNCHUS FLORIDANUS* AND *PODISUS MACULIVENTRIS* (HETEROPTERA: PENTATOMIDAE)

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Diaprepes root weevil or citrus weevil, *Diaprepes abbreviatus* (L.) (Coleoptera: Curculionidae), a native of the Caribbean (Martorell 1976; Wolcott & French 1936), is an important pest of citrus, sugarcane, ornamentals and other crops in Florida (Peña & Amalin 2011). It was first reported in Florida in 1964 in Orange County (Woodruff 1968), and since has spread throughout southern and central Florida. It is estimated that citrus root weevil is responsible for more than US$ 70 million in damage to at least 40,000 ha of citrus groves in Florida (Weissling et al. 2012). This weevil is relatively large with adults ranging from 10 to 20 mm in length. There are several morphotypes with yellow or orange stripes on a black background on the elytra. In 2000, the citrus root weevil was found in a citrus grove in the Rio Grande Valley of Texas (Skaria & French 2001), where it quickly became established. This insect was first found in Orange and Los Angeles counties, California in 2005 and in fall 2006 in San Diego County. Efforts to eradicate the citrus weevil in California were unsuccessful and it is currently established in several counties presenting a high risk of spreading further (Jetter & Godfrey 2009). In its native range in the Caribbean islands, it is one of the most important crop pests, feeding on many hosts (more than 290 plant species in 59 families) including citrus, legumes, vegetables, corn, sorghum and several weeds (Simpson et al. 1996). The most significant damage is caused by the larvae feeding on the roots of host plants. Females have a great reproductive potential laying an average of 5,000 eggs during a lifetime of approximately 5 months (Wolcott & French 1936). Females lay a cluster of 30 to 264 eggs on the leaves. Larvae emerge after 7 to 10 days, crawl around for 24-48 h and then drop from the leaves to the ground to search for fine, fibrous roots, switching to larger roots as they mature. These beetles can have as many as 11 instars or as few as 6 which develop over 8 to 15 months. Typically the third to ninth instars are the most active feeders. The total life cycle of *D. abbreviatus* ranges from less than 1 yr to about 2 yr (Wolcott & French 1936). Larval feeding girdles the root crown area stunting growth and sometimes killing the plant. Adult citrus weevils feeding on young tender leaves produces notches similar to the feeding damage caused by other weevil species or grasshoppers but it is not as damaging as the larval root feeding.

Management tactics for *D. abbreviatus* in Florida are based mostly on chemical methods (McCoy et al. 2000; Bullock et al. 1988), plant resistance (Lapointe & Bowman 2002), entomopathogenic nematodes (Duncan et al. 2000; McCoy et al. 1995; Schroeder 1990) and use of egg and larval parasitoids (Peña & Amalin 2011; Peña et al. 1998; Sutton et al. 1972). However, no attempts have been made to use predatory insects in an IPM program for citrus root weevil (Peña & Amalin 2011). Control of the larval stages of the citrus root weevil using naturally occurring or commercially available entopathogenic nematodes has been relatively successful in sandy soils. The nematodes are less effective in heavier clay and loam soils than in sandy soil conditions (Duncan & Stelinski 2013; Hall et al. 2001). Studies were conducted at the UF-Citrus Research and Education Center in Lake Alfred, Florida, to determine 'induced response' by citrus trees to root feeding damage by citrus root weevil larvae. The use of synthetic attractants in the field to enhance suitable habitat conditions (sandy soils) to attract beneficial nematodes in response to insect attack showed great potential as part of an IPM program (Duncan & Stelenski 2013). Several parasitoids have been introduced and released in Florida by state and federal agencies. *Quadrastichus haitiensis* Grahan (Hymenoptera: Eulophidae), introduced from Puerto Rico, is one of the first egg-parasitoids released (more than 160,000 specimens since 1998) in untreated citrus groves in central and south areas. This parasitoid got successful established and it has been recovered from weevil eggs in Dade, Glades, Hendry, and Polk counties (Weissling et al. 2012). *Ceratogramma etiennei* Delvare (Hymenoptera: Trichogrammatidae) was released in Florida but its effectiveness in the field has not been determined (Peña & Amalin 2011). Generalist predators, including *Euthyrhynchus floridanus* (L.), the regal jumping spider, *Phidippus regius* Koch (Araneae: Salticidae) (Jaffe et al. 1990; Tryon 1986), and several predatory ants (Whitcomb et al. 1982) have been reported attacking different stages of the citrus root weevil. Laboratory

and greenhouse experiments were conducted by Stuart et al. (2002) with 3 coccinellid species *Cycloneda sanguinea* (L.), *Harmonia axyridis* Pallas, and *Olla v-nigrum* (Mulsant) which are commonly found in the citrus canopy. Results indicated that these coccinellid species have the potential to be used for biological control of citrus root weevil eggs and neonate larvae before they drop to the ground, but their impact needs to be further studied.

Laboratory feeding experiments were conducted exposing adult and nymphal predatory stink bugs *Euthyrhynchus floridanus* and *Podisus maculiventris* Say (Heteroptera: Pentatomidae) (Fig. 1) to adult *Diaprepes abbreviatus* at 25° ± 3 °C, 50-55% RH and 16:8 h L:D. *Podisus maculeventris* was chosen as a comparative organism because it is a common predatory pentatomid and can be found throughout the citrus growing regions of the USA (De Clercq 2008). Both male and female stink bugs and weevils were utilized. Predators were individually housed with moistened Kimwipe® paper, bean pod, and tissue paper in a Petri dish (14.0 cm × 2.3 cm) for 24 h with no prey. Then, a single (male or female) *D. abbreviatus* was added to the testing arena as prey. A randomized design with 20 replications was used. Five *D. abbreviatus* were kept with food and water in Petri dishes with no predators as a control. After 24 h, the number of dead prey was recorded.

Results obtained indicated that *E. floridanus* males consumed on average ($P < 0.05$) more *D. abbreviatus* adults than the *E. floridanus* females or 3rd-5th instars. All *E. floridanus* life stages consumed more *Diaprepes* adults than all life stages of *P. maculiventris*. There was no significant difference ($P > 0.05$) in the percentage of *Diaprepes* male or female adults consumed by the *P. maculiventris* developmental stages tested (Table 1).

In this study *E. floridanus* was a more effective predator of *D. abbreviatus* than *P. maculiventris* in a laboratory setting (Fig. 2). With further study, *E. floridanus* may show the potential to augment biological control programs

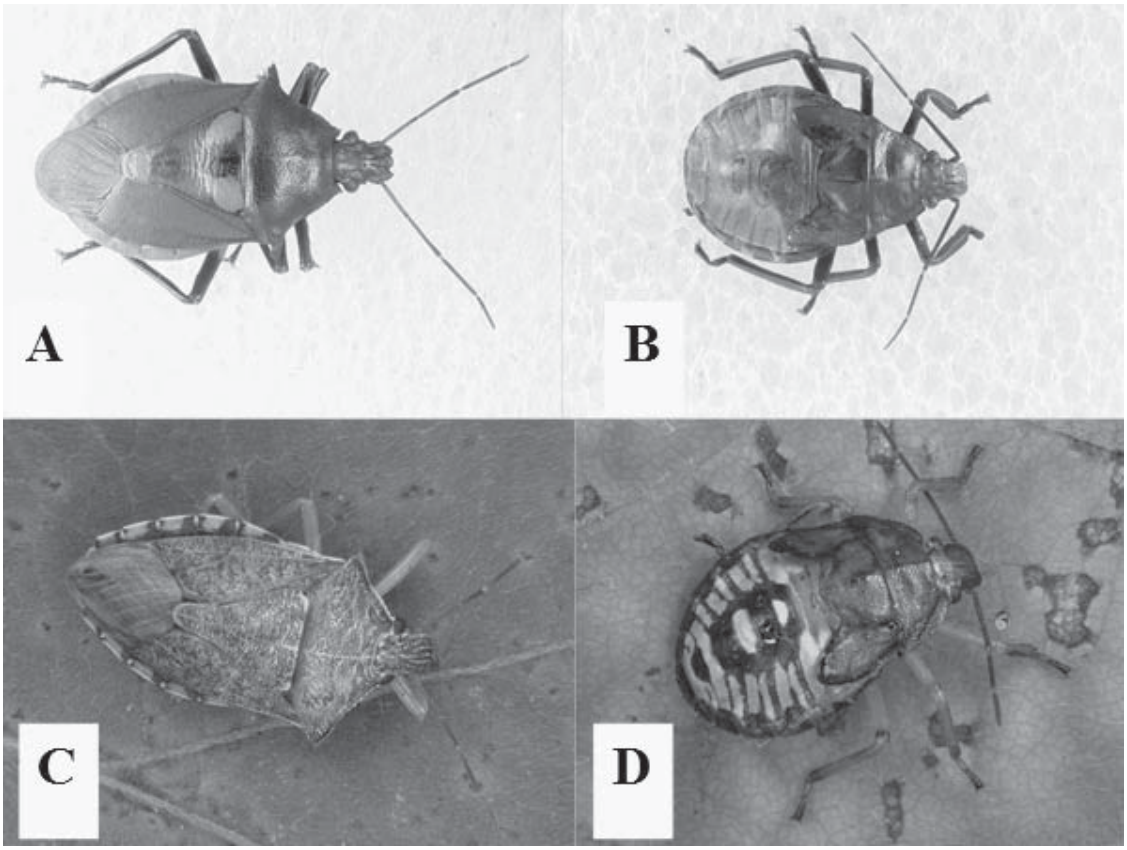

Fig. 1. Predators evaluated for predation of *Diaprepes abbreviatus* adults. A. *Euthyrhynchus floridanus* adult. B. *Euthyrhynchus floridanus* nymph. C. *Podisus maculiventris* adult. D. *Podisus maculiventris* nymph.

TABLE 1. LABORATORY FEEDING RESPONSES OF ADULT AND IMMATURE *EUTHYRHYNCHUS FLORIDANUS* AND *PODISUS MACULIVENTRIS* TO ADULT *DIAPREPES ABBREVIATUS*. IN A RANDOMIZED EXPERIMENT WITH 20 REPLICATIONS, A SINGLE PREDATOR IN A PETRI DISH WAS PRESENTED WITH A SINGLE (MALE OR FEMALE) *D. ABBREVIATES,* AND WHETHER THE LATTER WAS KILLED WAS DETERMINED AFTER 24 HOURS.

		Predation by Predator Species (%)	
Predator stage	Prey stage	*E. floridanus*	*P. maculiventris*
Adult male	Adult male	80 a	15 a
	Adult female	90 a	25 a
Adult female	Adult male	70 ab	20 a
	Adult female	60 b	10 a
3th-5th instars	Adult male	90 a	15 a
	Adult female	60 b	10 a

The means within the same column followed by a different letter are significantly different from each other according to the Sign Test ($P < 0.05$).

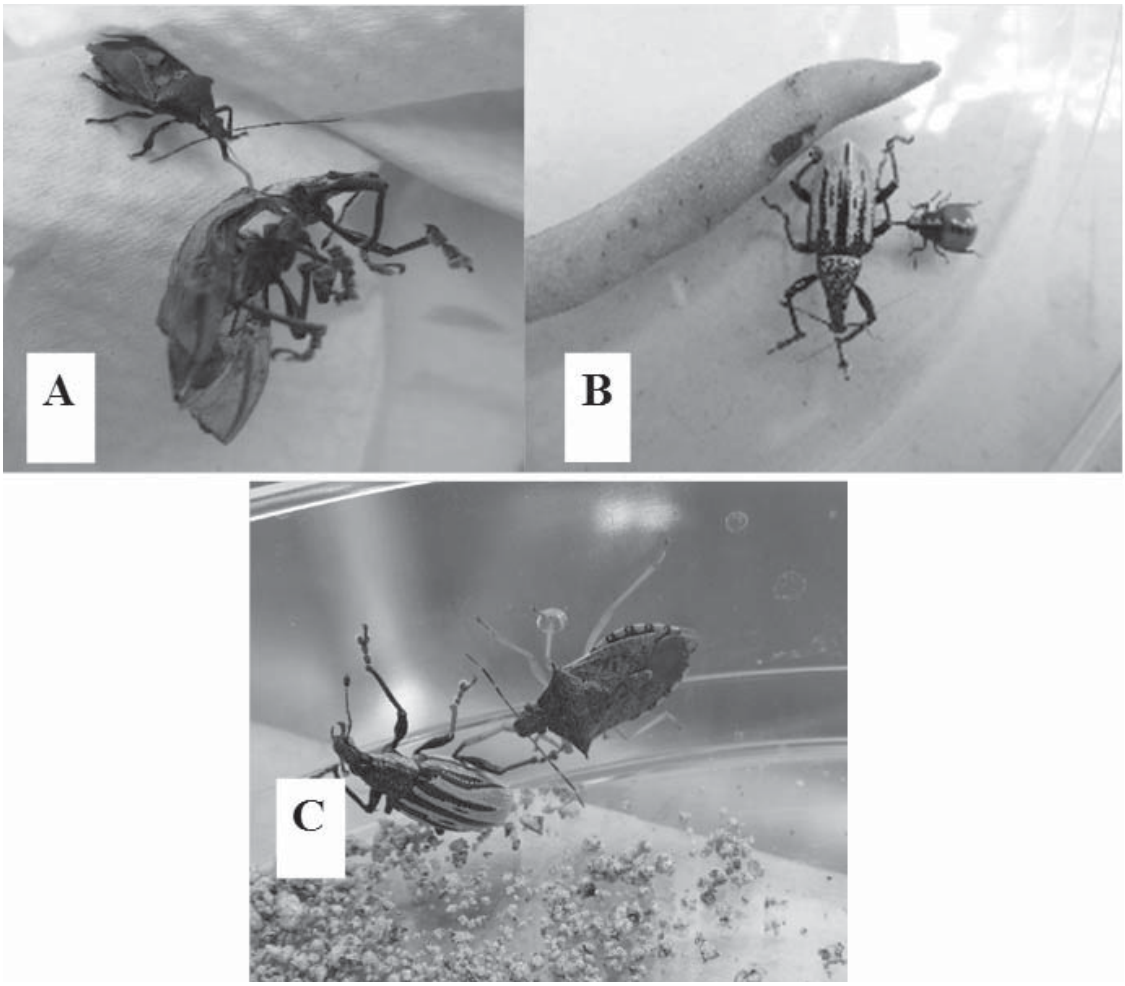

Fig. 2. A. *Euthyrhynchus floridanus* adult male feeding on *Diaprepes abbreviatus* adult. B. *Euthyrhynchus floridanus* nymph feeding on *D. abbreviatus* adult. C. *Podisus maculiventris* adult female feeding on *D. abbreviatus* adult.

for suppressing populations of citrus root weevil. However, more testing is necessary to determine if this insect actually prefers *D. abbreviatus* when given a choice.

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SUMMARY

The feeding responses of the predatory stink bugs *E. floridanus* and *P. maculiventris* to the citrus root weevil *D. abbreviatus* were studied at the Florida Department of Agriculture and Consumer Services, Division of Plant Industry's Florida Biological Control Laboratory in Gainesville, FL. This work was done in quarantine at temperatures of 25° ± 3 °C with a 16-hour photoperiod (16:8 L/D) and a relative humidity of 50-55%. The *E. floridanus* and *P. maculiventris* males, females and 3rd-5th instars were kept individually in a Petri dish with a bean pod and moistened paper for 24 h. They were then exposed to a single *D. abbreviatus* male or female in Petri-dishes for 24 h. Twenty replications were made. At the end of the experiment percent predation was determined. *Euthyrhynchus floridanus* was more efficient than *P. maculiventris* at feeding on *D. abbreviatus* adults in the lab with no choice tests. This particular stinkbug can be easily mass reared and therefore has potential as augmentative biological control agent for the citrus root weevil. However, more testing is necessary to determine the overall impact of this predator in the field.

Key Words: Generalist predator, Pentatomidae, citrus root weevil

RESUMEN

Las repuestas alimenticias de los chinches *E. floridanus* y *P. maculiventris* depredadores del picudo de la raíz de cítricos fueron estudiadas en la cuarentena de Gainesville a una temperatura de 25° ± 3 °C, 16 horas de fotoperíodo (16:8 Luz/Oscuridad) y una humedad relativa de 50-55%. Machos, hembras y ninfas del 3ro-5to estadío de *E. floridanus* y *P. maculiventris* fueron mantenidos individualmente en platos de Petri con papel humedecido y una vaina de frijol común sin presa durante 24 h. Luego de este período, los depredadores fueron expuestos a un macho o una hembra adulta de *D. abbreviatus* por 24 h. Se utilizaron veinte repeticiones. Al final del experimento, se determinó el porcentaje de depredación. *Euthyrhynchus floridanus* fue más eficiente que *P. maculiventris* alimentándose de adultos del picudo de la raíz de cítricos. *Euthyrhynchus floridanus* podría criarse masivamente para ser utilizado en programas de control biológico del picudo de la raíz de cítricos por aumentación y conservación en los Estados Unidos de Norte América. Sin embargo, estudios adicionales son necesarios para determinar el posible impacto de este depredador en el campo

Palabras Clave: depredador generalista, Pentatomidae, picudo de la raíz de cítrico

REFERENCES CITED

BULLOCK, R. C., MCCOY, C., AND FOJTIK, J. 1988. Foliar sprays to control adults of the citrus root weevil complex in Florida. Proc. Florida Hort. Soc. 101: 1-5.

DE CLERCQ, P. 2008. Spined soldier bug, *Podisus maculiventris* Say (Hemiptera: Pentatomidae: Asopinae), pp. 3,508-3,510 *In* J. L. Capinera [ed.] Encyclopedia of Entomology, Vol 4. Springer, Heidelberg.

DUNCAN, L. W. 2000. Burrowing nematodes, pp. 167-168 *In* Otis C. Maloy and Timothy D. Murray [eds.], Encyclopedia of Plant Pathology. John Wiley and Sons, Inc., New York, NY.

DUNCAN, L., AND STELINSKI, L. 2013. Targeting *Diaprepes* root weevil by using native nematodes. Citrus Industry, March, pp. 6-9.

HALL, D. G., PEÑA, J., FRANQUI, R., NGUYEN, R., STANSLY, P., MCCOY, C., LAPOINTE, S. L., ADAIR, C., AND BULLOCK, B. 2001. Status of biological control by egg parasitoids of *Diaprepes abbreviates* (Coleoptera: Curculionidae) in citrus in Florida and Puerto Rico. BioControl 46: 61-70.

GRAFTON-CARDWELL, E. E., GODFREY, K. E., PEÑA, J. E., MCCOY, C. W., AND LUCK, R. F. 2004. *Diaprepes* root weevil. Univ. California, Div. Agric. Nat. Resources. Publ. 8131. 8 pp.

JAFFE, K., MAULEON, H., AND KERMARREC, A. 1990. Predatory ants of *Diaprepes abbreviatus* (Coleoptera: Curculionidae) in citrus groves in Martinique and Guadeloupe, F. W. I. Florida Entomol. 73(4): 684-687.

JETTER, K. M., AND GODFREY, K. 2009. *Diaprepes* root weevil, a new California pest, will raise cost for pest control and trigger quarantines. California Agric. 63(3): 121-126.

LAPOINTE, S. L., AND BOWMAN, K. D. 2002. Is there meaningful plant resistance to *Diaprepes abbreviatus* (Coleoptera: Curculionidae) in citrus rootstocks? J. Econ. Entomol. 95: 1059-1065.

MARTORELL, L. 1976. Annotated food plant catalog of the insects of Puerto Rico. Univ. Puerto Rico Agric. Exp. Stn., Dept. Entomol. 303 pp.

MCCOY, C. W., SHAPIRO, D. I., DUNCAN, L. W., AND NGUYEN, K. 2000. Entomopathogenic nematodes and other natural enemies as mortality factors for larvae of *Diaprepes abbreviatus* (Coleoptera: Curculionidae). Biol. Control 19: 182-190.

MCCOY, C. W., QUINTELA, E., SIMPSON, S., AND FOJTIK, J. 1995. Effect of surface-applied and soil-incorporated insecticides for the control of neonate larvae

of *Diaprepes abbreviatus* in container-grown citrus. Proc. Florida Hort. Soc. 108: 130-136.

PEÑA, J. E., AND AMALIN, D. M. 2011. Biological control of *Diaprepes abbreviatus* by parasitoids. Univ. Florida-IFAS, Tropical Research and Education Center. 9 pp.

PEÑA, J. E., ETIENNE, J., DUNCAN, R., AND PINTO, J. 1998. Introduction of *Ceratogramma etiennei* (Hymenoptera: Trichogrammatidae) for biological control of *Diaprepes abbreviatus* in Florida, USA, pp. 145-148 *In* S. A. Hassan [ed.], 5th Intl. Symp. Egg Parasitoids, IOBC. Cali, Colombia.

SCHROEDER, W. 1990. Suppression of *Diaprepes abbreviatus* (Coleoptera: Curculionidae) adult emergence with soil application of entomopathogenic nematodes (Nematoda: Rhabditidae). Florida Entomol. 73: 680-683.

SKARIA, M., AND FRENCH, J. V. 2001. Phytophthora disease of citrus associated with root weevils in Texas. Phytopathology 91(6) Suppl. S203.

SIMPSON, S., NIGG, H., COLIE, N., AND ADAIR, R. 1996. *Diaprepes abbreviatus* Coleoptera: Curculionidae: Host-plant associations. Environ. Entomol. 25(2): 333-349.

STUART, R. J., MICHAUD, J. P., OLSEN, L., AND MCCOY, W. 2002. Lady beetles as potential predators of the root weevil *Diaprepes abbrebiatus* (Coleoptera: Curculionidae) in Florida Citrus. Florida Entomol. 85: 409-416.

TRYON, E. H. 1986. The striped earwig and ant predators of sugarcane rootstock borer, in Florida citrus. Florida Entomol. 69: 336-343.

WEISSLING, T. J., PEÑA, J. E., GIBLIN-DAVIS, R. M., AND KNAPP, J. L. 2012. *Diaprepes* root weevil. UF-IFAS, Entomol. & Nematol. Dept. Publ. No. EENY-24. 8 pp.

WHITCOMB, W. B., GOWAN, T. D., AND BUREN, W. F. 1982. Predators of *Diaprepes abbreviatus* larvae. Florida Entomol. 65: 150-158.

WOLCOTT, M., AND FRENCH, J. V. 1936. The life history of *Diaprepes abbreviatus* at Rio Piedras, Puerto Rico. J. Agric. Univ. Puerto Rico 20: 883-914.

WOODRUFF, R. E. 1968. The present status of a West Indian weevil (*Diaprepes abbreviatus* (L.) in Florida (Coleoptera: Curculionidae). Gainesville: Florida Dept. of Agric. Div. Plant Industry Entomol. Cicular 77. 4 pp.