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EGG PARASITOIDS OF THE LEAFHOPPERS *DALBULUS MAIDIS* AND *DALBULUS ELIMATUS* (HEMIPTERA: CICADELLIDAE) IN TWO MAIZE HABITATS

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Dalbulus maidis (DeLong & Wolcott) and *D. elimatus* (Ball) (Hemiptera: Cicadellidae) are important pest of maize (*Zea mays* L. ssp. *mays*) in Latin America. They are efficient vectors of the corn stunt spiroplasma (*Spiroplasma kunkelii* Whitcomb), maize bushy stunt phytoplasma (*Candidatus* Phytoplasma asteris), and *Maize rayado fino virus* (MRFV) (Nault 1980; Ebbert et al. 2001). Little is known about the natural enemies of these leafhoppers. Eggs of *D. maidis* are parasitized mainly by Mymaridae and Trichogrammatidae wasps (Moya-Raygoza et al. 2012). Egg parasitoids are considered good tools for biological control because they show higher parasitism rates than parasitoids of other leafhopper stages (Freytag 1985).

It's unknown whether egg parasitoids that attack *D. maidis* also attack *D. elimatus.* These sister leafhopper species belong to different phyletic groups, showing differences in morphology, isoenzymes, molecular characters, oviposition behavior, and allopatric distribution (Heady et al. 1985; Triplehorn & Nault 1985; Triplehorn et al. 1990; Dietrich et al. 1998). During the process of speciation, *D. maidis* spread mainly in low (< 1,000 m asl) elevation maize habitats and *D. elimatus* spread mainly in high (> 1,000 m asl) elevation maize habitats (Triplehorn & Nault 1985).

Previous surveys identified 6 egg parasitoid species of *D. maidis* in Jalisco, Mexico (Virla et al. 2009; Moya-Raygoza et al. 2012). However, no reports of *D. elimatus* egg parasitoids are available. Moreover, little is known about levels of parasitism and the successful development of parasitoids on the 2 leafhoppers. The objective of this study was to identify the egg parasitoids and the parasitism rates of *D. maidis* and *D. elimatus* in low and high elevation maize habitats in Jalisco, Mexico.

Parasitoids were surveyed in 2 sites with contrasting environmental conditions during the 2009 maize growing season. El Grullo (868 m asl; N 19° 47' W 104° 12') is a permanent maize habitat where maize is cultivated throughout the year. By contrast in Zapopan (1,650 m asl; N 20° 74' W 103° 30') maize is cultivated during the Jun through Sep-Oct season, which is characterized by high rainfall and high temperatures (Larsen et al. 1992). The experiments were conducted in pesticide-free cornfields at each of the 2 sites during the 2009 maize growing season. The presence of *D. maidis* and *D. elimatus* adults was confirmed at each sampling date by using a heavy sweep net (38 cm diam net ring) for 20 m over the foliage of maize; adult leafhoppers were identified using the taxonomic keys by Triplehorn & Nault (1985).

Laboratory-reared, 2-week-old females of each *Dalbulus* species were allowed to oviposit on potted ancho-pozolero maize plants at the 3 leaf stage. Five females of each *Dalbulus* species were confined separately in a leaf-cage for 72 h under laboratory conditions (25 ± 2 °C; 50% RH; 12:12 h L:D). The leaf-cage size was (4.0 × 5.5 × 2.0 cm with a small hole covered with fine mesh). After the oviposition period, the adult females were removed, the numbers of eggs on each maize leaf were counted, and the plants were immediately transported to the field sites. The transportation time to Zapopan was approximately 1 h and to El Grullo 3 h. A potted plant with eggs was considered a single replicate. On each sampling date 20 plants per *Dalbulus* species were placed along the edge of one 1.5-2 ha cornfield in each site. New plants with fresh leafhopper eggs were exposed in each site on 29 Jun, 23 Jul, 20 Aug, and 12 Sep. The plants were placed in pairs, each pair having 1 plant infested separately with eggs of each of the *Dalbulus* species. The distance between each pair of plants was 5 m. The eggs were exposed to parasitoids in the cornfields for 4 days. Then the plants were retrieved and taken to the laboratory, where the sections of the leaves with the egg masses were cut and transferred to Petri dishes lined with wet tissue paper. The dishes were covered with clear plastic food wrap to avoid desiccation and prevent the wasps from escaping. The egg masses were checked daily until emergence of leafhopper nymphs and/or adult wasps. The time from oviposition to egg-hatch at the local temperature is approximately 14-15 days (Nault 1990). Adult parasitoids were counted and preserved in 95% ethanol. The numbers of exposed and para-

sitized eggs of *D. maidis* and *D. elimatus* were compared using chi square goodness of fit tests. The levels of parasitism between *Dalbulus* species and habitats were compared using a Kruskal-Wallis test and SPSS software (SPSS 11.5 for Windows, SPSS, Chicago, Illinois, USA).

The parasitoids were identified using the keys by Triapitsyn (1999 & 2002) and Viggiani (1981), and by comparison with type specimens. Voucher specimens were deposited in the entomological collection of the University of Guadalajara, Mexico, and in the entomological collection of the Instituto y Fundación "Miguel Lillo", San Miguel de Tucumán, Argentina (IMLA).

Dalbulus maidis eggs were parasitized by *Paracentrobia tapajosae* Viggiani (Hymenoptera: Trichogrammatidae), *Anagrus breviphragma* Soyka (Hymenoptera: Mymaridae), *Aphelinoidea semifuscipennis* Girault (Hymenoptera: Trichogrammatidae) Girault, *Pseudoligosita longifrangiata* (Viggiani) (Hymenoptera: Trichogrammatidae), and *Oligosita desantisi* Viggiani (Hymenoptera: Trichogrammatidae) in El Grullo site, and by *P. tapajosae*, *P. longifrangiata,* and *A. breviphragma* in the Zapopan site (Table 1). This is the first report of *O. desantisi* attacking *D. maidis* eggs in Mexico. In previous studies in the same sites the following parasitoids were found attacking *D. maidis* eggs: *A. breviphragma*, *A. semifuscipennis*, *Oligosita clarimaculosa* (Girault)*, P. tapajosae, Polynema saga* (Girault), and *P. longifrangiata* in El Grullo and *A. breviphragma*, *A. semifuscipennis*, *O. clarimaculosa*, and *P. tapajosae* in Zapopan (Virla et al. 2009; Moya-Raygoza et al. 2012).

This is the first report of parasitoids attacking *D. elimatus* eggs. Eggs of *D. elimatus* were parasitized by *P. tapajosae*, *A. semifuscipennis,* and *P. longifrangiata* in El Grullo and by *P. tapajosae* and *A. breviphragma* in Zapopan (Table 1).

No evidence of host specificity was observed in the parasitoids as most species parasitized both *D. maidis* and *D. elimatus*. No significant differences in the total number (χ^2 = 0.97; df = 1; P = 0.32) and the percentages of (χ^2 = 0.001; df = 1; P = 1.00) parasitized eggs of *D. maidis* and *D. elimatus* were observed. All parasitoids developed and reached the adult stage on *D. maidis* and *D. elimatus* (Table 1). The overall parasitism level was higher for both *D. maidis* and *D. elimatus* in the permanent maize habitat (El Grullo), compared with seasonal maize habitat (Zapopan) (H= 40.48; df = 1; P = 0.001) (Fig. 1). Landis & Menalled (1998) and Landis et al. (2000) also found high levels of parasitism in permanent habitats attributed to the stability and higher diversity of these habitats. Results of this study are consistent with previous studies (Moya-Raygoza et al. 2012) showing low parasitism in *D. maidis* during 2 summer seasons in seasonal maize habitat, where parasitoids are exposed to more variable

TABLE 1. EGG PARASITOID SPECIES OF *DALBULUS MAIDIS* AND *DALBULUS ELIMATUS* IN PERENNIAL AND SEASONAL MAIZE HABITATS. TOTAL NUMBER OF EMERGED ADULT PARASITOIDS ARE SHOWN IN PARENTHESIS.

Permanent maize habitat (El Grullo)		Seasonal maize habitat (Zapopan)		
D. maidis	*D. elimatus*	*D. maidis*	*D. elimatus*	Collection date
Not sampled		*P. tapajosae* (1) *P. longifrangiata* (2)	*P. tapajosae* (4)	June
P. tapajosae (51) *A. breviphragma* (1)	*P. tapajosae* (15)	Not found		July
A. semifuscipennis (8)	*A.semifuscipennis* (7) *P. tapajosae* (20)	*A. breviphragma* (26)	*A.breviphragma*(19) *P. tapajosae* (26)	August
P. tapajosae (132) *A. semifuscipennis* (1) *P. longifrangiata* (3) *O. desantisi* (1)	*P. tapajosae* (100) *A. semifuscipennis* (2) *P. longifrangiata* (1)	*P. tapajosae* (14) *A. breviphragma* (2)	*P. tapajosae* (13) *A. breviphragma* (13)	September

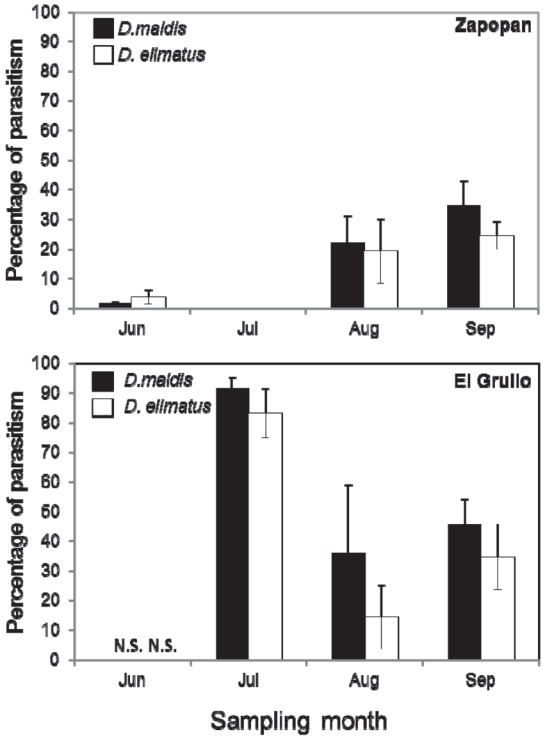

Fig. 1. Mean percentage of parasitism of *Dalbulus maidis* and *Dalbulus elimatus* eggs in a perennial maize habitat (El Grullo) and a seasonal maize habitat (Zapopan) in Jalisco, Mexico, during the 2009 maize growing season. Error bars represent the standard error. N.S. = not sampled.

environmental conditions. A similar pattern of parasitism was found not only for *D. maidis* but also for *D. elimatus*. More studies to determine the specific abiotic factors that influence the parasitism rates in permanent and seasonal maize habitats are needed.

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Summary

Maize plants with similar numbers of *Dalbulus maidis* (DeLong & Wolcott) and *Dalbulus elimatus* (Ball) (Hemiptera: Cicadellidae) eggs were exposed to egg parasitoids in seasonal and perennial maize habitats. Both leafhopper species were parasitized by *Paracentrobia tapajosae* Viggiani (Hymenoptera: Trichogrammatidae), *Anagrus breviphragma* Soyka (Hymenoptera: Mymaridae), *Aphelinoidea semifuscipennis* Girault (Hymenoptera: Trichogrammatidae), and *Pseudoligosita longifrangiata* (Viggiani) (Hymenoptera: Trichogrammatidae). All parasitoids that attacked *D. elimatus* eggs are reported for the first time. Both leafhopper species showed similar number of parasitized eggs and similar percentages of parasitism. The parasitoids reached the adult stage. The levels of parasitism varied among the 2 habitats; a higher level of parasitism was observed in the perennial maize habitat compared with the seasonal maize habitat.

Key words: maize pests, egg parasitoids, leafhoppers

Resumen

Plantas de maíz con similar número de huevos de *D. maidis* y *D. elimatus* fueron expuestos a los parasitoides. Ambas especies de chicharritas fueron parasitadas por *Paracentrobia tapajosae* Viggiani (Hymenoptera: Trichogrammatidae), *Anagrus breviphragma* Soyka (Hymenoptera: Mymaridae), *Aphelinoidea semifuscipennis* (Hymenoptera: Trichogrammatidae) y *Pseudoligosita longifrangiata* (Viggiani) (Hymenoptera: Trichogrammatidae). Todas las especies de parasitoides que atacan a los huevos de *D. elimatus* son reportadas por primera vez. Además, en ambas especies de chicharritas se encontró un número similar de huevos parasitados y porcentaje de parasitismo, y los parasitoides encontrados llegaron a su estado adulto. La tasa total de parasitismo depende del tipo de hábitat; en el hábitat donde se cultiva maíz todo el año, una alta tasa de parasitismo fue encontrada, mientras que en el hábitat con maíz estacional, la tasa de parasitismo fue baja.

Pabras Clave: maize pests, egg parasitoids, leafhoppers

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