SHORT COMMUNICATION

Abundance and Parity Rate of *Lutzomyia cruciata* (Diptera: Psychodidae) in an Endemic Focus of Localized Cutaneous Leishmaniasis in Southern Mexico

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ABSTRACT Human bait catches were carried out from 5 through 27 March 1994 in an endemic focus of cutaneous leishmaniasis in the state of Campeche, Mexico. Females of *Lutzomyia cruciata* (Coquillet) were dissected and 67% were parous. The number of total and parous females collected per day was analyzed by time series, but neither the gonotrophic cycle length nor survivorship could be estimated. However, a survival rate per oviposition cycle of 0.68 was estimated from the least square regression of parous on total females. Additional evidence for *L. cruciata* as a vector of human leishmaniasis is discussed.

KEY WORDS *Lutzomyia cruciata*, age-structure, vector ecology, survivorship, Mexico

LOCALIZED CUTANEOUS LEISHMANIASIS is a serious health problem in the state of Campeche. During a survey of human-biting sand flies in Campeche in February 1994, 4 of 79 females (5.1%) of *Lutzomyia cruciata* (Coquillet) were found infected, possibly with *Leishmania mexicana* Biagi (E.A.R.-T., unpublished data). *Lutzomyia olmeca olmeca* (Vargas & Diaz-Najera) is presumed to be the primary vector (Biagi et al. 1965); however, other studies have indicated that *L. cruciata* also may be a vector of cutaneous leishmaniasis. In Belize, Disney (1968) found a 0.8% infection rate of *L. cruciata* and experimental transmission of *L. mexicana* by *L. cruciata* has been demonstrated (Williams 1970). More recently, *L. cruciata* has been reported as one of the more anthropophilic species of sand flies in Belize, with an infection rate of 0.2% (Rowton et al. 1991). In the state of Quintana Roo in the Yucatan Peninsula, Mexico, *L. cruciata* was the main human-biting species of sand fly, constituting 55.6% of the total specimens caught (Cruz-Ruiz et al. 1994). This species has been found infected in the state of Campeche, possibly with *L. mexicana* (F.J.A.-N., unpublished data).

Despite all the information gathered about the possible role of *L. cruciata* as vector of cutaneous leishmaniasis, little is known about the age structure of this species during the months before the outbreaks of leishmaniasis. One of most important parameters in vectorial capacity (Garrett-Jones 1964) is the estimate of daily survivorship (Milby and Reisen 1989) and the length of the gonotrophic cycle, an indication of blood-feeding frequency.

Because the annual peak of human cases of leishmaniasis is presented each year during May (N. Albertos-Alpuche, University of Yucatan, personal communication) and taking in consideration the incubation period of *L. mexicana* in humans (15–45 d), the month of March was selected to carry out the current study. The objectives were to describe the abundance and age structure of a *L. cruciata* population and to determine whether the data could be used to estimate the daily survivorship and the gonotrophic cycle length using time-cross series analysis (Birley and Rajagopalan 1981, Holmes and Birley 1987).

Material and Methods

Study Site. The study site was located 8 km southeast of the village La Libertad, county of Escarcega, state of Campeche, Mexico. The habitat was a subperennial tropical forest. The climate was classified as dry–humid with an annual rainfall of 1,400 mm and a mean temperature of 27°C (Flores and Espejel 1994). The altitude was 150 m. Some areas within the forest were cleared and planted mainly with corn. Because their houses are far from their work place, workers often spend the night in the forest, sleeping in small huts constructed with palm leaf and wood. One representative hut served as the collection site for this study.

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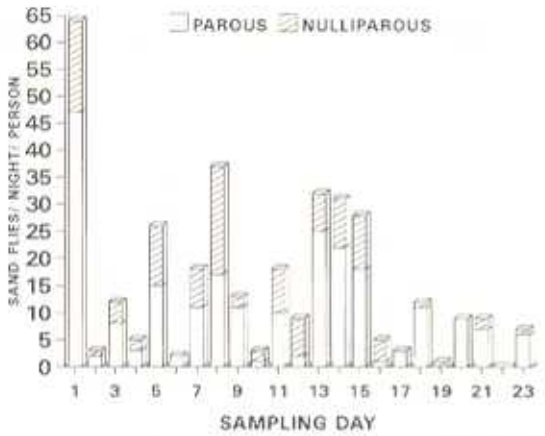

Fig. 1. Number of parous and nulliparous females of *L. cruciata* collected in a forest of Campeche state, Mexico, 5–27 March 1994 (night, 1800–2200 hours).

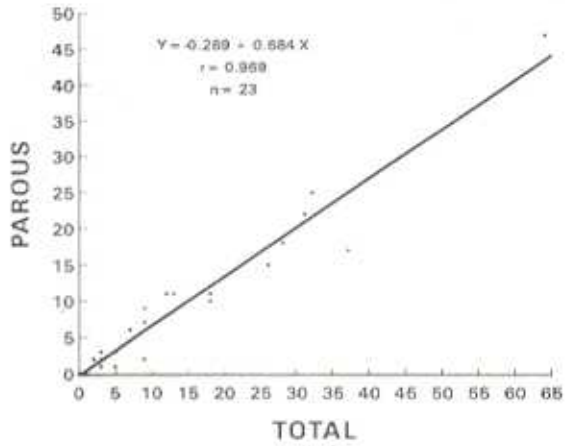

Fig. 2. Least-square regression of parous on total *L. cruciata* collected in Campeche, Mexico, 5–27 March 1994.

Sand Flies Collection and Processing. Landing collections were made daily from 5 through 27 March 1994, from 1800 to 2200 hours, the period when *L. cruciata* is most active (Biagi et al. 1966). Sand flies were collected by aspirator as they landed on the exposed arms and legs on a single bait (E.A.R.-T.). Sand flies were placed in labeled cryotubes containing a mixture of saline solution (0.65%) and glycerol (10%) (Evans et al. 1989), and frozen in liquid nitrogen.

Females were dissected in 0.65% saline to determine parity based on the morphology of the tracheolar system (Detinova 1962). Characteristics such as the cibarial teeth and shape of the spermateca identified females of *L. cruciata* from other sand flies (Forattini 1973).

Methods of Analysis. The total number and the number of parous *L. cruciata* collected each day were used to determine the daily parity rate. The slope of a least-square regression of parous females on total females of *L. cruciata* estimated the survival rate (Holmes and Birley 1987). A time series analysis of the number of parous and total *L. cruciata* collected each day was conducted with time lags of 0–10 d to estimate duration of the gonotrophic cycle and survivorship (Birley and Rajagopalan 1981). The time series were filtered using an autoregressive process with a lag of 1 d to exclude spurious but statistically significant cross-correlation coefficients. Values of cross-correlations exceeding the value of $\pm \sqrt{2/n}$ with n paired data points were considered statistically significant at 95% CI (Chatfield 1975).

Results and Discussion

Overall, 347 female *L. cruciata* were collected and dissected (Fig. 1). Approximately a 3- to 4-d pattern of peak abundance was found during the 23 d of collection. The maximum catch was on the 1st d, followed by lesser peaks at intervals of 3–4 d. Although no apparent change in parity was found, these 3- to 4-d intervals could represent the time elapsed between blood meals or emergence by a fraction of the population. Of 347 females caught, 231 (66.6%) were parous. Only unfed (i.e., not blood fed or gravid) females were found in human bait catches, indicating that *L. cruciata* does not take multiple blood meals within gonotrophic cycles. Because the number of dilations were not counted, there was no way to determine if *L. cruciata* females had >1 previous ovipositions.

Cross-correlations of total and parous females failed to provide a good estimate of either length of the gonotrophic cycle or survivorship. Nonsignificant cross-correlations could be caused by the low sample size of daily catches, and therefore the accuracy of parity rates, or that the formula of Chatfield (1975) might be too rigid (Mutero and Birley 1987). Alternatively, Holmes and Birley (1987) suggested that the slope of the linear regression of the number of parous females on total females may estimate the survival rate per gonotrophic cycle (Fig. 2). Using this method the survival rate was $\beta = 0.68$, and the fitted regression was highly significant (t-test = 17.97, df = 21, $P < 0.01$). This estimate is in close agreement with the overall parity rate of 66.6% for the 23-d study.

The parity rate of 66.6% determined by examination of tracheolar skeins in our study was lower than the reported previously. Lewis (1965), who examined follicular relics, found that 96% of host-seeking *L. cruciata* were parous, and he interpreted these data as being indicative of autogeny. Porter et al. (1987) reported a parity rate of 87% for this species collected in Guatemala. Perkins (1982) maintained a laboratory colony of *L. cruciata* for 26 generations without blood feeding. In our study, autogeny was not determined. However, we considered that only a small fraction were autogenous, because nullipars had nearly all their ovarian tracheoles tightly coiled.

An average of 15 flies per night were collected between 1800 and 2200 hours. Taking into account the 5.1% infection rate of the previous month, the proportion of females old enough to be infective (p^n), with $P = 0.88$, $n = 6$ d, the incubation period of leishmanial forms (Lawyer and Young 1987), humans in this habitat may receive 11 infective bites during March.

Previous reports of human-feeding and *Leishmania* infections in *L. cruciata* as well as the abundance and parity data from our study indicated that *L. cruciata* might be important as a vector of localized cutaneous leishmaniasis in Campeche. Lainson (1982) reached a similar conclusion concerning the importance of *L. cruciata* as a vector in Belize. Additional studies to estimate the gonotrophic cycle duration and further define the survival rate of *L. cruciata* in Campeche will help to determine the effectiveness of this species as a vector of cutaneous leishmaniasis in the Yucatan Peninsula.

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