CHAPTER 13

CIRCADIAN AND SEASONAL PREFERENCES FOR HEMATOPHAGY AMONG *HAEMAGOGUS CAPRICORNII*, *HG. JANTHINOMYS*, AND *HG. LEUCOCELAENUS* (DIPTERA: CULICIDAE) IN DIFFERENT REGIONS OF BRAZIL

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Since the 1980s, and with greater evidence in the 1990s, wild-type yellow fever (WTYF) has re-emerged in both Africa and the Americas (Vasconcelos 2003a). In Brazil, the natural focus of WTYF is maintained within about 70% of the territory by a cycle that involves non-human primates and mosquitoes mainly of the genus *Haemagogus* (Vasconcelos et al. 1997a). Among the 28 known species of *Haemagogus* (Arnell 1973), three are considered as the main vectors in the natural cycle of WTYF. *Haemagogus (Haemagogus) capricornii* Lutz, 1904 is an efficient vector of WTYF virus (Waddell 1949). Because of similar behavior and morphology, it has often been confused with *Haemagogus (Haemagogus) janthinomys* Dyar, 1921. Since this latter species presents the greatest geographical distribution among the Brazilian species (Vasconcelos et al. 1997b), it is today

considered to be the principal vector of WTYF virus. On the other hand, *Hg. (Conopostegus) leucocelaenus* (Dyar & Shannon, 1924) is the most common species of this genus in Brazil and has recently been found naturally infected with the WTYF virus in the State of Rio Grande do Sul (Vasconcelos 2003b).

Knowledge of the feeding activity of culicids is of fundamental importance in assessing their participation in disease transmission (Guimarães and Victorio 1986). The present study was designed to observe the hematophagous behavior of populations of *Hg. capricornii*, *Hg. janthinomys,* and *Hg. leucocelaenus* in three different geographical regions of Brazil. The influences of temperature and relative humidity (RH) on the activity of these species at different times of the day and over the course of the seasons of the year were analyzed.

Following the methodology of Guimarães et al. (1987), daytime and dusk captures were performed every two months and for five consecutive days at ground level during the morning (10:00-12:00), the afternoon (14:00-16:00) and the evening (17:30-19:30). The sampling was performed in areas inside the Peixe Angical hydroelectric scheme in the State of Tocantins (S 12° 01' 30''; W 48° 32' 21''), from February 2004 to April 2006; in areas near the Serra da Mesa hydroelectric power station in the State of Goiás (S 13° 31' 59'' ; W 48° 13' 12''), from March 1996 to December 1997; and in the Tinguá Biological Reserve in the State of Rio de Janeiro (S 22° 45' 33'' ; W 43° 13' 12''), from October 1994 to June 1996. In Peixe Angical, the climate is tropical, with mean annual temperatures of 26° C in the rainy months (October-March) and 32° C during the dry season (April- September). The mean annual rainfall is 1000 mm (Nimer 1979). In Serra da Mesa, the climate is tropical and semi-humid, with mean annual rainfall of around 1200 mm. The dry season lasts four months (May–August), during which the RH falls to levels of less than 20% and the rainfall rarely reaches 20 mm per month. The biome of the Serra da Mesa region is broadly characterized as savanna, going from very open landscapes such as open grasslands, to relatively closed forms such as dense woodland (Peixoto and Coradin 1993). In Tinguá Biological Reserve, the climate is hot and humid, with a mean annual temperature of 22° C and rainfall of 2000 mm. The vegetation, characterized as dense ombrophilous forest, is typical of the Brazilian Atlantic Forest. During the sampling periods, variations in temperature and RH were measured every hour with a thermohygrometer (Oregon Scientific, model RMR132HG), set up at the capture location at a height of one meter above ground level. The specimens were identified, using available dichotomous keys (Arnell 1973).

The data were analyzed in such a way as to express the ecological relationship that existed between the populations of *Haemagogus* and the time-of-the-day and seasonal distributions. The data analysis was performed by visual observation of the means according to time of the day and species, and by means of scatter plots of the points as a function of temperature and RH.

A total of 401 *Haemagogus* specimens was analyzed: *Hg. capricornii* (48 specimens), *Hg. leucocelaenus* (60 specimens), and *Hg. janthinomys* (293 specimens). In the the State of Tocantins (S 12° 01' 30"; W 48° 32' 21"), from Goiás station, *Hg. janthinomys*, *Hg. capricornii,* and *Hg. leucocelaenus* showed peak activity during the rainy season (December - February) (Figure 1). In the Rio de Janeiro locality, *Hg. leucocelaenus* showed an inverted seasonal cycle, with maximum activity in June. For the latter species, this indicates that seasonality has a strong environmental component. The number of *Hg. janthinomys* specimens collected in the second locality (Goiás) was insufficient to show any seasonal trend. For all species and localities except for *Hg. leucocelaenus* collected in Goiás, there was a peak of feeding activity across the middle of the day (Figure 2). *Hg. janthinomys* was collected when RH was greater than 70% and the mean temperature was very high (24°-30° C) (Figure 3, left). In the regression analysis, the relationship Q = temp + RH/3 explains the seasonality of collections of this species. *Hg. capricornii* seemed to need high temperatures (around 28° C), while tolerating lower and varying RH (60%-85%) (Figure 3, center). However, the low significance of seasonal correlations between the temperatures and the collections may be due to the small sample size. The activity of *Hg. leucocelaenus* did not seem to be influenced by temperature (range: 21-31° C) but, rather, by RH, which was always greater than 70% when this species was captured (Figure 3, right). The seasonal distribution of RH in the two localities where this species was collected (Figure 4) also explains the contraposition of its seasonal activity cycles and the differences in its diurnal cycle. In Goiás, the peak of activity in the middle of the day that was observed in Rio de Janeiro was not present, because of the much lower RH during this period. The results reported above are in general agreement with those presented on other occasions for the same species which were characterized by their "diurnal cycle" (Guimarães and Victorio 1986, Guimarães et al. 1987). However, two interesting departures from this behavior have been noted in our study: a significant activity of *Hg. janthinomys* during the first hours of the dusk period and specific responses of the three species to temperature and humidity variations.

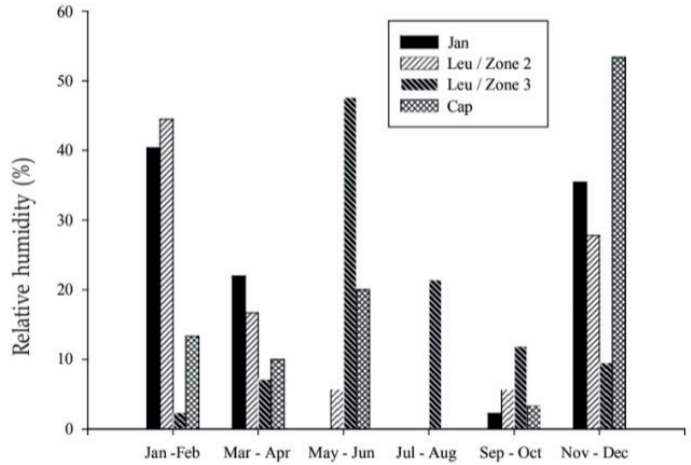

Figure 1. Seasonality according to species and locality. Jan = *Hg. janthinomys;* Cap = *Hg. capricornii. Hg. leucocelaenus* (Leu) was the only species collected at two different localities (zone 2 = Goias; zone 3 = RJ).

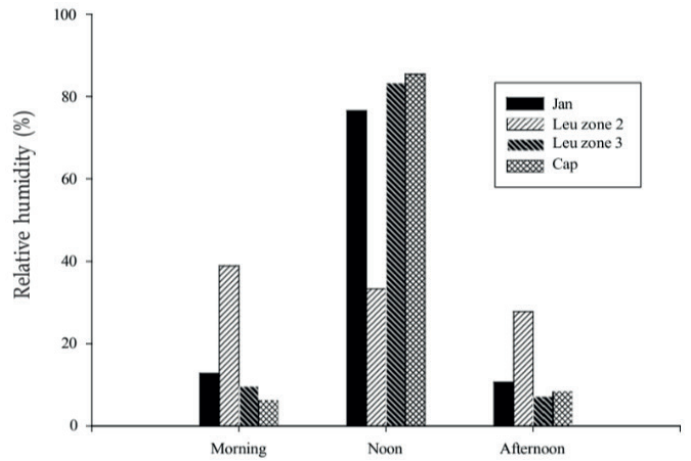

Figure 2. Diurnal preference of activity (three time periods), according to species and locality.

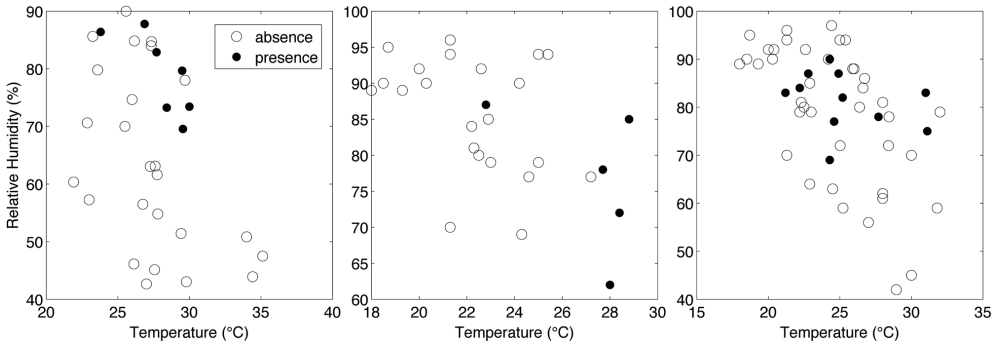

Figure 3. Scatter plots of mean temperature versus relative humidity for each collecting session, and presence (filled circles) or absence (open circles) of *Hg. janthinomys* (left), *Hg. capricornii* (center) and *Hg. leucocelaenus* (right).

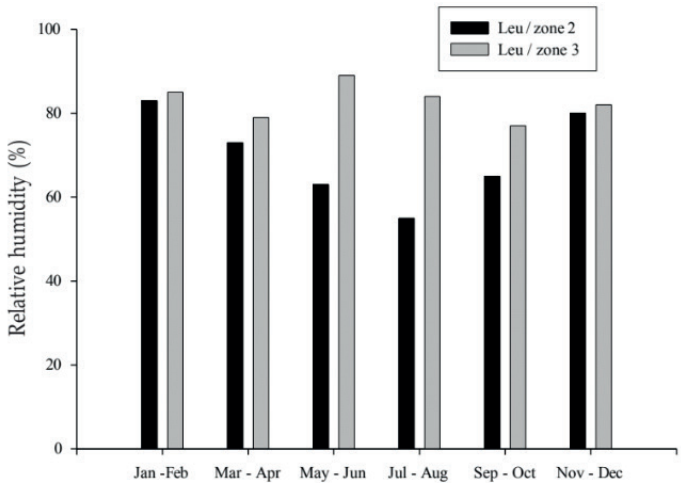

Figure 4. Seasonal variation of relative humidity in Goias (zone 2) and RJ (zone 3) where *Hg. leucocelaenus* was collected.

Guimarães and Arlé (1984) reported the occurrence of *Hg. leucocelaenus* in all months of the year except June and November, thus differing from *Hg. capricornii*, which presented a concentration of 90% of its specimens in December. This was not observed in the present report, considering that *Hg. leucocelaenus* disappeared completely from the sampling in the month of August. Such local and/or seasonal variations in host-seeking behavior need further studies in light of human activities in order to better evaluate the risk of WTYF infection.

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