Journal of the American Mosquito Control Association, 10(4):522–526, 1994

SEASONAL ABUNDANCE, BITING CYCLE, AND PARITY OF THE MOSQUITO *ANOPHELES HOMUNCULUS* IN TRINIDAD, WEST INDIES

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ABSTRACT. Seasonal abundance, daily biting activity, and the age composition of adult *Anopheles homunculus* female populations were monitored weekly during 1989–90 by human bait on the ground at Cumaca Forest, Platanal, Trinidad. Landing collections of *An. homunculus* showed diurnal and nocturnal activity, with a single peak between 1600 and 2000 hours. Overall, 27.7% of *An. homunculus* were collected during the dry season and 72.3% during the wet season. Similar seasonal parous rates were observed in wet (58.9%) and dry (56.1%) seasons. Diel periodicities of nullipars and pars were almost identical during the wet and dry seasons.

INTRODUCTION

In Trinidad the anopheline subgenus *Kerteszia* is represented by 2 species, *Anopheles bellator* Dyar and Knab and *Anopheles homunculus* Komp. Mosquitoes from the subgenus *Kerteszia* breed primarily in water held between the leaves of epiphytic bromeliads (Downs and Pittendrigh 1946). The importance of these two species in the bromeliad–anopheline–malaria complex has been recognized in Brazil and Trinidad since the 1900s (Zavortink 1973). However, much work has been done on *An. bellator* because of its role as a vector of malaria, whereas *An. homunculus* has been neglected because it was not considered as important a vector (Downs and Pittendrigh 1946).

Much is known of the bromeliad flora, incidence of bromeliad malaria, and geographical distribution and control of bromeliad malaria in Trinidad (Downs and Pittendrigh 1946, Pittendrigh 1948). But surprisingly little is known about these anopheline mosquitoes in the rest of the Neotropics. During the 1980s interest in anopheline mosquitoes was renewed due to the increase in the number of imported cases of malaria in Trinidad (Chadee 1989). Consequently, studies were conducted on the ecology of *Anopheles albitarsis* Lynch-Arribalzaga (Chadee 1992a) and the biting behavior of *An. bellator* (Chadee 1992b).

This study assessed the longevity (parous rates), seasonal abundance, and biting cycle of *An. homunculus* in the Cumaca forest, Trinidad.

MATERIALS AND METHODS

Study area: This study was conducted in the Cumaca forest at Platanal (61°10′N, 10°41′W), about 25 km NE of the Royal Borough of Arima. The Cumaca forest is predominately evergreen, mainly the *Byrsonima spicata* Rich–*Licania terratensis* Hook. (serrette–bois gris) association characteristic of the lower montane rain forest at and above 240 m. The canopy has only one story *ca.* 25 m high comprising the deciduous species mahoe (*Sterculia caribaea* R.Br.), wild cocoa (*Licania biglandulosa* Griseb), and wild kaimit (*Micropholis crugeriana* Pierre). Below the canopy layer is a less definable stratification from 3 to 15 m high, including carimbo (*Guarea glabra* Vahl.), niaure (*Calliandra guildingii* Benth.), bois l'ail (*Cassipourea latifolia* Alston), and wild calabash (*Tabebuia stenocalyx* Sprague and Stapf.).

The average annual rainfall is 1,778–3,810 mm. This is one of the wettest parts of Trinidad and lacks a well-marked dry season. The annual rainfall was measured by the Insect Vector Control Division, Ministry of Health. The topography is mainly mountainous averaging 245–762 m. Over the years very little human interference has taken place. Beard (1946) described the vegetation and topography of the area in detail.

Mosquito collections: The biting activity of *An. homunculus* was monitored using human-bait collectors at 3 sites in the forest following procedures similar to those of Haddow (1954). Routine weekly collections of mosquitoes were conducted from April 1989 to May 1990. Collections were made for 24 h using 6 workers in 3 8-h shifts starting at 0500 h. Suntime was used throughout this study, with the time of sunset on any given day being expressed as 1800 h. In terms of local standard time (LST), sunset fell between 1831 and 1740 h during the study period.

Catchers were stationed on the ground in the forest, equipped with a flashlight (put on only to collect landing mosquitoes, after which they were switched off), handnet, and aspirator. Female mosquitoes, which were mostly attracted to the collectors' lower legs and arms, were caught before biting and transferred into jars humidified by a bottom layer of moist plaster of Paris, using a separate jar for those collected during each 2-h

Table 1. Monthly numbers of *Anopheles homunculus* females landing on human bait (6 collectors) at Cumaca Forest, Trinidad.

Months	No. days	No. collected	Average no./day
Wet season			
1989			
May	4	302	75.5
June	4	567	141.5
July	5	1,223	244.6
August	4	615	153.8
September	3	63	21.0
October	5	281	56.2
November	4	279	69.8
Subtotal	29	3,330	114.8
Dry season			
1989			
December	5	209	41.8
1990			
January	4	290	72.5
February	4	193	48.3
March	5	254	50.8
1989			
April	5	332	66.8
Subtotal	23	1,278	55.6
Total	52	4,608	88.6

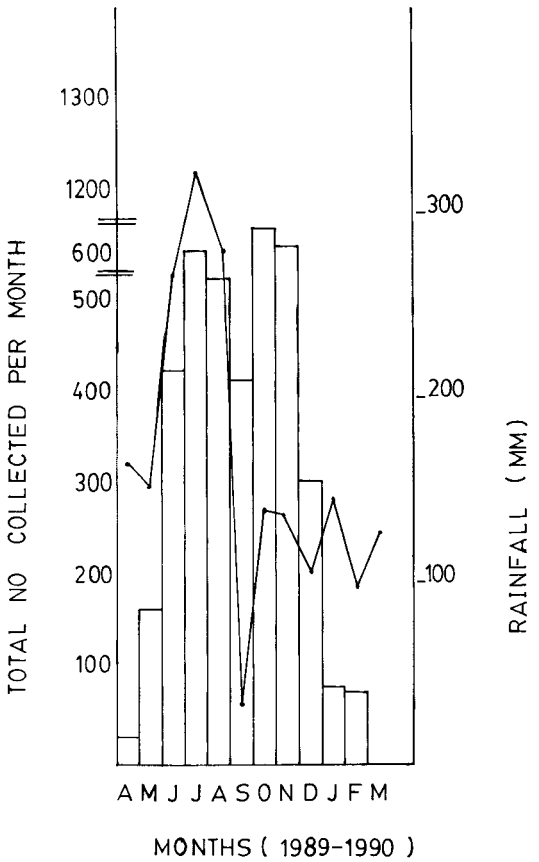

Fig. 1. Monthly rainfall and *Anopheles homunculus* abundance at Cumaca Forest, Platanal, Trinidad.

period. Each jar was labeled as to location and time of day of collection, date, and names of collectors. Mosquitoes were stored and transported in accordance with methods outlined by Aitken (1960).

At the Insect Vector Control Division laboratory, the adult mosquitoes were lightly anesthetized with chloroform, examined under a microscope at 40× magnification, identified, and counted. For a randomly selected subsample of about 27% of all *An. homunculus* collected, ovaries were examined for parity according to the method of Detinova (1962), that is, the presence or absence of tracheolar skeins. Mosquito collections were analyzed separately for the dry season (observations from December 1989 to March 1990 and for April 1989), the wet season (May 1989 to November 1989), and for both seasons combined. The unit of exposure was the collection day—a 24-h period during which female mosquitoes collected in each period of 2 h were monitored in accordance with Chadee (1992b). Numbers of mosquitoes are expressed as either arithmetic means ($\bar{x}$) or as Williams's means (Mw) (Haddow 1960).

RESULTS

Meteorology: Rainfall data are shown in Fig. 1. From April to March 1990, 1,935 mm of rain fell at the Cumaca forest. The heaviest rainfall occurred from June to November 1989 when 80% of the total rainfall for the year was recorded. During October 1989 the highest monthly total rainfall was recorded (296 mm).

Mosquito abundance: Anopheles homunculus females (n = 4,608) were collected landing on human bait during every month of the year (Table 1), densities being low during the dry season (1,278 = 27.7% of the annual total) and highest during the wet season (3,330 = 72.3% of annual total). The monthly mean of the daily number of female *An. homunculus* landing on human bait was 114.8/6 collectors/day in the wet season and was significantly higher ($\bar{x}$ = 312.8; $P < 0.001$) than that observed during the dry season (55.5/6 collectors/day), with an annual mean of 88.6 mosquitoes landing/6 collectors/day (Fig. 1 and Table 1).

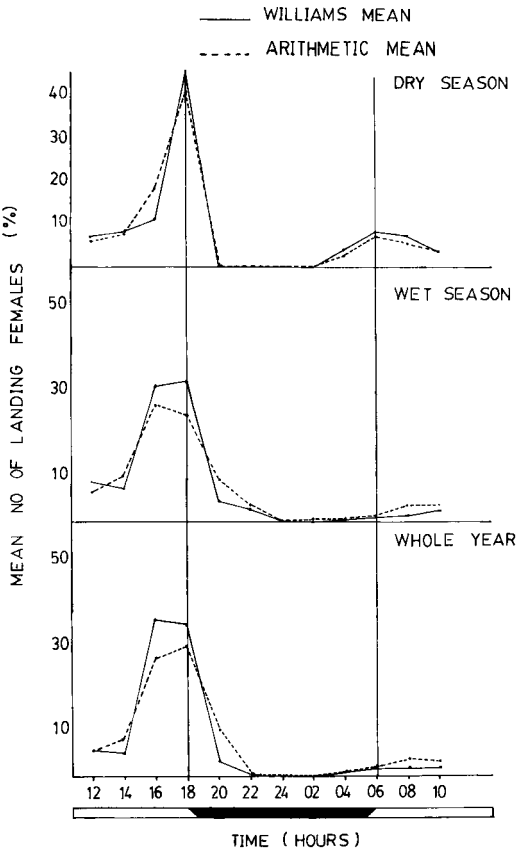

Fig. 2. Seasonal diel patterns of *Anopheles homunculus* landing on human bait at Cumaca Forest, Trinidad, during the dry months, December–April (top); wet season months, May–November (middle); and whole year, April 1989–March 1990 (bottom).

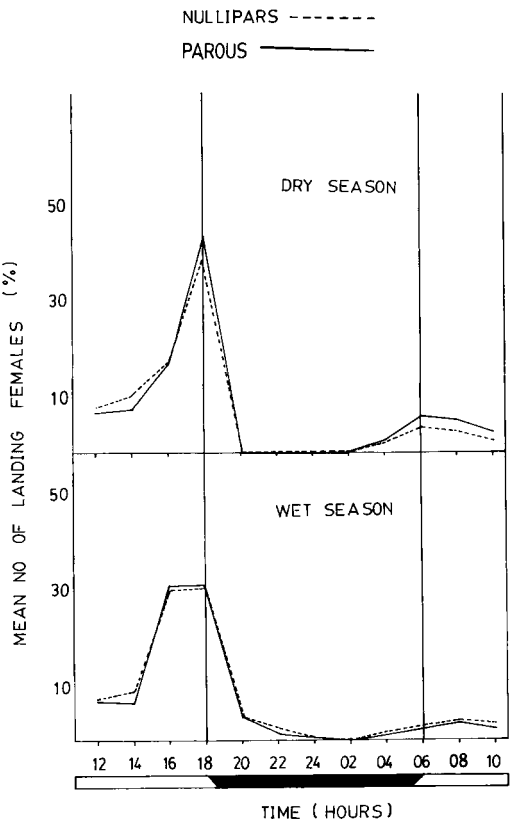

Fig. 3. Annual mean diel patterns of *Anopheles homunculus* landing on human bait at Cumaca Forest, Platanal, Trinidad (Williams's mean), April 1989–March 1990.

Biting cycle: The biting periodicity of *An. homunculus,* as recorded from mosquitoes landing on human bait, began at early dawn and stopped after midnight (Figs. 2 and 3). Diel landing rates per 2-h sampling period are presented in Fig. 2, showing both arithmetic ($\bar{x}$) and Williams's mean (Mw).

In the dry season (December–April) peak activity (>59% of females) occurred between 1600 and 2000 h, 10–14 h after sunrise (Fig. 2). In the wet season, a similar peak in activity occurred between 1600 and 2000 h (65% of females) (Fig. 2).

Age grading: The age composition of landing populations of *An. homunculus* is shown in Table 2 and Fig. 3. The diel periodicities of nullipars and pars were almost identical during the wet and dry season (Fig. 3). The overall parous rate was 58.1% (Table 2). During the dry season 56.1% (348/620) of all females collected were parous, indicating a high proportion of physiologically old mosquitoes being present in the Cumaca forest, compared with only 43.8% nullipars (Table 2).

During the wet season the overall parous rate of 58.9% was significantly ($P > 0.05$) greater than the overall nulliparous rate of 39.9% (251/629). However, the parous rates during the wet and dry seasons were similar (58.9 and 56.1%).

DISCUSSION

Little information is available on the seasonal patterns of *An. homunculus* mosquitoes in the Neotropics. Pittendrigh (1948) reported that in the wettest valleys in northeastern Trinidad, *An. homunculus* was abundant. The present study confirms this observation and shows a clearly defined seasonal pattern with more than 70% of the *An. homunculus* collected during the wet sea-

Table 2. Numbers of *Anopheles homunculus* females (and % parous) collected during the wet and dry season at Cumaca Forest, Trinidad.

Categories	Season		
	Wet (May–Nov.)	Dry (Dec.–April)	Total
No. of females	3,330	1,278	4,608
No. of females age graded	629 18.9%	620 47.6%	1,249 27.1%
No. of nullipars	251 39.9%	272 43.9%	523 41.9%
No. parous	378 58.9%	348 56.1%	726 58.1%

son. The early wet season peak recorded during May, June, and July (52%) may be due to the hatching of eggs (after the dry season) and these high population densities may play a significant role in the transmission of malaria. However, the decline in the *An. homunculus* populations during the middle and latter parts of the wet season may be explained by the loss of immatures due to water overflowing from the bromeliads. Similar loss of immatures, especially the floating egg stage, which is particularly vulnerable to mortality associated with rainfall, has been reported for aedine, sabethine, and toxorhynchitine inhabitants of phytotelmata (Lounibos and Machado-Allison 1987).

Collections of *An. homunculus* during the present study show a clearly defined diel landing pattern. Pittendrigh (1948) reported a diurnal pattern, with peak abundance occurring during the day near ground level within the forest. In contrast, during the present study landing activity started at dawn and continued throughout the day with peak activity occurring between 1600 and 2000 h and a decline after midnight. Similar results were reported by Pittendrigh (1950) who suggested an "ecocrepuscular" activity, that is, activity is high in the early morning and early evening and falls to a distinct trough during the middle of the day (Haddow 1954), with an increase in activity from 1600 to 1900 h and a sharp decline between 1900 and 2000 h.

Anopheles homunculus is considered an important vector of malaria in Brazil and Trinidad (Pittendrigh 1948, Zavortink 1973). Deane (1988), however, suggested that this species may only be of "secondary importance." In Trinidad, the parasite has not been isolated from field-collected specimens but Pittendrigh (1948) reported that "there can be no doubt of its vector status". From the 1,249 *An. homunculus* dissected, 58.1% were parous, with similar parous levels occurring during both wet and dry seasons (Table 2). This suggests that parous mosquitoes can equally transmit malaria during both wet and dry season providing they are long lived, although *An. homunculus* populations fluctuate during the dry season and during the middle and latter part of the wet season. No information is available on the length of the gonotrophic cycle, possibly due to high mortality of field-collected specimens and the general failure to colonize this species.

ACKNOWLEDGMENTS

Special thanks to R. Paul, Specialist Medical Officer, Insect Vector Control Division for valued help; J. M. Sutherland for reviewing a draft of the manuscript; and R. Ganesh, R. C. Persad, R. Manwah, R. Sideno, and the rest of the staff for laboratory and field assistance. This research was supported by the National Institute of Health grant R01 A129000 and the Forgaty International Research Collaboration Award R03 TW00240.

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