
Eduardo A. Rebollar-Téllez, María A. Loroño-Pino, Elsa M. Rodríguez-Angulo, José A. Farfán-Ale

1Depto. de Inmunología and 2Depto. de Arbovirología, Centro de Investigaciones Regionales "Dr. Hideyo Noguchi", Universidad Autónoma de Yucatán. Mérida, Yucatán, México.

SUMMARY.

Introduction. Dengue disease has been occurring in the state of Yucatan since 1979. However, little is known about important aspects of the vector’s biology such as, frequency of blood feeding and survivorship. Thus the objectives of the present study were to determine these two vector’s parameters.

Material and Methods. Aëdes aegypti were caught daily using humans as bait in an urban site of the city of Merida for 20 days. All the material was dissected and classified as nulliparous, parous or gravid females according to the appearance of the tracheolar system. Results were analysed using the cross-time series method for gonotrophic cycles and survivorship determinations.

Results and discussion. Two-hundred and sixty-seven females of Aëdes aegypti were dissected, from which 43.0 % were parous, 13.3 were nulliparous and 43.7% were semi or gravid. The estimate for the gonotrophic cycle length was 7 days. The survivorship per cycle was computed to be 0.343 and daily survivorship was determinated to be 0.564. Some aspects of Aëdes aegypti multiple blood feeding are also discussed.

Key words: Aëdes aegypti, vector survivorship, gonotrophic cycle, Dengue virus
RESUMEN.

Introducción. El Dengue ha estado ocurriendo en el estado de Yucatán, México, desde 1979, sin embargo, poco es conocido acerca de importantes aspectos de la biología del vector, tales como la frecuencia de alimentación y supervivencia. El objetivo del presente estudio fue para determinar estas variables del vector del Dengue en Yucatán.

Material y Métodos. Se realizaron capturas de Aëdes aegypti utilizando huevos como cebo, en una área urbana de la ciudad de Mérida, Yucatán, diariamente durante 20 días. Todo el material fue disectado y clasificado como nulíparo, párido o grávido de acuerdo con la apariencia del sistema traqueolar. Los resultados fueron analizados con el método de series cruzadas de tiempo para las determinaciones de ciclo gonotrófico y supervivencia.

Resultados y discusión. Doscientas sesenta y siete hembras de A. aegypti fueron disecadas, encontrando que el 43.0% fueron páridas, 13.3 nulíparas, y 43.7% fueron grávidas. El estimado para la duración del ciclo gonotrófico fue 7 días. La supervivencia por ciclo fue calculada en 0.343 y la sobrevivencia diaria fue determinada en 0.564. Algunos aspectos de la alimentación múltiple de A. aegypti se discuten también.

Palabras clave: Aëdes aegypti, supervivencia del vector, ciclo gonotrófico, virus Dengue.

INTRODUCTION.

Dengue fever is a disease caused by viruses of the family Flaviviridae, genus Flavivirus. Infections are mainly transmitted from human to human mainly by Aëdes aegypti and A. albopictus mosquitoes. The illness is present in tropical and sub-tropical regions, and about 100 million people are at high risk of developing the disease. In the New World, the disease has been present since 1780, when an epidemic was reported in the state of Pennsylvania, U.S.A. and subsequent outbreaks were reported in other countries (1). In Mexico, the mosquito A. aegypti was eradicated in the 60’s, but a new reinfestation occurred in 70’s, and the first case of Dengue Fever was reported in the state of Chiapas in 1978. Since then, Dengue viruses have spread into 29 states, and the total number of cases in 1990 were 227,229 (2). Regarding the state of Yucatan, Dengue Fever has been present since 1979 and until 1990, 19,997 cases had been reported (3). The epidemics were due to the serotypes DEN 1, DEN 2 and DEN 4 (4). In 1984, during the outbreak of Dengue Fever, 9 deaths were reported. One of which fulfilled the criteria pointed out by World Health Organization (WHO) to be described as a Dengue Hemorrhagic Fever case (5).

Since the mosquito vector is found close to human dwellings, a very obvious strategy is the elimination of the mosquito’s breeding places, which can be found in most houses’ backyards. Therefore, campaigns for a reduction in man-made water containers was thought to be an easy approach. Nevertheless, this strategy has failed to give the expected results (6), and incidence and prevalence rates are far from being low in the state of Yucatan, which may be due to poor community participation programs. For this reason, insecticide application against the mosquito’s larvae and insecticide spraying for the adult stage are still in use by the health authorities in Mexico. Methods for evaluation of insecticide applications for adults must be based mainly on determinations of mosquito’s population characteristics, such as age-grading determinations, which could be employed to see whether the older adults (females) were eliminated or not after an application. Another possibility is to analyze if such insecticide applications have an indirect lethal effect on the female’s biological characteristics. The most important characteristics in vector population are the assessment of the gonotrophic cycle length,
which indicates the frequency of female’s blood-feeding behaviour, and the crucial determination is the female’s survivorship, which measures the probability of the population to survive from day to day (7,8). In the present study, the objectives were: to estimate the gonotrophic cycle length, and to determine the daily survivorship of Aëdes aegypti females.

MATERIALS AND METHODS.

Landing collections of Aëdes aegypti females were performed from 1700 to 1900 h daily for 20 days from June 21 through July 10, 1994 in the Garcia Gineres neighborhood in the city of Merida, State of Yucatan, Mexico. Catches were conducted employing two humans like baits, wearing shirts and slacks rolled up to the knees. Mosquitos were caught as they landed on the exposed bait’s skin using either mouth or electrical aspirators. All the material caught was processed the following morning. Females were dissected in microscope slides using a drop of 65% saline solution. They were then classified as nuliparous, parous or gravid according to the appearance of the tracheolar system and/or the presence of eggs in their abdomens (9).

Estimation of the gonotrophic cycle was calculated from the dissection data, using the time-cross series of Birley and Rajagopalan (10) with the following equation:

\[ M(t) = P(u) \cdot T(t - u) \]

where:

\[ M(t) = \text{Number of parous females on day } (t) \]
\[ T(t - u) = \text{the total (nulliparous plus parous) on day } (t - u) \]
\[ P(u) = \text{the gonotrophic cycle length} \]
\[ n = \text{the gonotrophic cycle length} \]

RESULTS.

Two-hundred and sixty-seven females of Aëdes aegypti, were dissected, given a 43.0% parity rate over the study. In figure 1 two peaks of population occurred, the first peak was at day 8...
and a lower peak at day 15. Both peaks with an interval of seven days which could represent the gonotrophic cycle length obtained in this study. In the same figure it is clear that during the sampling period most of the mosquitoes caught (43.7%) were gravid. Analysis of dissection data showed the highest peak of significant correlation index R(u)= 7 (0.564). This estimate was significant.

**Figure 1.** Number of parous, nulliparous and gravid females of *A. aegypti* collected from human bait per day.

**Figure 2.** Cross correlation coefficients (CCF) between the filtered time series for the total number of *A. aegypti*, and the number of parous of *A. aegypti*, collected per day during the consecutive sampling study from 21 June to 10 July 1994, in the city of Merida, Yucatan, Mexico.

*Revista Biomédica*
with the test of $R(u) = \frac{2}{\sqrt{n}}$ (figure 2), which indicated that the length of the gonotrophic cycle is seven days. Results of the $T$ statistical to test the null hypothesis of intercept equals zero was not significant ($0.12$, $df = 11$, $p < 0.05$). Survivorship per cycle was estimated to be 0.343, and daily survivorship was calculated at 0.86. On the other hand, a high proportion (43.7%) of $A. aegypti$ females were found as semi or gravid with Christophs’s stages of egg development) in IV and V. The parity rate throughout the study was 14.1%.

**DISCUSSION.**

Previous studies about gonotrophic cycle in $Aëdes aegypti$ have shown that the species has quite a wide range of duration. For instance, Sheppard et al. (14) estimated the cycle to be 3 days in Bangkok. Similar results were obtained by McClelland and Conway (15) in East Africa. Additionally, Pant and Yasuno (16) estimated the gonotrophic cycle to be 3 days during the hot season, with 1 or 2 days of delay in the cool season in Bangkok, Thailand. Conway et al. (17), obtained an estimate of 4 days for the cycle length in Tanzania. Trpis and Hausermann (18), estimated the gonotrophic cycle at 7 days for nulliparous females and 4 to 5 days for parous females in Kenya, and Salas-Luevano (19) computed 5 days for $A. aegypti$ cycle in Monterrey, Nuevo Leon, Mexico. The calculation of 7 days for $Aëdes aegypti$ in Merida, Yucatan, is longer that most of the previous reports, and is only compared with the estimate of Trpis and Hausermann (18) for nulliparous females. It is not clear why the estimate obtained in this study is longer than the previous ones, but a possible explanation is the variability among strains of $A. aegypti$ in different populations.

Regarding survivorship estimates, Sheppard et al. (14), calculated the survivorship at 0.81. Conway et al. (17) obtained a value of 0.85. Very similar estimates were computed by Trpis and Hausermann (18), who reported 0.83 and 0.85, using two different methods of evaluation. The only report of survivorship for $A. aegypti$ in Mexico was given by Salas-Luevano (19), who estimated it at 0.87, similar to our estimate of 0.86.

On the other hand, the presence of semi or gravid females catches from human bait has been reported previously (14, 16, 18, 20, 21). These results indicate that the species takes multiple blood feedings during one single gonotrophic cycle, and thereby enhancing the probability of Dengue transmission (22). In a study carried out in Thailand, the probability of multiple blood-feeding was assessed, with values ranging from 0.0 to 1.0 in different seasons of the year (23).

Previous reports have demonstrated that $Aëdes aegypti$ has peripherical sensitive neurons, which respond to lactic acid and there are other neurons which are inhibited by the lactic acid. Both systems are located in the mosquito’s antennae (24). During the host-seeking behaviour, the first system is active, whereas the second is triggered after a blood-meal, and the threshold has been calculated in 2.5 µl. This volume is enough to initiate egg development, and simultaneously inhibit the host-seeking behaviour (25). After the digestion of the blood-meal and oviposition have taken place, the first system is once again activated, thereby re-establishing the host-seeking behaviour. The activation of both neuronal systems are regulated by means of hormones (25). Under this theoretic-scheme, the role played by hormones seems very clear, but results of multiple blood-feeding obtained from wild-caught females, are contradictory. In this paper, no attempts were made to determine the number of blood-meals in each $A. aegypti$ female. The importance of multiple blood-meals is clear in epidemiology, since it means that the potential number of infective bites spread by a single female of $A. aegypti$ at any time would be two or three-fold. The correlations between
this multiple blood-meals behaviour and physiological data about the role played by hormones, which have been obtained in the laboratory, should be determined in further studies.

ACKNOWLEDGMENT.

The authors wish to thank QBA Luis Felipe Flores, QBA Luis Manzano-Cabrera, QFB Elys del Pilar Rosado-Paredes and Biol. Carlos Navarro for their field and laboratory assistances. Also, to Dr. Maria del Rosario Garcia-Miss for her revision of an early draft of this paper.

REFERENCES.


9.- Detinova TS. Age-grading methods in Diptera of medical importance with special reference to some vectors of Malaria. WHO Monogr Ser No. 47 World Health Organization, Geneva, Switzerland 1962.


14.- Sheppard PM, Macdonald WW, Tonn RJ,
Blood-feeding and life expectancy of *Aëdes aegypti*.


