Field Release of *Lydella jalisco* Woodley (Diptera: Tachinidae) in Sugarcane and other Gramineous Crops for Biological Control of *Eoreuma loflini* (Dyar) (Lepidoptera: Pyralidae) in Texas

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ABSTRACT

The Mexican rice borer, *Eoreuma loftini* (Dyar) (Lepidoptera: Pyralidae), is the key pest of sugarcane in south Texas where it is not only responsible for continued yield reduction, but also threatens a variety of gramineous host crops. With chemical control being of limited success, research interest has focused on the introduction of biological control agents. Originating from Ameca (Jalisco, Mexico), *Lydella jalisco* Woodley (Diptera: Tachinidae), a recently described larval parasitoid of *E. loftini*, was re-introduced into Texas in 1998 and its potential in regulating populations of *E. loftini* was evaluated. During 1999 and 2000, several field-release trials were performed in walk-in field-cages and open-field conditions. Adult *L. jalisco* parasitoids emerged from *E. loftini* larvae recovered from sampled sugarcane, corn, rice and sorghum stalks. Percentage parasitism did not exceed 6.8% in field cages. Although considerable sampling efforts were undertaken, no progeny from adult *L. jalisco* parasitoids released in local sugarcane plantations was ever recovered, whereas a significant number of other natural enemies of *E. loftini* such as *Chelonus sonorensis* Cameron, *Digonogastra solitaria* Wharton & Quicke and *Parallorhogas pyralophagus* Marsh were collected. Adverse environmental conditions such as the ones encountered in the Lower Rio Grande Valley of Texas from May through September greatly affected the longevity and oviposition performance of *L. jalisco* females.

RESUMEN

El barrenador mexicano del arroz, *Eoreuma loftini* (Dyar) (Lepidoptera: Pyralidae), es el principal insecto plaga de la caña de azúcar en el sur de Texas, en donde no sólo es responsable de importantes pérdidas en cosechas anualmente, sino que amenaza también una variedad de gramíneas que lo hospedan. Ya que el éxito de los métodos de control químico es limitado, las investigaciones se han enfocado en la introducción de agentes de control biológico. Originario de Ameca (Jalisco, México), *Lydella jalisco* Woodley (Diptera: Tachinidae), un parasitoide de las larvas de *E. loftini* recientemente descrito, fue reintroducido a Texas en 1998 y su potencial para regular poblaciones de *E. loftini* fue evaluado. Durante 1999 y 2000, varios bioensayos fueron realizados en donde se liberaron adultos de *L. jalisco* tanto en jaulas como en condiciones de campo abierto. Parasitoides adultos de *L. jalisco* emergieron de larvas de *E. loftini* colectadas en los tallos de caña de azúcar, maíz, arroz y sorgo muestreados. Sin embargo, el porcentaje de parasitismo no rebasó el 6.8% en jaulas de campo. Además, a pesar de esfuerzos considerables en el muestreo de *E. loftini*, no se logró recuperar ejemplares de *L. jalisco* en las plantaciones comerciales de caña de azúcar locales donde se habían liberado los parasitoides adultos. Sin embargo, otras especies de parasitoides nativos y exóticos de *E. loftini* tales como *Chelonus sonorensis* Cameron, *Digonogastra solitaria* Wharton & Quicke y *Parallorhogas pyralophagus* Marsh fueron colectadas. Condiciones ambientales tan adversas como las existentes en el valle del Rio Grande de Texas durante los meses de mayo a septiembre afectaron considerablemente la longevidad y comportamiento de oviposición en las hembras de *L. jalisco*.

Additional index words: Mexican rice borer, parasitoid, sampling, stalkborer

Lydella jalisco Woodley (Diptera: Tachinidae) is a solitary endoparasitoid of the Mexican rice borer (MRB), *Eoreuma loftini* (Dyar) (Lepidoptera: Pyralidae). In its natural habitat, the Ameca Valley of Jalisco (Mexico), *L. jalisco* parasitizes up to 30% of *E. loftini* larvae (Rodríguez del Bosque and Smith 1996, Legaspi et al. 2000a). In 1998, this parasitoid was re-introduced into Texas as part of a classical biological control program to regulate populations of this insect pest (Legaspi et al. 2000a). For the last 20 years, *E. loftini* has been the primary insect pest of sugarcane in Texas (Johnson 1984, Legaspi et al. 1997). This stalkborer damages 20-30% of sugarcane internodes, thereby causing annual losses of $10-20 million in the Lower Rio Grande Valley (LRGV) (Legaspi et al. 1997). Several other gramineous plants such as corn, sorghum, rice, forage and wild grasses are attacked by the MRB (Johnson 1984). Such a host range could contribute to further geographical expansion of *E. loftini* north of Texas and threaten crops of significant economic importance.

Larvae of *E. loftini* develop inside the stalks where they bore tunnels that remain packed with their frass. This habit makes control techniques difficult, especially insecticidal and biological control methods, which have resulted in only moderate success to date (Legaspi et al. 1997). Adult females of *L. jalisco* do not need to directly contact the host. Instead, first instar larvae deposited near the entry of the stalkborer tunnel actively crawl and penetrate the stalk in search of the host (Rodríguez del Bosque and Smith 1996). Actual knowledge of the biology and behavior of *L. jalisco* with regard to its use as a biological control agent is deficient, however. From 1998 to 2000, a series of laboratory and field experiments were conducted at the Texas Agricultural Experiment Station (TAES), Weslaco, in order to better understand the *E. loftini* - *L. jalisco* relationships and the reproductive biology of *L. jalisco*, to develop and improve rearing techniques of both the host and the parasitoid, and to determine suitable conditions for field releases of this tachinid in Texas.

Herein we report the results of field release studies of adult *L. jalisco* parasitoids in large screen cages and open-field conditions in the LRGV and recovery of parasitoids of *E. loftini* on different crops during 1999 and 2000. Data are discussed in relation to parasitoid biology and behavior.

MATERIALS AND METHODS

All adults of *L. jalisco* used for field releases were obtained from a stock colony maintained by the senior author at the TAES in Weslaco, Texas. Parasitoids were reared on diet-fed MRB larvae using techniques modified from the original methods of Rodríguez del Bosque and Smith (1996) (Lauzière et al. 2000). Newly emerged adults (< 4 h; n = 20 to 25 pairs) were introduced into wood-framed screen cages (25 x 25 x 25 cm) to allow mating. Parasitoids were provided water and a 30% honey -10% egg yolk solution prior to releases. Environmental laboratory conditions were 22 + 2ºC, 60 ± 5% R.H. and a 12L:12D photoperiod provided by Chroma-50® fluorescent lamps (General Electric, 40 W, 30,000 lux). All parasitoid releases were made early in the morning to minimize heat stress. During field-cage release studies, temperature and relative humidity were monitored inside cages every hour using a HOBO® electronic data logger (Onset Computer Corporation, Bourne, MA).

Field-Cage *L. jalisco* Releases

First trial. Different host plants of *E. loftini* were selected and tested in this study: 1) sugarcane, interspecific *Saccharum* hybrid variety "CP 70-321"; 2) corn, *Zea mays* L. variety "3050 Pioneer"; 3) sorghum, *Sorghum bicolor* (L.) Moench variety "5319 Garst"; and 4) hybrid forage sorghum, variety "Oro Kandy Kane". The trial took place at the TAES fields, Weslaco, Texas. The sugarcane was planted in January 1999 in 6 rows of 75 m, 1.50 m apart (0.07 ha plot). The other crops were planted in February 1999, in a plot located 2 m from the sugarcane plot. Rows of corn were grown between both sorghum species and a total of 6 rows (75 m, 0.8 m apart) were planted for each plant species (1.1 ha plot). Drip irrigation was used for all crops. Ten metal-framed screen cages (2.4 x 2.4 x 2.4 m) were installed. Five cages were set randomly within the corn and sorghum area, each cage enclosing 3 rows, one row of 10 plants of each host plant species. The other 5 cages were used for the sugarcane alone and were randomly distributed within the plot. Each cage enclosed 2 rows of 15 stalks of sugarcane. All host plants were infested the first week of June 1999 using 10 third or fourth instar *E. loftini* larvae per plant. Seven-day-old adult parasitoids (n = 10 females; n = 5 males) were released into each cage one week after plant infestation. For each of those 2 plots, one cage received no parasitoids and served as a control. All parasitoids died within 3 days of release; therefore, host plants were harvested and carefully dissected one week after parasitoid release. Recovered stalkborer larvae were individually placed into 18.5 ml cups (Fill Rite, Newark, NJ) filled with artificial diet (Martinez el al. 1988) and sealed with polycoated pull tab lids (Stanpac, Lewinston, NY). Stalkborer larvae were held in an incubator (Percival Scientific, Boone, IA) at 28 ± 2º, 60 ± 10% R.H. in continuous darkness until pupation or emergence of adult parasitoids occurred. In this experiment and the following ones, percent parasitism was calculated using numbers of host parasitized divided by the number of stalkborer larvae recovered.

Second trial. In December 1999, 250 sugarcane stalks sustaining heavy stalkborer damage were harvested at Bell Farm, 11 km south of Donna, Texas. Bell Farm is a commercial plantation of 31 ha planted to variety "CP 72-1210" and last harvested the second week of February 1999. Equal numbers of ablated stalks were randomly distributed into 5 empty metal-framed screen cages set randomly within the TAES sugarcane plot to provide a more natural environment. One hundred and fifty 7- to 12-day-old adult parasitoids were released into each of 4 field cages. Parasitoids were not individually sexed in this study; the proportion of males to females was assumed to be 1:1. One week after parasitoid release, all sugarcane stalks were collected and dissected for stalkborers. As previously described, all stalkborer larvae recovered were individually placed on diet and held in an incubator until insect development was complete.

Third trial. From January to April 2000, another study of L. *jalisco* parasitizing *E. loftini* on sugarcane was conducted at

Table 1. Number of *Eoreuma loftini* recovered from different crops and observed parasitism by *Lydella jalisco* females released into field-cages at the TAES Annex in 2000.

Host plant	Stalkborer larvae[z]	*Lydella jalisco*[z]	Percent parasitism[y]
Corn	74	6	8.1ab
Rice	52	3	5.8a
Sugarcane	11	3	27.3b
Sorghum	124	3	2.4a

[z]Data were pooled among identical host plants within all 4 cages
[y]Percentages followed by a different letter are significantly different (Chi-square; $P < 0.05$)

the Annex, a TAES field located 3 km north-west of Mercedes, Texas. Field cages were randomly installed within a 0.2 ha plot of sugarcane (variety "CP 70-321") planted the last week of February 1999. Cages enclosed 2 rows of sugarcane with 25 sugarcane stalks each. From mid-January to mid-February, sugarcane stalks were each manually infested with approximately 50 newly emerged first instar *E. loftini* larvae produced in the laboratory. Newly emerged *E. loftini* females (n = 130) collected from our stock colony and mated under laboratory conditions were also released into each cage. Stalkborers were allowed to establish and develop on the plants for 3 months. Flood irrigation was performed at the Annex every other week. Two samples (March and April) were obtained from the control cage to evaluate the infestation level and the size of the stalkborers. To increase the availability of hosts for *L. jalisco*, 30 sugarcane stalks (variety "CP 72- 1210") originally planted mid-August 1999, and sustaining heavy stalkborer damage were harvested at the Jesse Russell Farm, 8 km south of Donna, Texas, and randomly distributed into each cage. The third week of April, 35 females and 35 males of *L. jalisco* (5- to 7-day-old adults) were released into each of 4 cages. Sugarcane stalks (regular and ablated) were individually sampled a week following parasitoid release. As previously described, recovered stalkborer larvae were maintained on artificial diet in an incubator until they pupated or parasitoids developed.

Fourth trial. Four plant species were selected as host plants of *E. loftini*: 1) sugarcane, variety "CP 65-357"; 2) corn, variety "8325 Garst"; 3) sorghum, variety "5515 Garst"; and 4) rice, *Oryza sativa* L., variety "Jefferson". During the last week of March 2000, the corn and sorghum were planted randomly at the Annex in a 0.1 ha plot. The field was flood-irrigated every 2 weeks. Sugarcane, planted the first week of November 1999, and rice, planted the third week of March 2000, were grown at the greenhouse in 9.5 liter plastic pots (Nursery Supplies Inc., Orange, CA) containing Metro Mix® 300 growing media (Scotts-Sierra Horticultural Products, Marysville, OH). We used 3-4 rice plants (3-5 shoots each) and 1 sugarcane plant per pot. Cages were installed randomly within the experimental plot and where necessary, the numbers of corn and sorghum plants were reduced to 20. All host plants were manually infested with second to fourth instar *E. loftini* larvae at a rate of 30 stalkborers per plant. Stalkborer larvae were given 5 weeks to establish on the plants. Twenty pots of sugarcane and 10 pots of rice were then randomly distributed into each cage. Fifty females and 50 males of *L. jalisco* (12-day-old adults) were released into each of 4 cages during the first week of July. As previously described, all plants were individually sampled a week from parasitoid release and all stalkborer larvae recovered were maintained on diet in an incubator until their fate could be determined. Data were pooled among identical host plants within all 4 cages. In this trial, the effect of host plant on percent parasitism was analyzed using a chi-square test. Level of significance was P = 0.05.

Open-Field *L. jalisco* Releases

From mid-August to mid-November 1999, weekly parasitoid releases were performed at the Hardwicke Farm, 6 km south of Donna, Texas. The Hardwicke Farm is a commercial plantation comprised of 10.5 ha of sugarcane (variety "CP 71-1240") and last harvested the third week of February 1999. Similarly, from mid-September to the end of November 1999, parasitoid releases took place at the previously described 0.07 ha TAES experimental plot, Weslaco, Texas, planted to sugarcane variety "CP 70-321" in January 1999. A total of 1,400 and 2,000 7-day-old adult parasitoids were released at each site, respectively. At the Hardwicke Farm plantation, releases took place at a single selected area, 100 m from the west extremity of the field and at an equal distance on the north-south axes. At the TAES plot, parasitoids were released randomly, the planted area being relatively small.

During the designated period, 6 sugarcane samples were obtained from the Hardwicke Farm plantation. Samples consisted of 80 sugarcane stalks collected at random within a 100 m range of the release site. At the TAES plot, 4 samples were obtained, each consisting of 60 sugarcane stalks collected at random. Because the observed percentage of stalkborer infestation by *E. loftini* was low at the TAES plot (see Results section), on 3 occasions, 50 sugarcane stalks showing heavy stalkborer damage were collected at the Cannon Farm, 5 km north of Monte Alto,Texas, a 16.5 ha commercial farm planted to sugarcane variety "TCP 87-3388" and last harvested the second week of April 1999. Ablated stalks were attached with twine to planted sugarcane stalks to form 10 clusters randomly distributed within the plot. Ablated stalks were removed after a 2-week period. All sugarcane stalks were carefully dissected and numbers of internodes, damaged internodes, stalkborers and parasitoids (when parasitism was obvious, i.e., cocoons were found) were recorded. Recovered stalkborer larvae were treated as previously described. For each site, the percentage of stalkborer damage was calculated using the number of damaged sugarcane internodes and dividing it by the total number of internodes. Percent parasitism was calculated by dividing the number of parasitized hosts by the number of stalkborer larvae recovered.

RESULTS

Field-Cage *L. jalisco* Releases

First trial. Only 68 of 1500 artificially infested *E. loftini* larvae were recovered from the 150 sugarcane stalks, 24 of which originated from the stalks of the control cage. From the 44 stalkborer larvae collected in sugarcane stalks that belonged

Table 2. Stalkborers and parasitoids recovered from sugarcane stalks collected at the Hardwicke Farm in 1999.

Sampling date		Number collected[z]	Number parasitized	Parasitoids			
				Chelonus sonorensis	*Digonogastra solitaria*	*Parallorhogas pyralophagus*	*Cotesia flavipes*
08/17/99	*Eoreuma loftini*	163	5	4	0	1	
	Diatraea saccharalis	4	0				
	Parasitoid cocoons	5		2	3		
08/31/99	*Eoreuma loftini*	75	7	7			
	Diatraea saccharalis	2	0				
	Parasitoid cocoons	1			1		
09/14/99	*Eoreuma loftini*	106	11	9	1	1	
	Diatraea saccharalis	4	0				
	Parasitoid cocoons	3			3		
09/28/99	*Eoreuma loftini*	177	22	21		1	
	Diatraea saccharalis	3	0				
	Parasitoid cocoons	5		1	4		
10/12/99	*Eoreuma loftini*	167	19	19			
	Diatraea saccharalis	1	0				
	Parasitoid cocoons	6		1	4		1
11/09/99	*Eoreuma loftini*	146	7	4	2	1	
	Diatraea saccharalis	0	0				
	Parasitoid cocoons	15		3	11	1	

[z]Sample of 80 sugarcane stalks

to the cages where parasitoids were released, only 3 (6.8%) *L. jalisco* parasitoids emerged; no other parasitoid species was recovered. From the corn and sorghum plants, 10.9% (164 of 1500) of *E. loftini* larvae were recovered, of which 30 stalkborer larvae came from the control plants. Where adult female parasitoids were released, only 3 stalkborer larvae of 134 (2.2%) were parasitized by *L. jalisco*, 1 was recovered from sorghum, 2 from forage sorghum. Since the number of *L. jalisco* parasitoids recovered was low, no attempt was made to statistically compare host plant effects on parasitism.

Second trial. A total of 443 *E. loftini* larvae were recovered in this experiment, 356 of which were recovered from the cages where adult *L. jalisco* females were released, giving an average of 1.8 stalkborers per stalk. Excluding data from the control cage, total (all parasitoid species included) percent parasitism was 30.9% (110 of 356). Percent parasitism by *Chelonus sonorensis* Cameron (Hymenoptera: Braconidae) reached 27.8% (99 of 356), largely exceeding parasitism by *L. jalisco* (2.8%; 10 of 356) and *Digonogastra solitaria* Wharton & Quicke (Hymenoptera: Braconidae) (0.3%; 1 of 356). Stalkborer larvae recovered from ablated stalks and parasitized by parasitoids other than *L. jalisco* were more than likely parasitized before sugarcane stalks were collected for the purpose of this study.

Third trial. Although large numbers of *E. loftini* larvae and adult females were released into each cage, sugarcane stalks showed a very low level of infestation. Only 30 stalkborers were recovered from all 250 growing stalks, 3 of which originated from the stalks of the control cage. Two parasitoids developed, one *C. sonorensis* and one *Parallorhogas (Allorhogas) pyralophagus* Marsh (Hymenoptera: Braconidae). Although apparently heavily damaged, the ablated stalks were not heavily infested either. A recovery of 29 stalkborers was made, 6 of which were found parasitized by *C. sonorensis*. No *L. jalisco* progeny was recovered from any of those stalkborer larvae.

Fourth trial. Numbers of stalkborer larvae and parasitoids recovered from different host plants are shown in Table 1. Except from corn where a few (n = 4) *Diatraea lineolata* (Walker) (Lepidoptera: Pyralidae) larvae were collected, all stalkborer larvae recovered were *E. loftini*. A total of 328 *E. loftini* larvae were recovered, 67 of which were from the control cage. The success of artificial stalk infestation varied greatly among host plants. Overall, percentage parasitism by *L. jalisco* was 5.7% (15 of 261). Females of *L. jalisco* exhibited a preference for *E. loftini* larvae feeding on sugarcane stalks compared to other host plants (X^2 = 12.71; d.f. = 3; P = 0.005), however the number of parasitoids recovered was low in all cages.

Open-Field *L. jalisco* Releases

Number of stalkborers and parasitoids recovered from samples collected at the Hardwicke Farm and the TAES sugarcane plot are presented in Tables 2 and 3, respectively. From August to November 1999, mean percentage of stalkborer damage at the Hardwicke Farm plantation was 23.1%. We collected an average of 1.8 stalkborer larvae per sugarcane stalk (848 in 480 sampled stalks). An additional 35 stalkborers were parasitized (cocoon) at the time of collection. Infestation by *E. loftini* comprised 98.3% (834 of 848) of the total stalkborer infestation. Remaining stalkborers were all *Diatraea saccharalis* F. (Lepidoptera: Pyralidae). On average, 12.0% (106 of 883) of recovered stalkborers were parasitized and the percentage of parasitism gradually increased over the season, starting at 6.0% and reaching about 14.0% at the end of

Table 3. Stalkborers and parasitoids recovered from sugarcane stalks collected at the TABS plot in 1999.

Sampling date		Number collected	Number parasitized	Parasitoids	
				Chelonus sonorensis	Digonogastra solitaria
Regular stalks[z]					
09/23/99	Foreuma loftini	13	0		
	Parasitoid cocoons	0			
10/05/99	Foreuma loftini	22	3	3	
	Parasitoid cocoons	0			
10/21/99	Foreuma loftini	21	1	1	
	Parasitoid cocoons	0			
11/22/99	Foreuma loftini	17	0		
	Parasitoid cocoons	0			
Ablated stalks[y]					
10/19/99	Foreuma loftini	50	8	8	
	Parasitoid cocoons	2		2	
11/15/99	Foreuma loftini	39	10	10	
	Parasitoid cocoons	0			
12/02/99	Foreuma loftini	83	9	9	
	Parasitoid cocoons	1			1

[z]Sample of 60 sugarcane stalks
[y]Sample of 50 sugarcane stalks

the season (Table 2). *Chelonus sonorensis* (8.0%; 71 of 883) and *D. solitaria* (3.3%; 29 of 883) were most abundant. In comparison, in 1999, mean percentage of stalkborer damage was 5.9 % at the TAES sugarcane plot, with a mean of 0.4 stalkborer larva collected per stalk. Additional (ablated) stalks collected at the Cannon Farm showed a 28.5% stalkborer damage, each stalk bearing 1.2 stalkborer larvae on average. No *D. saccharalis* were recovered from the stalks collected at the TAES sugarcane plot, neither at the Cannon Farm. Mean percentage parasitism was 5.5% (4 of 73) at the TAES plot; only *C. sonorensis* was recovered (Table 3). In the ablated stalks, 17.1% (30 of 175) of stalkborers collected were parasitized, mostly by *C. sonorensis* (16.6%; 29 of 175). None of the stalkborers recovered were parasitized by *L. jalisco* at either site.

DISCUSSION

During 1999 and 2000, considerable efforts were made to study *L. jalisco*, especially its potential to successfully parasitize *E. loftini* larvae developing on different susceptible crops under local environmental conditions. Sugarcane and other important gramineous host crops were therefore tested using walk-in field cages. Parasitoid releases showed that *L. jalisco* parasitized *E. loftini* larvae established on sugarcane, corn, rice and sorghum (grain and forage). In field-cages, percent parasitism by *L. jalisco* varied between 0 and 6.8% of MRB larvae recovered. Female parasitoids exhibited a preference for *E. loftini* larvae established on sugarcane, followed by corn, rice and sorghum, which is consistent with data from a previous experiment performed under semi-natural (greenhouse) conditions (Legaspi et al. 2000b).

Crops planted at the TAES experimental plots did not show stalkborer damage from natural infestation. Artificial plant infestation using MRB larvae from our stock colony was not as successful as we expected. When successful, stalkborer infestation did not exceed 1.1 stalkborer larvae per plant. In comparison, the percentage of stalkborer infestation averaged 1.8 stalkborer larvae per sugarcane stalk collected from local commercial plantations. Adverse environmental conditions, the presence of numerous predators, and eventually, the decreased vigor of diet-reared *E. loftini* probably combined to prevent released stalkborers from establishing successfully on the plants.

As an alternative, ablated sugarcane stalks collected locally in commercial plantations did offer a higher number of potential hosts for *L. jalisco*. However, sugarcane stalks sustaining heavy damage were old, i.e., 10- and 8-month-old in Trials 2 and 3, respectively, which may have contributed to the relatively low percentage of parasitism (<3%) of *E. loftini* by *L. jalisco* we observed. Indeed, old stalkborer tunnels are packed with old, dry frass, undoubtedly making it difficult for first instar *L. jalisco* larvae to reach hidden hosts.

Environmental conditions at the time of parasitoid releases also had a major impact on the parasitoid's ability to successfully parasitize *E. loftini*. Heat and low relative humidity as encountered in the LRGV of Texas especially from May through September greatly affect parasitoid survival. The longevity of honey-fed mated *L. jalisco* females is 13.57 ± 8.07 days at 22ºC (Lauzière et al. 2000). However, recent laboratory observations indicated that adult female longevity decreased to 6.2 ± 2.2 and 4.7 ± 1.2 days at a temperature of 30 and 40ºC, respectively (Lauzière et al. 2002). Daytime temperatures exceeding 35ºC and relative humidities of 40 to 50% were recorded during performance of Trials 1, 3 and 4 (June, April and July) between 11:00 and 18:00. In accordance with recent observations of reproductive development in *L. jalisco* mated females, first instar larvae are available in 7- to 21-day-old females with a maximum production between days 9 and 14 (Lauzière et al. 2000). Consequently, 5- to 7-day-old female parasitoids released in Trials 1 and 3, even when successfully mated, may have died without having the possibility of completing egg maturation, and therefore oviposition.

In 1999, open-field releases also took place in two sugarcane fields, one commercial and one experimental, in the LRGV of Texas. Although significant sampling efforts were made at both sites, *L. jalisco* was never recovered, though relatively small numbers of adult parasitoids were released. Overall, naturally occurring parasitism of MRB larvae recovered in sugarcane stalks harvested from commercial plantations near Weslaco, Texas, was 14.9% (233 of 1565) in 1999. Parasitoid species commonly recovered in our samples were the native parasitoids *C. sonorensis* and *D. solitaria*, as well as the introduced species, *P. pyralophagus*, all three in the family Braconidae. The egg-larval parasitoid *C. sonorensis* predominated with 14.4% (225 of 1565) of stalkborer larvae collected in sugarcane stalks parasitized. To a much lesser extent, *D. solitaria*, a larval ectoparasitoid of *E. loftini* parasitized between 0.3 and 3.3% of MRB larvae recovered according to the site and time of the year. This parasitoid species is essentially identical to *D. kimballi*, the latter being gregarious (Wharton et al. 1989). The larval ectoparasitoid *P. pyralophagus* also had a minimal impact on *E. loftini* populations with percent parasitism reaching 0.3% of stalkborer larvae recovered.

A combination of abiotic and biotic factors were shown to have an important impact on the establishment and success of *L. jalisco* as a biological control agent of *E. loftini* in Texas. Because adult longevity is greatly shortened at elevated ambient temperatures, best results were obtained in field-cages trials when releasing older mated *L. jalisco* females which presented a higher probability of carrying fully incubated eggs directly used for oviposition. Release trials taking place during the fall and spring when temperatures are more favorable to *L. jalisco* may be more successful and should be considered in the LRGV of Texas. While biological requisites for successful introduction and establishment of *L. jalisco* may not be fully met in south Texas, this parasitoid may have some potential in reducing populations of the MRB in cooler areas north of Texas, should this stalkborer become established northward on crops like corn, sorghum or rice. Furthermore, although *E. loftini* is not the key pest of sugarcane in Ameca, Jalisco, Mexico (< 5% bored internodes; Legaspi et al. 2000a), biological control by augmentation of *L. jalisco* might have a significant impact on *E. loftini* populations. To a lesser extent, *L. jalisco* also develops to adulthood from other stalkborers such as *D. saccharalis* and *D. grandiosella* Dyar (I. Lauzière unpublished data), suggesting possible impact against other stalkborers.

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