**ABSTRACT.** Chagas disease, caused by *Trypanosoma cruzi* Chagas, is one of the most epidemiologically important vector-borne zoonoses in Mexico. Among the 32 reported triatomine species from Mexico, *Meccus mazzottii* (Usinger) (Hemiptera: Reduviidae) is one of the most important vectors of *T. cruzi* in the southern part of the country. Variability among populations of triatomines has been recorded for several species (*Meccus longipennis* Usinger and *Meccus pollidipennis* Stal) that are closely related to *M. mazzottii*, showing an apparent influence of local environmental conditions on the biology of each population, which could modify the impact of vector control measurements. Therefore, this study sought to compare the biological features of populations of *M. mazzottii* from two geographically far apart areas that have similar environmental characteristics to compare populations from close geographical areas that have different environmental characteristics. The mean longevity, percentages of mortality of nymphs, the total mean number of bloodmeals to molt (considered instar by instar), the mean number of eggs laid by females, and the percentage of hatched eggs were similar between the two localities that are geographically far apart but have similar environmental characteristics. On the other hand, important differences were noticed when a comparison was carried out on the two localities with similar environmental conditions with respect to that locality with different conditions, independent of geographic distance. Most of the studied parameters led us to conclude that the three studied populations are very highly influenced by local environmental conditions. The results of this study indicate the importance of studying the biological characteristics of local populations of triatomines to carry out specific control measurements, instead of using standard ones that could fail if they are not adapted to the target population.

**Key Words:** *Meccus mazzottii*, population, biological variation, life statistics, laboratory condition
assessed in three cohorts of populations of *M. mazzottii* from a range of distinct isolated habitats in Mexico.

**Materials and Methods**

Although laboratory rearing imposes a certain degree of selection pressure on aspects of triatomine biology, all colonies were exposed to standardized environmental conditions that were favorable to triatomine survival. Hence, it was assumed that estimates of biological parameters derived from data collected from the colonized wild populations represent a maximum expression of their biological parameters and are likely to reflect true differences between geographically isolated populations. Similar assumptions were made by Suman et al. (2011) to compare the life-table strategies of geographically distinct strains of *Culex quinquefasciatus* after colonization in standard laboratory conditions for many generations.

**Triatomines.** To carry out this study, three laboratory colonies of *M. mazzottii* established in 2011 from at least 30 specimens were used. These triatomines were collected in two localities (Santiago Textitlán, 16° 41’ N, 97° 15’ W and Santo Reyes Nopala, 16° 06’ N, 97° 09’ W) that are close to each other (≈70 km) in the Oaxaca state but which have different environmental characteristics. A third colony was initiated with specimens from El Parotal (17° 35’ N, 100° 59’ W) in the state of Guerrero, a locality about 480–500 km west of the two localities in the state of Oaxaca (Fig. 1), with environmental characteristics (Secretaría de Gobernación (SEGOB) 2010) similar to those of Santo Reyes Nopala (Table 1). The specimens were identified according to the taxonomic key of Lent and Wygodzinsky (1979), taking into account the revalidation of the genus *Meccus* (Carcavallo et al. 2000).

**Biology.** Colonies were maintained under conditions similar to those in a previously published study on the biology of *M. mazzottii* (Martínez-Ibarra et al. 2006), at 27 ± 1°C and 75 ± 5% relative humidity (RH) and a photoperiod of 12:12 (L/D) h. Individuals were fed on immobilized and anesthetized New Zealand rabbits (*Oryctolagus cuniculus*) on a fortnightly basis. The rabbits were anesthetized according to the Norma Oficial Mexicana regulations using 0.25 ml/kg of ketamine, which was applied intramuscularly according to established guidelines (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA) 1999). Eggs from a minimum of 10 females of each colony were grouped by date of oviposition to initiate a cohort by population of 100 eggs each. After eclosion, the groups of each species of first-instar nymphs were separated individually into

### Table 1. Environmental characteristics of the localities where founders of the three studied populations of *M. mazzottii* were initially collected

| Environmental characteristics | Santiago Textitlán | El Parotal | Santos Reyes Nopala |
|------------------------------|-------------------|------------|---------------------|
| Altitude (m.a.s.l.)           | 1,710             | 260        | 460                 |
| Climate                       | Cw                | Aw         | Aw                  |
| Vegetation                    | Pinus hartwegii   | P. teocote | P. teocote          |
|                              | Quercus spp.      | Enterolobium cyclocarpum | E. cyclocarpum |
| Abies religiosa               | Quercus alba      | Cedrela odorata |
|                              | Cedrela odorata   |             |
| Mean annual temperature       | 20°C              | 27°C       |                     |
| Pluvial precipitance (mm)     | 2,750             | 900        | 1,100               |

![Fig. 1. Locations where the populations were initially collected.](image-url)
plastic containers (5.5 cm in diameter by 10.5 cm in height), with an upcenter support of absorbent cardboard. Three days after eclosion, each cohort of nymphs was individually fed on New Zealand rabbits for a 1 h period; for the subsequent bloodmeals, they were fed weekly. Nymphs were observed at the end of feeding for recording of blood ingestion. The bugs were maintained in a dark incubator at 27 ± 1°C and 75 ± 5% RH and were checked daily for ecdysis or death. At the end of the cycle, the sex ratio of each studied cohort was recorded. From the insects that completed development to adult instar, 10 adult couples of each cohort were placed in individual containers (5.5 cm in diameter by 10.5 cm in height) and maintained as previously described to determine oviposition patterns. Eggs were collected every day along 30 d and placed in individual containers until hatching.

Statistical Analysis. Variables showing normal distribution were compared using a one-way analysis of variance (ANOVA). After that, the Holm–Sidak (HS) test was used to compare the amount of eggs laid per female, the developmental cycle periods, and the number of bloodmeals before molt in the three cohorts studied. The chi-square test was used to compare frequencies. Differences were considered significant at \( P < 0.05 \).

**Results**

Nonsignificant differences (ANOVA, \( F = 0.6, \text{df} = 2, P > 0.05 \)) were found when the longevity (d) of the eggs of the three studied populations was compared. On the other hand, significant differences (ANOVA, \( F = 6.32, \text{df} = 2, P < 0.01 \)) were found when the longevity (d) of the first-instar nymphs of the three studied populations was compared. However, nonsignificant differences (HS, \( t = 0.74, \text{df} = 1, P = 0.46 \)) were recorded when the populations from El Parotal and Santos Reyes Nopala were compared. Similar results were recorded when an instar-by-instar comparison of the three studied populations was carried out. Similarly, significant differences (ANOVA, \( F = 38.1, \text{df} = 2, P < 0.001 \)) were recorded when the longevity (d) from first-instar nymph to adult of the thee studied populations was also compared (Table 2). Nonsignificant differences (HS, \( t = 0.15, \text{df} = 1, P = 0.88 \)) were recorded when the populations from El Parotal and Santos Reyes Nopala were compared.

Percentages of mortality were higher in first- and second-instar nymphs. Percentages of mortality from first-instar nymph to adult were significantly different (\( \chi^2 = 11.55, \text{df} = 2, P = 0.03 \)) when the three studied populations were compared. The differences, however, were not significant (\( \chi^2 = 1.1, \text{df} = 2, P = 0.29 \)) when the populations from El Parotal and Santos Reyes Nopala were compared (Table 2).

The comparison on the total mean number of bloodmeals to molt growth stage by stage showed significant differences (\( P < 0.001 \)) in the population from Santiago Textitlán from the two other studied populations, except on third-instar nymphs when the three populations were not significantly different (ANOVA, \( F = 0.8, \text{df} = 2, P = 0.45 \)) and on second-instar nymphs when the three studied populations were different (ANOVA, \( F = 23.86, \text{df} = 2, P = 0.001 \)), one to each other (Table 3). The total mean of bloodmeals to molt from first-instar nymphs to adult was not significantly different (ANOVA, \( F = 1.41, \text{df} = 2, P = 0.32 \)) among the three studied populations (Table 3).

The mean numbers of eggs laid by the females of the three studied populations were significantly different (ANOVA, \( F = 9.65, \text{df} = 2, P < 0.001 \)) when the three studied populations were compared. However, the differences were not significant (HS, \( t = 1.63, \text{df} = 2, P = 0.11 \)) between the populations from Santiago Textitlán and El Parotal (Table 4). The mean numbers of hatched eggs laid by studied females were also significantly different (ANOVA, \( F = 8.67, \text{df} = 2, P < 0.001 \)) when the three studied populations were compared. The percentages of hatched eggs were significantly different (\( \chi^2 = 361.14, \text{df} = 2, P < 0.001 \)) among the three studied populations. Similar to some other studied biological parameters, the differences were not significant (\( \chi^2 = 0.59, \text{df} = 2, P = 0.44 \)) when the populations of the El Parotal and Santos Reyes Nopala were compared (Table 4).

**Discussion**

The mean longevity for the three studied cohorts was short (slightly longer than five months). They were similar to the longevity for three

### Table 2. The longevity (d) and mortality (%) of different growth stages of three populations of *M. mazzottii* under laboratory conditions

| Growth stage       | Santiago Textitlán Mean ± SD (d) | El Parotal Mean ± SD (d) | Santos Reyes Nopala Mean ± SD (d) | Mortality (%)                         |
|--------------------|----------------------------------|--------------------------|-----------------------------------|---------------------------------------|
| Egg                | 19.6 ± 2.8a                      | 20.6 ± 4.8a              |                                   |                                       |
| First nymph        | 24.1 ± 6.7a                      | 21.2 ± 5.10b             |                                   |                                       |
| Second nymph       | 24.64 ± 7.5a                     | 22.14 ± 3.57b            |                                   |                                       |
| Third nymph        | 28.67 ± 8.3b                     | 21.37 ± 4.68b            |                                   |                                       |
| Fourth nymph       | 43.46 ± 9.12a                    | 35.6 ± 10.10b            |                                   |                                       |
| Fifth nymph        | 59.78 ± 14.02a                   | 49.37 ± 9.44b            |                                   |                                       |
| First nymph to adult | 182.11 ± 14.67b               | 151.31 ± 13.19b          |                                   |                                       |

Different small letters among columns of longevity indicate significant differences (\( P < 0.05 \)). Different capital letters among columns of mortality indicate significant differences (\( P < 0.05 \)).

### Table 3. Number of bloodmeals to molt for three populations of *M. mazzottii* under laboratory conditions

| Growth stage       | Santiago Textitlán Number of bloodmeals | El Parotal Number of bloodmeals | Santos Reyes Nopala Number of bloodmeals |
|--------------------|-----------------------------------------|---------------------------------|------------------------------------------|
|                    | Min | Max | Total (mean ± SD) | Min | Max | Total (mean ± SD) | Min | Max | Total (mean ± SD) |
| First nymph        | 1   | 3   | 1.64 ± 0.28\(^a\) | 1   | 2   | 1.14 ± 0.35\(^b\) | 1   | 2   | 1.22 ± 0.42\(^b\) |
| Second nymph       | 1   | 4   | 2.02 ± 0.38\(^a\) | 1   | 3   | 1.61 ± 0.58\(^b\) | 1   | 2   | 1.15 ± 0.36\(^b\) |
| Third nymph        | 1   | 7   | 2.32 ± 0.41\(^a\) | 1   | 3   | 2.12 ± 0.71\(^b\) | 1   | 3   | 2.45 ± 0.56\(^b\) |
| Fourth nymph       | 1   | 6   | 2.45 ± 0.99\(^a\) | 1   | 4   | 3.03 ± 0.92\(^b\) | 1   | 5   | 3.17 ± 0.87\(^a\) |
| Fifth nymph        | 1   | 7   | 3.22 ± 1.04\(^a\) | 2   | 4   | 3.86 ± 1.01\(^b\) | 1   | 6   | 3.46 ± 0.97\(^b\) |
| First nymph to adult | 6   | 16  | 11.46 ± 3.67\(^a\) | 9   | 16  | 11.38 ± 4.01\(^a\) | 9   | 15  | 11.27 ± 3.31\(^b\) |

Different letters among columns indicate significant differences (\( P < 0.05 \)).
populations of *M. pallipennis* (143.73-162.37 d) and four of *M. longipennis* (173.9-181.8 d) (Martinez-Ibarra et al. 2012, 2013a,b), two closely related species, and members of the Phyllosoma complex, similar to *M. mazzottii*. Data for *M. mazzottii* (181.9 d) in a previous study (using specimens from the city of Oaxaca, in the state of Oaxaca) (Martinez-Ibarra et al. 2006) showed a longer mean longevity than the mean longevitys for two of the three studied populations of *M. mazzottii* in this study; in contrast, those data for the specimens from the city of Oaxaca were similar to those for the population from Santiago Textitlán, from this study. A possible explanation to that phenomenon is that the city of Oaxaca and Santiago Textitlán share some environmental characteristics, such as altitude, mean annual temperature, and vegetation (Cw) (Secretaría de Educación Pública (SEP) 2010).

Percentages of mortality were higher on the youngest nymphs of the three studied populations. The total mean of bloodmeals to molt from first-instar nymphs to adult was similar among the three studied populations. On the other hand, longevity, mortality, and the mean number of bloodmeals to molt, considering growth stage by stage, were similar in both localities (El Parotal and Santos Reyes Nopala) with similar environmental conditions (altitude, climate [Aw], vegetation, mean annual temperature, and pluvial precipitation), independent of the long geographical distance between them (≈500 km). In contrast, the comparison of the two close geographical (not farther apart by >70 km) populations sited in the state of Oaxaca (Santiago Textitlán and Santos Reyes Nopala), but with very different environmental conditions (as described above), showed important differences.

The mean number of eggs laid by females of the populations of Santiago Textitlán and El Parotal were between 50% and 75% higher than that mean number for females of the population from Santos Reyes Nopala. However, the percentage of hatched eggs was the highest (over 87%) in that last population. The percentages of hatched eggs (over 85%) in the populations from El Parotal and Santos Reyes Nopala contribute to explain the high abundance of *M. mazzottii* in these geographic areas and the scarcity of this species in Santiago Textitlán (Ramsey et al. 2000; Benitez-Alva et al. 2012).

As previously established (Dujardin et al. 2002), triatomines are “K” strategist, which frequently fix those most adapted phenotypes to each specific environment on their habitats, and they also regulate themselves according the capacity of supporting them by the environment. It has been also established that the most important climatic factors related to development of triatomines are the RH and the temperature. On that way, temperatures lower than 20°C affects triatomines metabolism producing an extension of the life cycles and sometimes, impacts in the reproductive cycle (Curto de Casas et al. 1999). Those established facts fit with those results for Santiago Textitlán on the current studied parameters, which apparently reflect the influence of nonfavorable environmental conditions on that town.

The results of this study lead to conclude that is important studying the biological characteristics of local populations of triatomines to carry out specific control measurements, instead of using standard ones that could have a not expected impact on the target population. That conclusion is complimentary to those from previous studies (Barbu et al. 2009, 2010, 2011) on *Triatoma dimidiata* dispersal characteristics and on nonconventional control of nondomiciliated triatomines, which suggest that spatially targeted interventions by pyrethroid spraying in the periphery of the village (with higher abundances of insects), use of insect screens, and peridomicile cleaning may allow to optimize the cost efficacy of vector control activities within villages.

**Table 4. Percentage of hatched eggs laid by three populations of *M. mazzottii* under laboratory conditions**

| Population            | Eggs laid | Hatched eggs | Percentage of hatched eggs ± SD |
|-----------------------|-----------|--------------|---------------------------------|
| Santiago Textitlán    | 731       | 347          | 47.47 ± 7.45^a                  |
| El Parotal            | 874       | 749          | 85.70 ± 8.74^a                  |
| Santos Reyes Nopala   | 492       | 429          | 87.20 ± 9.56^a                  |

Different letters among lines of the same column indicate significant differences (*P* < 0.05).

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