

## POPULATION DYNAMICS AND BITING RHYTHM OF THE ANTHROPOPHILIC SANDFLY *LUTZOMYIA CRUCIATA* (DIPTERA: PSYCHODIDAE) IN SOUTHEAST, MEXICO

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### SUMMARY

Sandflies attracted by human bait were caught in an endemic focus of localized cutaneous leishmaniasis in the state of Campeche, Mexico. Catches were carried out monthly from February 1994 to January 1995 between 18:00 and 22:00 h. *Lutzomyia cruciata* was the only species caught. The highest population peak of *Lu. cruciata* was found in March with lesser peaks in February, December 1994, and January 1995. Maximum biting rate of *Lu. cruciata* was found between 18:00 and 19:00 h. The host-seeking females of *Lu. cruciata* were directly related to levels of humidity between 88 and 100%. Low and high temperature had a negative effect upon *Lu. cruciata* activity. The possible role of *Lu. cruciata* as vector of leishmaniasis in the state of Campeche, Mexico is discussed.

**KEYWORDS:** *Lutzomyia cruciata*; Population dynamics; Transmission cycle; Diptera; Psychodidae.

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### INTRODUCTION

Human leishmaniasis are caused by at least 13 different species of parasite of the genus *Leishmania*. These parasites are transmitted to human from infected mammals by the sandfly vector when taking repetitive bloodmeals<sup>20</sup>. Disease has been reported in 80 countries and about 400,000 new cases occur each year<sup>16</sup>. Leishmaniasis are endemic in many areas of the New World, and transmission cycle is mainly zoonotic<sup>14</sup>. In México the illness was first described by SEIDELIN<sup>19</sup> in the Peninsula of Yucatán. Later on, disease was found endemic in this region<sup>4</sup>.

Little is known about the identity and the biology of vectors of cutaneous leishmaniasis in Mexico. In the state of Quintana Roo, BIAGI et al.<sup>6</sup> reported 7.1% *Lutzomyia* (*Nissomyia*) *olmeca olmeca* (Vargas & Díaz-Nájera) in-

fecting, and proved that this sandfly was able to transmit the parasite to humans during bloodfeeding.

Females of *Lutzomyia* (*Lutzomyia*) *cruciata* (Coquillett) are anthropophilic<sup>13</sup>. Distribution of *Lu. cruciata* in the Peninsula of Yucatán overlaps the distribution of localized cutaneous leishmaniasis<sup>5</sup>, and *Lu. cruciata* has been found as one of the most anthropophilic species of sandflies<sup>7,9</sup>. Recently, 10 females of this species were found naturally infected with flagellates of *Leishmania* sp.<sup>3</sup>. In this study we sought to describe the abundance of anthropophilic species of sandflies collected on human bait, and to correlate the time-activity and abundance of *Lu. cruciata* with temperature and relative humidity, in endemic focus of localized cutaneous leishmaniasis in the Peninsula of Yucatán, México.

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## MATERIAL AND METHODS

The study site was located at 8 Km. Southeast of La Libertad (18° 34'N, 90° 31'W), in the state of Campeche, Mexico (Fig. 1). The altitude is 150 m. the average of temperature is 27°C and the annual rainfall is 1401 mm<sup>11</sup>. Since 1990 in La Libertad 40 well-documented cases of cutaneous leishmaniasis had been reported (A. Vargas-González, University of Yucatán, per. com.). Of these 27 (67.5%) corresponded to the high risk population<sup>2</sup>.

Field trips were carried out approximately every 3 - 4 weeks from february 1994 to January 1995. Sandflies were caught during 10 consecutive nights per month. The first author, wearing a T-shirt and trousers rolled up to the knees served as human bait. Hourly collections of sandflies from 18:00 to 22:00 h were kept in separate vials. The next morning, sandflies were killed, placed in disposable polypropylene cryotubes containing a mix of saline solution (0.65%) and glycerol (10%), and frozen in liquid nitrogen. Once in the laboratory of the Regional Research Center of the University of Yucatan, sandflies were counted, and identified according with the shape of both the pharyngeal armatures and spermathecae<sup>13,22</sup>.

Temperature and humidity were recorded nightly using a hygrometer (Cole-Parmer Instrument Company, Chicago, Illinois 60648 USA). Data on monthly rainfall were obtained from the Forestry Experimental Station of "El Tormento", Escárcega, Campeche situated at 34 Km of the study site.

Data of temperature and humidity were analysed with the linear regression ( $Y = \alpha + \beta X$ ) and second degree polynomial regression ( $Y = \alpha + \beta X + \beta X^2$ )<sup>15</sup>, the number of sandflies collected were transformed to logarithms. Pearson's correlation were also calculated for both climatic parameters. Regressions were assessed to be significant by ANOVA. Pearson's correlation was evaluated by a t test at  $p < 0.05$ <sup>9</sup>.

## RESULTS

During the 110 baiting-nights, the only species attracted to human was *Lu. cruciata*. A total of 526 females were caught. Population of *Lu. cruciata* had its highest peak of abundance in March (Fig. 2), which represented 34.8% of all the catches. Lesser peaks were found in February, December 1994 and January 1995 which correspond to the most humid and coolest months of the year. These four months represented the 86.3% of all sandflies caught. From March to December, during the rainy season, very low densities were recorded (Fig. 2). During September 1994 no sampling was done because of heavy rains.

The highest peak of contacts *Lu. cruciata* and man

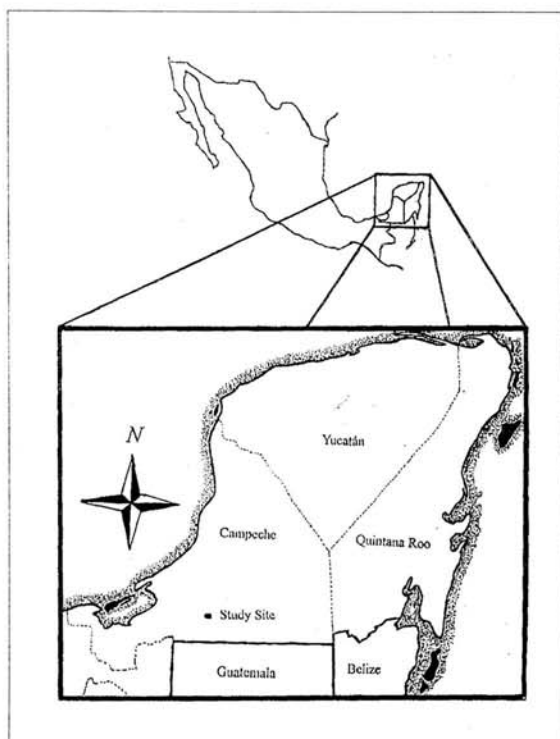


Fig. 1 - Map of the Peninsula of Yucatán, indicating the location of the study site.

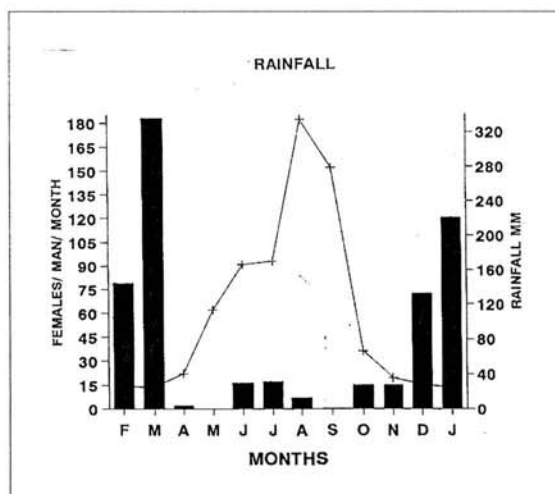


Fig. 2 - Abundance of *Lu. cruciata* females collected with human bait from February 1994 to January 1995, in La Libertad, state of Campeche, México.

occurred between 18:00 and 19:00 h. A lower peak was also found from 19:00 to 20:00 h. Both peaks represented 66.2% of all the catches (Fig. 3).

The relationship between humidity and catches of *Lu. cruciata* was best explained with the linear regression model (Fig. 4). The equation was  $Y = -1.186 + 0.026X$  ( $F = 18.71$ ,  $df = 28$ ;  $p < 0.01$ ). Pearson's coefficient was also significant ( $t$  test = 4.37,  $df = 28$ ,  $p < 0.01$ ). Number of *Lu. cruciata* females were related with temperature, and the second degree polynomial regression had the best fit of data. The equation gave  $Y = -14.82 + 1.49X + (-0.033)X^2$  ( $F = 40.59$ ,  $df = 12$ ;  $p < 0.05$ ). Pearson's correlation was also significant ( $t$  test = 6.99,  $df = 13$ ,  $p < 0.01$ ). Low and high temperatures had a negative effect upon *Lu. cruciata* activity (Fig. 5).

Maximum host-seeking behaviour of *Lu. cruciata* occurred when temperature was 21 - 22°C, which seems to be the optimum for the aforementioned species.

## DISCUSSION

Reproductive season of *Lu. cruciata* was comprised between December and March. The same pattern had been reported by RAMIREZ-FRAIRE<sup>17</sup> for anthropophilic *Lutzomyia* species caught with Shannon-trap at 200 m. of La Libertad. Population peaks of *Lu. cruciata* were associated with low temperature ( $< 25^{\circ}\text{C}$ ), high levels of humidity ( $> 80\%$ ) and low rainfall (Fig. 2).

Little has been published about the time-activity of *Lu. cruciata* in Mexico. BIAGI et al.<sup>7</sup> reported that *Lu. cruciata* in Escarcega, Campeche has a peak of activity between 1800 to 1900 h, which is in full agreement with the findings of this study. BIAGI & BIAGI<sup>5</sup> have pointed out that low and high temperatures are disadvantageous for females of *Lu. cruciata*, which is in agreement with our results. Nevertheless, these authors pointed out that high humidity has a negative effect on *Lu. cruciata* activity, which is contrary to the findings of this study.

The reproductive season of *Lu. cruciata* can be associated with important epidemiological factors. Indeed, small terrestrial rodents infected with *Leishmania* (*Leishmania mexicana* (Biagi), in the same area of research as the present study, have been found only from November and March<sup>8</sup>. The number of human cases of leishmaniasis reported each year has a peak from March to July<sup>1</sup>. If the incubation period of parasite in human is considered, then there is a strong correlation between

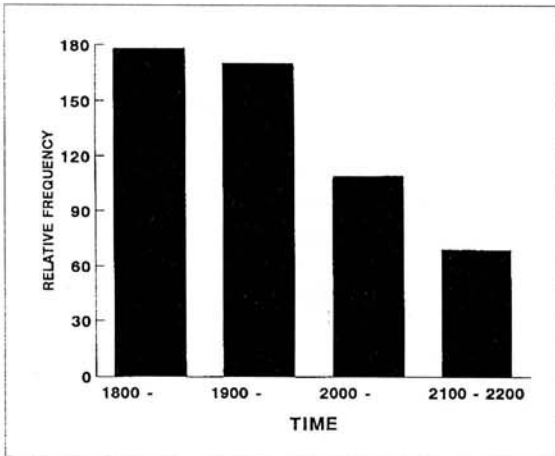


Fig. 3 - Biting rhythm of *Lu. cruciata* collected with human bait from 18:00 to 22:00 h, in La Libertad, state of Campeche, México.

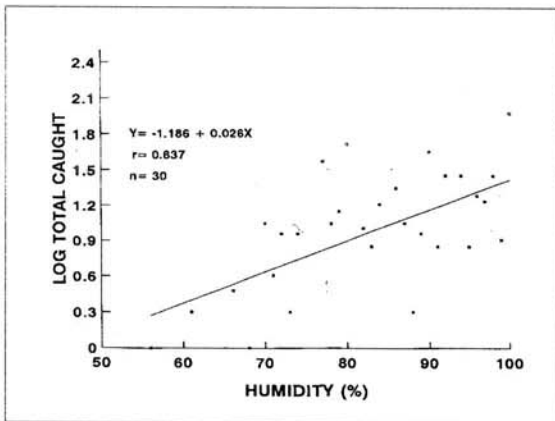


Fig. 4 - Linear regression calculated to describe the relationship between humidity and the log of total females of *Lu. cruciata*.

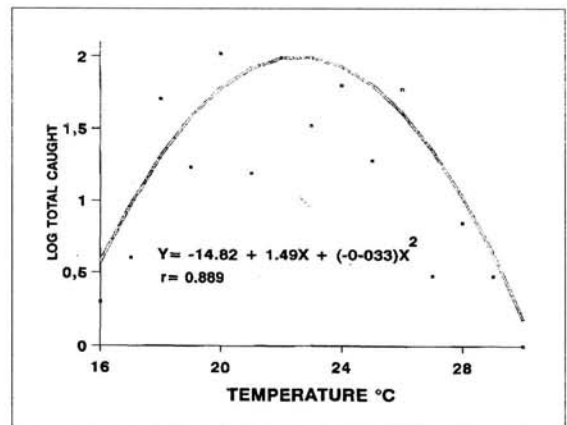


Fig. 5 - Second degree polynomial regression calculated to describe the relationship between temperature and the log of total females of *Lu. cruciata*.

the population peak of *Lu. cruciata* during March and the human cases of leishmaniasis. Furthermore, during months of high abundance of *Lu. cruciata*, human activities deep in the forest are also high. Among these labourers are chicle collectors, woodcutters and hunters who overnigh in the forest, and thereby the risk of being bitten and infected by the sandfly vector is enhanced. All these epidemiological factors do suggest that transmission dynamics of *Le. mexicana* in the state of Campeche is taking place from November to March.

The role played by *Lu. cruciata* as a vector of *Le. mexicana* is highly suspected. DISNEY<sup>11</sup> in Belize, found 0.8% of infection rate in this sandfly, and described this sandfly as the main species attracted to human. In Nacaragua, ZELEDON & MURILLO<sup>23</sup> reported *Lu. cruciata* as one of the most anthropophilic species. More recently, ROWTON et al.<sup>18</sup> in Belize, dissected and examined 2,450 females of *Lu. cruciata* caught in human bait, they found the parasite in five females (0.2%). Vectorial competence of *Lu. cruciata* has been also proved under laboratory conditions to human volunteers<sup>21</sup>.

RAMIREZ-FRAIRE<sup>17</sup> in the state of Campeche and CRUZ-RUIZ<sup>9</sup> in the state of Quintana Roo, reported *Lu. cruciata* as the most anthropophilic species, but no female was infected with *Le. mexicana*. Whilst in the same area of this study ANDRADE et al.<sup>3</sup> found 10 females of *Lu. cruciata* infected with flagellates probably of the genus *Leishmania*. However, the species of parasite was not determined.

The highly anthropophilic habit of *Lu. cruciata* and its peak of abundance synchronised with infected reservoir and human activities are two key factors to predict outbreaks of leishmaniasis. However, additional studies to demonstrate that isolates from wild-caught females of *Lu. cruciata* are undistinguishable from those of human and reservoir, as well as to prove the vector competence of *Lu. cruciata* are required to fully incriminate this sandfly as vector of localized cutaneous leishmaniasis in Campeche, México.

## RESUMO

### Dinámica poblacional y ritmo de picadura de la papalotilla antropofílica *Lutzomyia cruciata* (Diptera: Psychodidae) en el sureste de México.

Flebótomos atraídos por cebo humano fueron co-

lectados en un foco endémico de leishmaniasis cutánea localizada en el estado de Campeche, México. Colectas fueron llevadas a cabo mensualmente de Febrero 1994 a Enero 1995 entre las 18:00 a 22:00 h. *Lutzomyia cruciata* fue la única especie capturada. El mayor pico poblacional fue encontrado en Marzo con picos similares en Febrero, Diciembre 1994 y Enero 1995. La tasa máxima de picadura de *Lu. cruciata* estuvo comprendida entre 18:00 a 19:00 h. Las hembras hambrientas de *Lu. cruciata*, fueron directamente relacionadas con niveles de humedad relativa entre 88 a 100%. Bajas y altas temperaturas tuvieron un efecto negativo sobre la actividad de *Lu. cruciata*. Se discute el posible papel de *Lu. cruciata* como vector de leishmaniasis en el estado de Campeche, México.

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