INCIDENCE OF MEXICAN RICE BORER (LEPIDOPTERA: PYRALIDAE) AND JALISCO FLY PARASITE (DIPTERA: TACHINIDAE) IN MEXICO

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ABSTRACT

We surveyed the incidence of *Eoreuma loftini* (Dyar) (Lepidoptera: Pyralidae) in selected fields in the state of Jalisco, Mexico, in October, 1998, and collected borer larvae from eight sites from August 1998 to March 1999 to measure parasitism and to initiate a colony of the Jalisco fly, *Lydella jalisco* Woodley (Diptera: Tachinidae). Sugarcane injury from *E. loftini* larval tunneling was relatively low, ranging from 3-4.4% bored internodes. Bored internodes caused by another stalkborer, *Diatraea considerata* Heinrich (Pyralidae), ranged from 1.3-6.3%. The extant stalkborer population was almost equally divided between the two species. A total of 3,040 *E. loftini* larvae were collected, 209 of which were parasitized (6.9%). *Lydella jalisco* was collected most consistently from the Los Lirios, Ejido Caimanero locality, which yielded 16.1% parasitism (193 fly larvae/1,197 borer larvae). Parasitization by *L. jalisco* was most successful from mid-August (1998) to mid-October when parasitism was close to 30%. After mid-October, *L. jalisco* declined and parasitism was predominantly due to the egg-larval parasite *Chelonus sonorensis* Cameron (Hymenoptera: Braconidae).

INTRODUCTION

The sugarcane industry of Texas is largely confined to the Lower Rio Grande Valley along the Mexican border where it is an important component of the local agriculture. Land planted to sugarcane is variable, but averages about 18,000 ha, producing annual gross income of as much as $64 million. Stalk-boring Lepidoptera have been the most serious pests

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of sugarcane in southern Texas since the early 1970's. Currently, the key pest is the Mexican rice borer, *Eoreuma loftini* (Dyar) (Lepidoptera: Pyralidae) (Legaspi et al. 1997a, Meagher et al. 1998) , an exotic pest from Mexico first reported in Texas in 1980 (Johnson 1984). In a typical season, *E. loftini* damages about 20% of the cane internodes, which translates to annual losses of $10-20 million (Legaspi et al. 1999). However, local growers do not apply insecticides to sugarcane to control infestations of *E. loftini* larvae because of the protection afforded the concealed larvae boring in the stalk. The characteristic tunneling behavior of the larvae reduces larval exposure to insecticides and precludes insecticides as a viable economic tactic for controlling this pest (Meagher et al. 1998).

To mitigate economic losses due to *E. loftini*, numerous explorations have been conducted in its native Mexico for parasites as biological control agents. Parasites reared from *E. loftini* in Mexico included: *Chelonus sonorensis* Cameron (Hymenoptera: Braconidae); *Macrocentrus prolificus* Wharton (Braconidae); *Allorhogas pyralophagus* Marsh (Braconidae); *Orgilus gelechiaevorus* (Cushman) (Braconidae); *Mallochia pyralidis* Wharton (Hymenoptera: Ichneumonidae); and the Jalisco fly, *Lydella jalisco* Woodley (Diptera: Tachinidae) (Rodríguez-del-Bosque and Smith 1996, 1997). The Jalisco fly was discovered in 1988 during a survey of stalk-boring pyralidae in the Ameca Valley, Jalisco, Mexico (Rodríguez-del-Bosque and Smith 1996). Parasitized borers were imported into the Biological Control Laboratory at Texas A&M University (College Station). A sample of 16 borers collected from a commercial sugarcane field in Ejido Caimanero in the Ameca Valley, near Guadalajara, Jalisco, on 30 May 1988, yielded one female and three males of a previously unrecorded tachinid, later described as a new species, *Lydella jalisco* (Woodley 1994).

A subsequent and more intensive survey in September 1988 yielded 304 borer larvae, 101 (33%) of which were parasitized. Extensive previous and subsequent surveys failed to detect the fly in other areas of Mexico or on other hosts (Rodríguez-del-Bosque and Smith 1996). Accordingly, the host-parasitoid relationship was believed to be restricted both geographically and biologically. Emerging adults were the founders for a laboratory colony which was used for subsequent biological research. The high levels of recorded field parasitism, as well as the apparent specificity for the target host suggested that the Jalisco fly was a promising candidate for biological control of *E. loftini*. Consequently, field colonization trials were performed in south Texas sugarcane fields. From April to November 1989, 3,015 presumably-mated adult flies were released in sugarcane fields into the Lower Rio Grande Valley (Pfannenstiel et al. 1990). Subsequent surveys yielded 13 *E. loftini* larvae parasitized by *L. jalisco*, which the authors considered encouraging given the small number of flies released.

In April 1998, the USDA ARS Kika de la Garza Subtropical Agricultural Research Center and the Texas Agricultural Experiment Station (both in Weslaco, Texas), initiated a three-year collaborative research project to import and evaluate *L. jalisco* as a biological control agent against *E. loftini*. The project was facilitated by support from the Department of Entomology, Texas A&M University (College Station, Texas) and the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP) (Mexico City, Guadalajara, and Ameca Stations). This bi-national research project provides the best opportunity to date for biological control of the Mexican rice borer in southern Texas. In this paper, we report results of the first stage of the project, local surveys and collections of *E. loftini* larvae from several sugarcane fields in the Ameca Valley, Jalisco, Mexico.

MATERIALS AND METHODS

Monthly mean air temperatures (°C) and rainfall (mm) for the City of Ameca, Jalisco and Weslaco, Texas were compared using historical data recorded since January 1990. Weather data from Ameca were obtained from the Secretaria de Agricultura Ganadería y Desarrollo Rural (SAGAR) and those for Weslaco from the Texas Agricultural Experiment Station. Three sampling sites were selected to assess the levels of damage caused by *E. loftini* and other stalk-borers native to southwestern Mexico. The sugarcane fields selected were 'El Bajío, Ejido Caimanero' (Ameca) situated 20° 32' 02" N, 103° 59' 54" W, (sugarcane variety 'MEX 57473'; sampled 21 October 1998); 'Los Lirios, Ejido Caimanero' (Ameca) situated 20° 33' 13" N, 103° 59' 14" W ('CP 2648'; 22 October 1998); and, 'Los Amezcua, Ejido Tala' (Tala) situated 20° 38' 20" N, 103° 42' 48" W (no. '1410-2086-290'; 21 October 1998). At each sampling site, 60 sugarcane stalks were randomly selected, excised and split longitudinally. For each excised stalk, the following information was recorded: total number of internodes, number of nodes damaged by *E. loftini*, number of *E. loftini* recovered, number of internodes damaged by other stalkborers, number of other stalkborers, and number of parasites found.

Eight sugarcane fields were chosen in Ameca and Tala, Jalisco, for collecting larvae of *E. loftini*. Collections are reported from 18 August 1998 to 22 March 1999, essentially a full crop season. The sugarcane fields within the municipality of Ameca were 'La Cajilota (Ejido Caimanero)' planted to variety 'MEX 57473' ,'El Bajío (Ejido Caimanero)' 'MEX 57473', 'Los Lirios (Ejido Caimanero)' 'CP 2648', 'Los Tanques (Ejido Ameca)' (cane variety not recorded), and 'El Saus amarillo (Ejido San Ignacio)' variety known locally as 'Morada'. In the Tala municipality, the fields selected were Los Espinos (Ejido Cuisillos)', 'Los Amezcua (Ejido Tala)', and 'Los Espinos (Ejido Tala)'. Fields in Tala were planted to varieties known locally as numbers '1410', '2086', and '290'. Workers attempted to collect as many *E. loftini* larvae as possible during each collection effort. Sugarcane plants were examined for external damage (holes or purplish discoloration characteristic of *E. loftini* larval tunneling (Legaspi et al. 1997b). Larvae were placed into 5/8 oz (18.5 ml) plastic cups (Fill Rite, Newark, NJ), containing artificial diet (Martinez et al. 1988), and covered with 37.5 mm polycoated pull tab caps (Stanpac, Lewiston, NY). The larvae were transported to Entomology Quarantine, Biological Control Laboratory, Department of Entomology, College Station, Texas, for observation and parasite retrieval. Emergent adult Jalisco flies were identified, sexed, checked for contamination, and shipped to the Texas Agricultural Experiment Station in Weslaco for laboratory colony establishment and biological study.

RESULTS

Monthly mean air temperatures between Weslaco, Texas, (23.7 ± 5.1 °C, $\bar{x}$ ± SD; range = 16.0-30.0) and Ameca City, Mexico, (22.7 ± 2.9 °C; range = 18.0-26.6 °C) were not significantly different when analyzed on a yearly basis (paired *t*-test = 1.3; df = 11; $P = 0.2$) (Fig. 1A). However, over the critical sugarcane growing period from May to October, mean monthly temperatures in Mexico (25.2 ± 0.9 °C; range = 23.9-26.6 °C) were cooler than in Texas (28.0 ± 2.2 °C; range = 24.4-29.9 °C) (paired *t*-test = 3.7; df = 5; $P = 0.013$). Rainfall between the two localities was quite variable (Fig. 1B). Monthly rainfall in Ameca (79.02 ± 89.4 mm, $\bar{x}$ ± SD) was not significantly different from that of Weslaco (53.6 ± 29.7 mm) (paired *t*-test = 1.05; df = 11; $P = 0.32$).

At El Bajío, the 60 sugarcane stalks sampled contained a total of 834 internodes. Of the total internodes, 25 were injured by *E. loftini*, resulting in about 3% bored internodes. A total of 15 *E. loftini* larvae were collected, indicating a mean of about 0.25 borers per plant

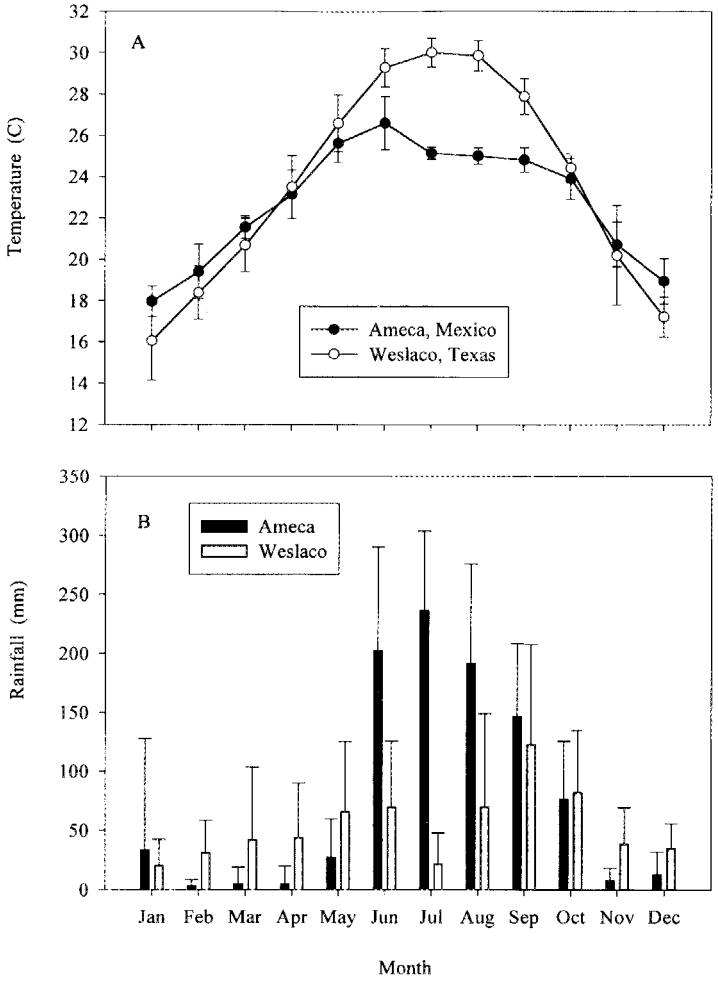

FIG. 1. A) Mean monthly (± SD) temperatures (^{o}C) and B) rainfall (mm) for the Ameca Valley, Mexico, and Weslaco, Texas, from 1990 to 1999 (February for Mexico, April for Texas).

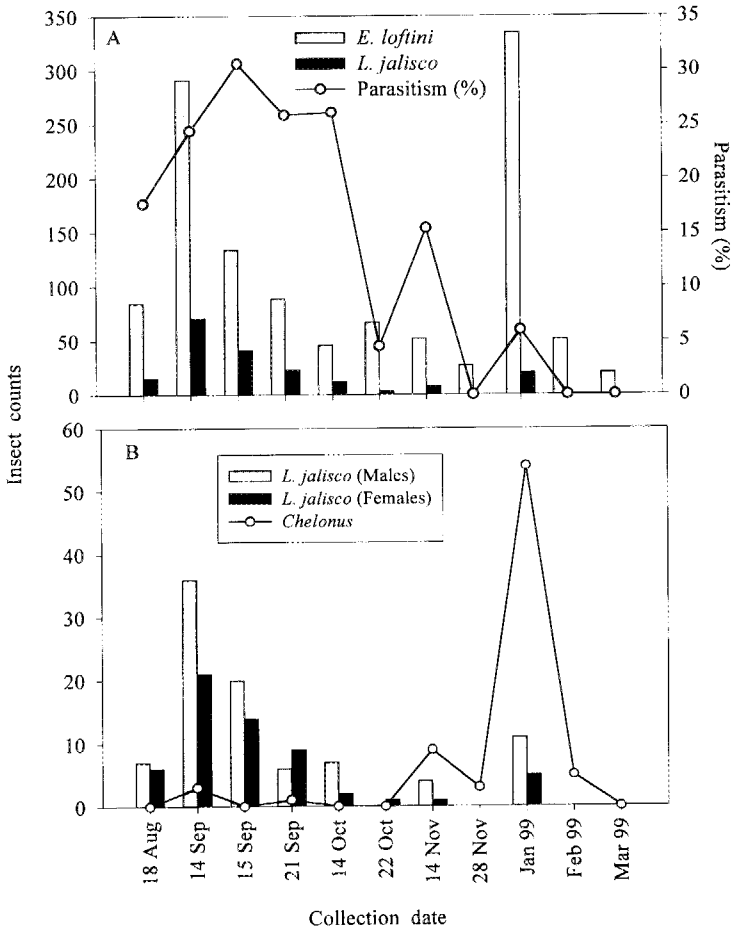

FIG. 2. Collections of *E. loftini* from Los Lirios, Ejido Caimanero, Ameca, Jalisco, Mexico (August 1998 to March 1999). A) Numbers of *E. loftini* and *L. jalisco*, together with corresponding percentage parasitism. B) Jalisco flies shown by sex, together with incidence of *Chelonus sonorensis*.

(15/60). The percentage of bored internodes due to the stalkborer *Diatraea considerata* Heinrich (determined by A. Solis, USDA Systematic Entomology Laboratory, Beltsville, MD), was about 6.1% (51/834), roughly twice that caused by *E. loftini*. A total of 21 larvae of *D. considerata* were recovered from the samples, with a mean infestation per plant of about 0.35 (21/60).

At Los Lirios, 1,076 internodes were recorded. Of the total internodes, 47 were injured by *E. loftini* larvae, resulting in about 4.4% bored internodes. A total of 21 *E. loftini* larvae were collected, with a mean of about 0.35 borers per plant (21/60). The percentage of bored internodes due to *D. considerata* larvae was about 6.3% (68/1,076). A total of 13 larvae of *D. considerata* were recovered from the samples, with a mean infestation per plant of about 0.2 (13/60). At Los Amezcua, 827 internodes were recorded; 29 were injured by *E. loftini*, resulting in 3.5% bored internodes. Nine *E. loftini* larvae were collected, with a mean of about 0.15 borers per plant (9/60). Bored internodes due to *D. considerata* was about 1.3% (11/827). No *D. considerata* larvae were recovered.

A total of 3,040 *E. loftini* larvae were recovered from the sugarcane fields, but parasitization by the Jalisco fly was variable among locations (Table 1). From a total of 79 borers recovered from the field, 45 (57%) were *E. loftini*, the remaining 34 (43%) being *D. considerata*. Of the *E. loftini* larvae collected, 209 were parasitized by *L. jalisco* indicating an overall percentage parasitism of 6.9% (209/3,040). However, site specific parasitism was variable. The site where *L. jalisco* was collected most consistently was Los Lirios (Ejido Caimanero), which yielded 16.1% parasitism (193/1,197). Collection of the fly was most successful from mid-August (1998) to mid-October when parasitism was close to 30% (Fig. 2). After mid-October, parasitism was predominantly due to *C. sonorensis* (Fig. 3B). In comparison, collections from Los Espinos, Ejido Tala, yielded many borers from November to mid-December (1998) (Fig. 3), but only two Jalisco flies were recovered from collections conducted on 26 November 1998. *E. loftini* larvae were predominately parasitized by *C. sonorensis* with 13.8% parasitism (132/957) over the collection period.

DISCUSSION

More than 72,000 ha are planted to sugarcane in the state of Jalisco, compared to 18,000 ha in Texas. About 6,300 ha is grown in the Ameca area, and 11,240 ha in Tala (INEGI 1998). For the field sites sampled in Mexico, damage due to *E. loftini* was relatively low, ranging from 3-4.4% bored internodes, much less than the 20% commonly reported in the Lower Rio Grande Valley of Texas (Legaspi et al. 1999). Damage caused by *D. considerata* also was quite low, ranging from 1.3-6.3%. The endemic stalkborer population sampled was almost equally divided between these two species. Much of the information known about *D. considerata* details the distribution and host range of its parasitoid, *Apanteles deplanatus* Muesebeck (Hymenoptera: Braconidae), in Mexico (Smith and Rodríguez-del-Bosque 1994, Rodríguez-del-Bosque and Smith 1997). *D. considerata* larvae were collected from sugarcane along the western coast of Mexico in the states of Sinaloa, Nayarit, Jalisco, Michoacan, and Colima. *Apanteles deplanatus* is a common parasite of *D. considerata* in Nayarit, Jalisco, and Michoacan, states just to the south of Sinaloa (Smith and Rodríguez-del-Bosque 1994).

From 1981-1989, Rodríguez-del-Bosque and Smith (1996) conducted a large-scale survey for stalk-borers and their parasitoids throughout the major sugarcane growing areas of Mexico. In addition to sugarcane, insect samples were taken from field corn (*Zea mays* L.), grain sorghum (*Sorghum bicolor* (L.) Moench), johnsongrass (*Sorghum halepense* (L.) Pers.) and other noncultivated wild grasses near sugarcane fields. Several stalkborer species were collected, including *E. loftini*, *Diatraea lineolata* (Walker), *D. considerata*, *D.*

TABLE 1. Field Collections of *E. Loftini* Larvae from Sugarcane in the Ameca Valley, Jalisco, Mexico.

Field	Collection date(s)	*Eoreuma loftini*	*Lydella jalisco*[a]	Other parasitoids[b]
La Cajilota, Ejido Caimanero	8/18/98	49	0	*Chelonus* (3), unknown (1)
Los Espinos, Ejido Cuisillos	10/5/98	34	0	*Chelonus* (3)
Los Amezcua, Ejido Tala	10/5/98 -11/12/98	277	4?	*Chelonus* (15), unknown (5)
El Bajío, Ejido Caimanero	9/15/98 - 3/12/99	432	4♂, 2♀	*Bracon* sp. (1), *Chelonus* (22), *Allorhogas* (1), *Palpozenillia* spp. (3)
Los Espinos, Ejido Tala[c]	11/13/98 - 12/14/98	957	2?	*Chelonus* (132), *Mallochia* (1), unknown (4)
Los Lirios, Ejido Caimanero[d]	8/18/98 - 3/22/99	1197	91♂, 59♀, 43?	*Chelonus* (75), *Bracon* sp. (1), unknown (19)
Los Tanques, Ejido Ameca	9/21/98 - 10/2/98	26	1♀	(none)
El Saus amarillo, Ejido San Ignacio	3/16/99 - 3/19/99	68	0	*Chelonus* (2)

[a] '?' indicates death as pupae prior to determination of sex

[b] Specific names: *Chelonus sonorensis, Allorhogas pyralophagus, Mallochia pyralidis*; *Palpozenillia* (Tachinidae); numbers collected in parentheses

[c] See Fig. 3 for details

[d] See Fig. 2 for details

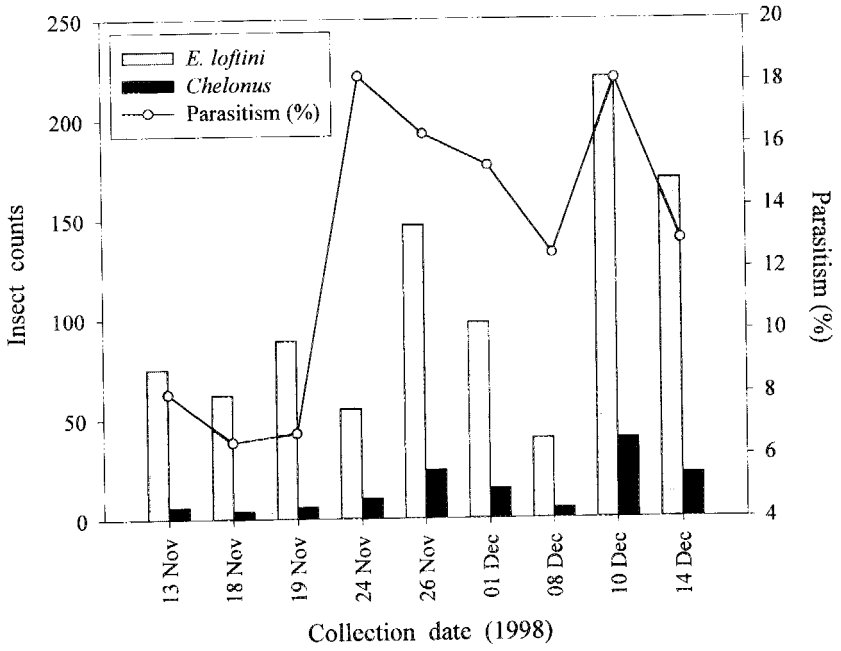

FIG. 3. Collections from Los Espinos, Ejido Tala (Tala, Jalisco, Mexico). Bars indicate numbers of *E. loftini* collected and numbers of *Chelonus sonorensis* reared from larvae. The line indicates corresponding percentage parasitism.

saccharalis (F.), and *D. magnifactella* (Dyar). *L. jalisco* was reared only from *E. loftini* and only from borers collected in the Ameca Valley. Laboratory host specificity experiments using alternate hosts, including *D. considerata, D. grandiosella, D. saccharalis*, and *Galleria mellonella* (L.) (Lepidoptera: Galleridae) further indicated that *L. jalisco* was specific to *E. loftini* (Smith and Rodríguez-del-Bosque 1994).

The relatively cooler temperatures of the native habitat of *L. jalisco* during the critical sugarcane growing season may affect its efficacy as a biological control agent in southern Texas. The city of Ameca has an altitude of 1,250 m, and Tala of 1,330 m (INEGI 1998), compared to the Lower Rio Grande Valley which is close to sea level. Field tests in sugarcane and other gramineous crops are currently underway in southern Texas to evaluate the efficacy of *L. jalisco* under local climatic conditions. Other parasitoids reared from borer larvae were single specimens of *Mallochia pyralidis* Wharton (Hymenoptera: Ichneumonidae) and *Allorhogas pyralophagus* Marsh (Braconidae). There were 29 unidentified parasitoids collected (Table 1). Future collection efforts for *L. jalisco* should focus on Los Lirios during fall seasons because of the likelihood of success.

Overall parasitism by *C. sonorensis* was 8.3% (252/3,040), slightly higher than the overall 6.9% found for *L. jalisco*. It is difficult to draw general conclusions regarding the phenologies of the host insect and these two parasitoids because their relative abundances are no doubt related to the collection efforts made at specific sites during the field season. Nevertheless, it is apparent that the abundance of *L. jalisco* at Los Lirios, Ejido Caimanero, declines in late October, after which *C. sonorensis* becomes the dominant parasitoid. At Los Espinos, Ejido Tala, *C. sonorensis* was dominant during the cooler months of November and December. Because collection efforts were not made during August and September, it is not possible to know whether *L. jalisco* was present at this site earlier in the season. *Chelonus sonorensis* is the dominant parasitoid of *E. loftini* in sugarcane in the Lower Rio Grande Valley, comprising 50-95% of parasitoids reared from field-collected larvae during the 1990s (Legaspi et al. 1997a). Although it a common parasitoid during the winter in Mexico, *C. sonorensis* is apparently acclimated to the southern Texas climate.

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