BITING ACTIVITY PATTERNS OF *CULEX (MELANOCONION) RIBEIRENSIS* IN SOUTHERN BRAZIL[1]

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ABSTRACT. The biting activity of *Culex ribeirensis* was studied in the highland region of Southern Brazil and compared with data previously obtained in a lowland area of the same region. Hourly sampling with human bait showed a bimodal pattern, with a greater peak in the evening crepuscular period. Behavior was similar in both the highland area of Lupo Farm and the lowland of the Ribeira Valley but with a notable feature in the former. In relation to the vespertine crepuscular period, precrepuscular peaks were observed in the highland area. The adaptability of this species to man-made environments and its epidemiological significance are considered.

INTRODUCTION

Species of *Culex* subgenus *Melanoconion* are of epidemiological interest because of their role in the enzootic transmission of arboviruses in the neotropics (Lhuillier et al. 1981). Prior research in the epidemic Rocio (ROC) virus encephalitis region of the Ribeira Valley, São Paulo State, Brazil, suggested that these mosquitoes may be involved in ROC virus transmission (Forattini et al. 1978). Further observations in the same region showed that *Culex (Melanoconion) ribeirensis* Forattini and Sallum, previously identified as *Culex crybda* Dyar, was frequently found in modified environments in greater numbers than in the more natural areas (Forattini et al. 1981, 1986).

As the Ribeira Valley is a lowland region, situated near the Atlantica coast, a program of investigation in the highland area of São Paulo State was carried out with a view to observing mosquito behavior in the highly modified environments that exist there. This area is mainly represented by plantations and patchy residual forest. Results obtained on the biting activity of *Cx. ribeirensis* are compared with those previously observed in the Ribeira Valley.

The study site in Araraquara county, is known as Lupo Farm, and is situated about 4 km from the county seat. It consists of land highly modified by agricultural exploitation. Residual forest patches are characteristic of the landscape. The study site is located approximately 22°S and 46°W and is situated in a patch of residual forest surrounded by open land and covered with fruit, sugarcane plantations and pastures. The woodland has been modified by human activity and its primitive characteristics have been altered.

The mean altitude is 500–600 m above sea level, as compared with 0–180 m in the Ribeira Valley. There are two rainy seasons, a hot rainy one from October to March with average rainfall of 1,000–1,100 mm, and a cooler drier one from April to September with 200–300 mm of rainfall ("Departamento de Águas e Energia Elétrica," 1972).

METHODS

Mosquito collecting. Hourly collections were made from human bait for a 25 hour period each month from April 1981 until April 1983, always in the same week of the month. The data are expressed as Williams' means (Haddow 1954). The crepuscular periods were converted into "crep" unit intervals (Nielsen 1961). Full details for these methods have been described (Forattini et al. 1981).

Additional catches were made with a Shannon trap at irregular intervals. These catches were carried out simultaneously, both inside the forest and outside on the open land, at a distance of 50 m from the edge of the wood. Catches were made from 1800 hr to 1200 midnight.

Meteorological data. Annual and monthly rainfall figures were recorded at the Bariri Meteorological Station (22°18′S,47°11′W), situated in the same general region as the study site, and were supplied by the São Paulo State civil service.[2]

RESULTS

Twenty-five human-bait and 15 Shannon-trap catches were carried out. A total of 1,012 mosquitoes were collected (Table 1).

Hourly activity. The results of the monthly human-bait collections, according to the time

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[2] "Fundação Sistema Estadual de Análise de Dados (SEADE)." 1981/1983 yearbooks, and "Secretaria de Obras e Meio Ambiente." Unpublished report, 1983.

Table 1. Number of *Culex ribeirensis* caught at Lupo Farm, according to site and collecting methods.

Site	Method: Human bait	Method: Shannon trap	Total
Inside forest	478	133	611
Outside forest (50 m from the edge)	...	401	401
Total	478	534	1,012

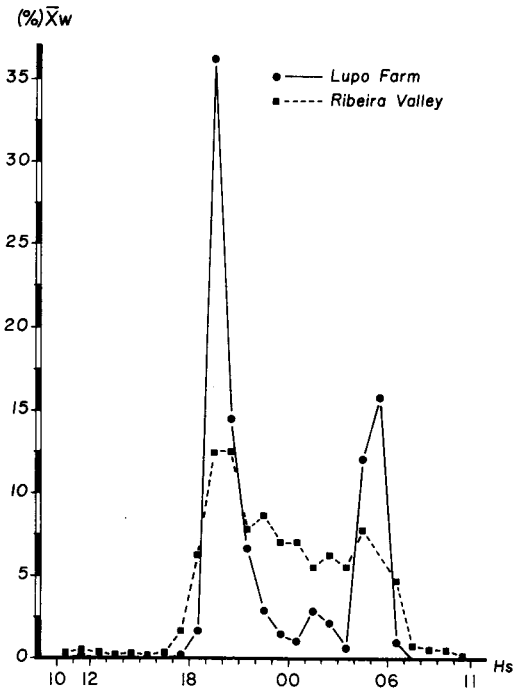

Fig. 1. Hourly activity of *Culex ribeirensis* observed with human bait, during regular monthly catches at the Lupo Farm area, compared with the data formerly obtained in the Ribeira Valley region. (%) $\bar{X}_w$—Williams' means percentage on the total obtained; Hs—hours.

intervals, are presented in Fig. 1. The essentially nocturnal flight activity of *Cx. ribeirensis* started with a pronounced sunset peak and ended with another less accentuated peak at dawn, and generally corresponded to the Ribeira Valley pattern. However, the evening and morning peaks were more distinct on the Lupo Farm.

Crepuscular and pericrepuscular activity. The period from 1700 to 2000 hr used for the evening catches and divided according to the "crep" intervals is shown in Fig. 2. The vespertine crepuscular period is represented by the 0.0–1.0 crep interval. The occurrence of flight activity peaks with pericrepuscular characteristics is evident. As observed in the Ribeira Valley, two postcrepuscular peaks occurred, one closely following the other, but here much more clearly defined. Furthermore, at the Lupo Farm, a precrepuscular peak appeared immediately before the vespertine crepuscular period. This was not the case in the Ribeira Valley.

Seasonal variation. The greatest activity of *Cx. ribeirensis* was in the hot, rainy months, i.e., from November to February (Fig. 3). The *Cx. ribeirensis* population diminished remarkably and even disappeared altogether in the cold period, i.e., April-September, notwithstanding intense rainfall, recorded in June 1980 when atypical rains produced 121.1 mm and affected the total for that period.

DISCUSSION

There is little published information on the biology of mosquitoes of the subgenus *Melanoconion* in southern Brazil. Since the previous observations were made in the Ribeira Valley, *Cx. ribeirensis* has been found to present a particular tendency towards survival in man-made environments (Forattini et al. 1986). In the coastal lowland of Rio de Janeiro State, belonging to the same Brazilian region, the presence of this mosquito in similar environments has also been observed (Oliveira 1984). Therefore, the results of the present study are interesting in that they report comparable mosquito behavior in a highland area of the southern Brazilian plateau where intensive human activity occurs and where, as a consequence, the primitive environment has been reduced to patchy modified residual forest. These studies demonstrated an appreciable presence of *Cx. ribeirensis* in the open-land catches made with the Shannon trap which was even greater than that observed inside the wood using the same technique (Table 1). As a result of this adaptation to modified environments, this species was noted as probably demonstrating some degree of endophily, being caught indoors on several occasions (Oliveira and Heyden 1986, Forattini et al. 1987). These data suggest that there may be an evolution in the habits of this mosquito in the direction of domiciliarity.

The hourly catches with human bait indicate *Cx. ribeirensis* as an essentially nocturnal species exhibiting a bimodal activity pattern, be it in the Ribeira Valley or at Lupo Farm. Nevertheless, as seen from Fig. 1, the two peaks corresponding to dusk and dawn were much more intensive at the latter site. In addition, the nocturnal activity in the Ribeira Valley was more constant than on the Lupo Farm where a pronounced reduction of activity was observed in

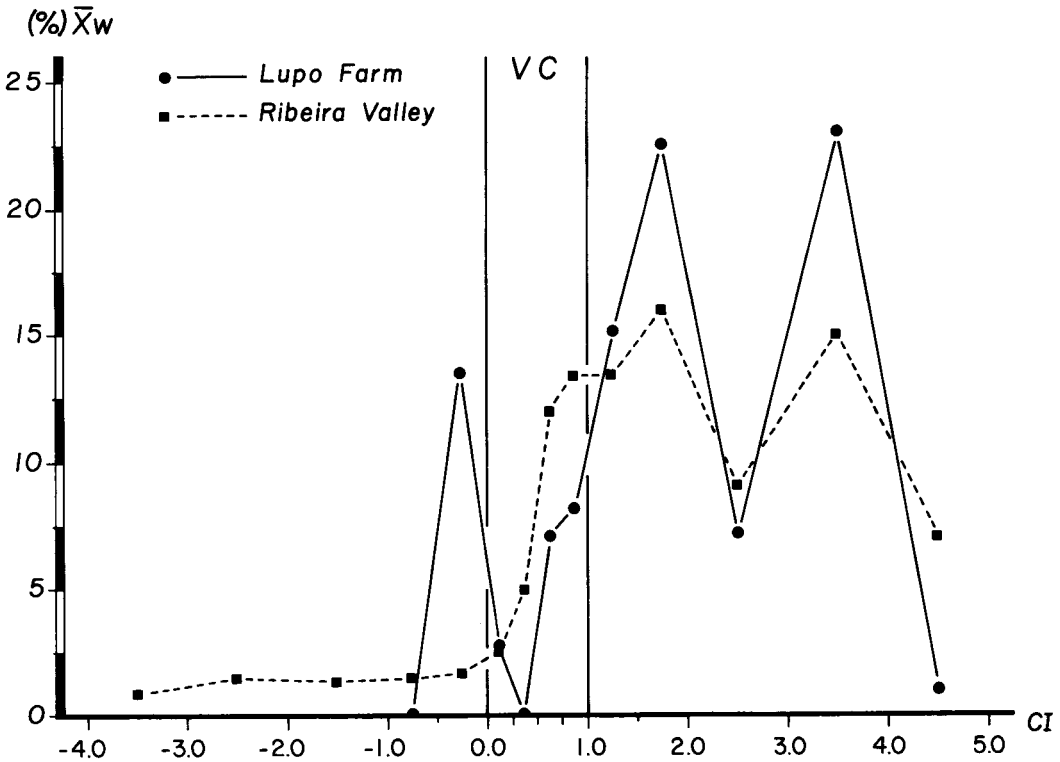

Fig. 2. Vespertine crepuscular and pericrepuscular activities of *Culex ribeirensis* with human bait at the Lupo Farm, compared with the data formerly obtained in the Ribeira Valley region. (%) $\bar{X}_w$—Williams' means percentage on the total obtained; CI—Nielsen "crep" intervals corresponding to 05.00–08.00 pm: VC—Vespertine crepuscular period.

the period between the two peaks (Fig. 2). At Lupo Farm there were two peaks in sequence that followed the vespertine crepuscular period. This was also observed to a lesser degree in the Ribeira Valley. However, a distinct precrepuscular peak occurred on the Lupo Farm that had not been observed in the Ribeira Valley. These varying behaviors may be characteristic of different populations, but may also be a consequence of the influence of environmental factors such as specific macro- and microclimatic conditions. Research on *Cx. portesi* Sénevet and Abonnenc and *Cx. taeniopus* Dyar and Knab in Trinidad has shown that moonlight influences the biting activity of these mosquitoes. At the full moon, the evening and the dawn peaks are replaced by increased activity during moonrise and in the middle of the night (Davies 1975). Nevertheless, endogenous factors that regulate the underlying circadian rhythm of flight for host-seeking activity are surely prerequisites for blood feeding. Generally the activity peak at dusk is higher than at dawn (Aschoff 1966). Therefore, the bimodal pattern of the basic circadian rhythm may be a basic mechanism that enables the mosquito to make contact with its host.

As regards seasonal incidence, it is evident that the annual cycle of activity is affected by exogenous factors. As a general pattern, *Cx. ribeirensis* reaches its greatest level of activity in the hot, rainy season that, in southern Brazil, occurs from October to March (Fig. 3).

Completing these considerations, it should be recalled that southern Brazil and northern Argentina represent the southern boundary of the geographical distribution of mosquitoes of the subgenus *Melanoconion*. There, some species have recently been identified as vectors of arboviruses, such as Venezuelan equine encephalitis (VEE) and others, in sylvatic cycles involving rodents and other vertebrates. In Argentina the VEE virus was isolated from *Cx. delpontei* Duret and other species, with high minimum infection rates, thus indicating the possibility of transovarial transmission (Mitchell et al. 1985, 1987). Therefore, it is of epidemiological interest to study the behavior of mosquitoes such as *Cx.*

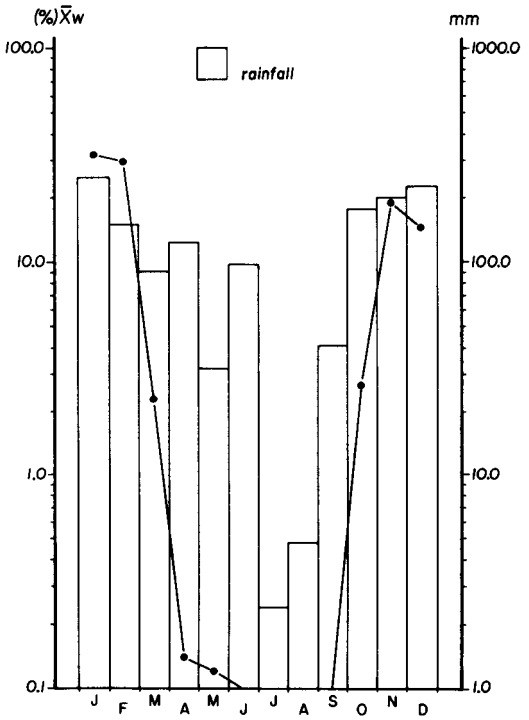

Fig. 3. Seasonal incidence of *Culex ribeirensis* with human bait at the Lupo Farm related to rainfall. (%) $\bar{X}_w$—Williams' means percentage on the total obtained; mm—monthly rainfall averages in mm; M—months.

ribeirensis which, in southern Brazil, are showing an increasing tendency to adapt to man-made modification of the environment.

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