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DAILY SURVIVAL RATES AND DISPERSAL OF *AEDES AEGYPTI* FEMALES IN RIO DE JANEIRO, BRAZIL

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Abstract. Daily survival rates, life expectancy, dispersal, and parity are important components of vectorial capacity of *Aedes aegypti*. These parameters were estimated for mosquito populations from a slum and a suburban district in Rio de Janeiro, during the wet and dry seasons in 2005. In each mark-release-recapture experiment, three cohorts of dust-marked *Ae. aegypti* females were released. Recaptures were carried out daily in randomly selected houses, using backpack aspirators, adult traps, and sticky ovitraps. Recapture varied between 6.81% and 14.26%. Daily survival was estimated by fitting two alternative models: exponential and nonlinear models with correction for the removal of individuals. Slum area presented higher survival and parity rates (68.5%). Dispersal rates were higher in the suburban area, where a maximum dispersal of 363 m was observed. Results suggest intense risk of dengue epidemic, particularly in the urban area.

INTRODUCTION

A precise estimation of life history parameters of *Aedes aegypti* is essential for the development of dengue transmission models.[1] Among these parameters, the daily survival probability of adult females is one of the most important, because small increases in survival may exponentially increase the vectorial capacity of mosquitoes.[2] As a rule, vectors must survive longer than the sum of the initial nonfeeding period plus the extrinsic incubation period to be able to infect another human. For dengue transmission, that means a lifespan of least 12 days (2 days of nonfeeding and 10 days of incubation).[3,4]

Besides survival, another important component of vectorial potential is dispersal. A very mobile infected vector has greater chance of finding susceptible humans than one with low dispersal. *Ae. aegypti* is not a very mobile species, generally flying 50–300 m during its lifetime[5]. Reports of longer distance flights exist and suggest that *Ae. aegypti* is capable of covering considerable distances in few days if necessary.[6,7] Variation in mosquito displacement may be explained by heterogeneity in the availability of breeding sites and blood opportunities.[8–10]

In Rio de Janeiro city, dengue fever has become endemic since its reintroduction in the 1980s. *Ae. aegypti* is specially abundant in urbanized and densely populated neighborhoods.[11–13] To provide parameters for the development of models of dengue transmission in Rio de Janeiro, we used a mark-release-recapture (MRR) study design to evaluate the variation in the probability of daily survival, average life expectancy, and dispersal of *Ae. aegypti* females in two areas of contrasting urbanization patterns in Rio de Janeiro during the dry and wet seasons. We also evaluated the ovarian development and parity rates of natural populations of *Ae. aegypti* living in the above conditions. The ultimate goal of this study is to increase the understanding on dengue transmission in Rio de Janeiro.

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MATERIALS AND METHODS

Study area. MRR studies were conducted in two neighborhoods at Rio de Janeiro city—Favela do Amorim and Tubiacanga—characterized by contrasting urbanization patterns and potential isolation from the surroundings, which is expected to minimize mosquito losses by emigration during MRR experiments.

Favela do Amorim (22°52′30″ S; 43°14′53″ W) was chosen to represent a densely populated (901.2 hab/ha) low-income urban area, characterized by disordered human occupation and scarce vegetation coverage (a typical Brazilian slum). There, 2,992 people live in 897 substandard houses, in an estimated area of 2.32 ha. Houses are very small—rarely with more than one room—and without yards or any kind of peridomestic area. The neighborhood is surrounded by large highways and the Oswaldo Cruz Foundation campus, which is a largely vegetated, non-residential area, which probably does not encourage *Ae. aegypti* females to emigrate from the slum.

Tubiacanga (22°47′08″ S; 43°13′36″ W) was chosen to represent a planned, suburban area. There, 2,902 residents live in 867 houses, which resulted in a human density of 337.4 hab/ha (an estimated area of 8.6 ha). This neighborhood is located in a lowland coastal area, partially surrounded by the Guanabara Bay shores and a 3-m wall of the Tom Jobim International Airport of Rio de Janeiro and its numerous landing strips. There is a single way to get into Tubiacanga by car: a 2.1-km paved road, which connects the area to the nearest neighborhood. Thus, mosquito emigration is not expected to happen in large scale. The area has extensive unpaved streets and moderate vegetation coverage. Most houses have a large peridomestic environment and at least two bedrooms.

Climate and MRR periodicity. Climate in Rio de Janeiro is characterized by a dry winter (May–August) and a wet summer season (November–March).[14] During the 1930–1990 period, dry and wet seasons in Rio de Janeiro had mean temperatures of 25.1°C and 28.8°C and mean total rainfall of 46.4 and 132 mm, respectively. MRR experiments were performed during both seasons in each area: Tubiacanga in February 2005 (wet) and July 2005 (dry) and Favela do Amorim in June 2005 (dry) and December 2005 (wet season). Air temperature and precipitation data for these months were obtained from a meteorological station located 5 km away from the two study areas.

Mosquitoes. *Aedes aegypti* used in MRR experiments came from a laboratory colony that is constantly renewed with eggs collected in Rio de Janeiro. Larvae were fed with fish food (Tetramin, Tetra Sales, Blacksburg, VA) and reared according to Consoli and Lourenço-de-Oliveira.[15] After emergence, females were kept together at 25 ± 3°C and 65 ± 5% relative humidity (RH) and fed with sucrose solution until the time to release.

Marking and releasing. Before each experiment, eggs were split into three groups and allowed to hatch on 3 consecutive days, producing three female adult cohorts. Each cohort was marked with a different color of fluorescent dust (Day-Glo Color Corp., Cleveland, OH) in small cylindrical cups (12 × 10 cm). Mated and unfed females were released outdoor at each area in the morning of their fourth day after emergence (between 8:00 AM and 9:00 AM), ~1 hour after dust marking. One mosquito cohort was released each day for 3 consecutive days in each area, both in dry and in wet seasons, totalizing 12 field experiments. Each cohort was released at different points of the study areas. Around 4–5 months elapsed between releases of the cohorts in each area.

Capturing. Dust-marked females were captured with CDC backpack aspirators (John W. Hock, Gainesville, FL), BG-Sentinels adult trap (BioSantos GmbH, Rejemsburg, Germany), and sticky ovitraps.[16–19] Captures started 1 day after the release of the first cohort. Fifteen houses were randomly selected per day for aspiration, which was done in 15–20 minutes per house. The whole house was aspirated, including the peridomestic area. BG-Sentinel traps (BGS-Trap) were installed in 15 houses, and remained there during the whole extension of the MRR study, being daily monitored for the presence of dust-marked females. Occasionally, aspiration was done in the same house where a BGS-Trap was installed. Results concerning species specificity, capture efficiency, and a more suitable description of BGS-Trap can be found elsewhere.[17,18] Finally, 20 sticky ovitraps were placed at the perimeter of the study areas, as an attempt to capture emigrating insects from study areas. Sticky ovitraps were placed on the ground, in the peridomestic environment, 30–40 m apart from each other in Tubiacanga and 50–60 m apart in Favela do Amorim. Because we assumed mosquito females would not fly toward the sea, we installed sticky ovitraps in only one half of the perimeter in Tubiacanga, which resulted in a more dense coverage in Tubiacanga than in Favela do Amorim. A prior report attested that oviposition traps (OTs) placed in the peridomestic area were more efficient at capturing *Ae. aegypti* mosquitoes in comparison with the OTs placed indoors.[20] Adhesive papers were applied to the internal section of ovitraps baited with hay infusion, as used in previous reports.[10] Sticky ovitraps were checked only once at the end of experimental period. Daily capture stopped when no dust-marked females were collected by any method for 3 consecutive days. Captured mosquitoes were examined under UV light to check for the presence of fluorescent dust.

Survival analysis. Daily probability of survival (PDS) was estimated by fitting two models: the exponential model[21] and the nonlinear model by Buonaccorsi.[22] The exponential model has been traditionally used for *Ae. aegypti*[23] but has two fundamental drawbacks. It assumes *a priori* that mosquito mortality does not vary with increasing age and does not consider removal of individuals by the capturing procedure. Recently, a non-linear survival model was proposed, which allows for the correction of estimates caused by the removal of individuals[22]:

$$C(t) = NS^{t}c(1 - c)^{t-1}$$

where $C(t)$ in the number of marked individuals captured on day t; c is the daily capture probability; and S is daily survival probability. Buonaccorsi[22] compared the two models using *Ae. aegypti* data from MRR experiments conducted in Thailand[24] and found that the new model had a better fit to the data. We fit both models to our data, using linear and nonlinear least squares standard procedures available in the software R 2.0.[25]

From the lower and upper 95% limits of the confidence interval for PDS (estimated by the nonlinear model), we derived two quantities: the average life expectancy (ALE), defined as $1/-\log_e \text{PDS}$[26], and longevity, defined as PDS^{10}, (where 10 is the duration of the extrinsic incubation period for dengue), which gives the expected proportion of mosquitoes surviving long enough to transmit dengue virus.

Dispersal analysis. The locations of all release and positive capture points were geo-referenced using a Global Position System (GPS; Garmin eTrex personal navigator, Gavmin International, Olathe, KS) to calculate distance between release and capture points. The flight behavior of *Ae. aegypti* females in the two study areas was summarized by a set of dispersal measures: mean distance traveled (MDT), maximum distance traveled (MAX), and flight ranges (FR).[27,28] Frequency distributions of the numbers of marked mosquitoes recaptured that had traveled < 100 and > 200 m from the release point were constructed to further characterize the flight range of *Ae. aegypti* females.

Ovarian development stage and parity rate. To evaluate the evolution of ovarian development in marked females, all dust-marked females captured with backpack battery-powered aspirator had their ovaries removed in saline solution, and skeins of the ovarian tracheal system were evaluated under a microscope. Ovarian of dissected females were classified according to Christophers,[29] with stages 1, 1–2, and 2 grouped as initial stages of development; stages 3 and 4 grouped as intermediary stages; and stage 5 classified as final stage (gravid females).

All non-marked females captured (i.e., wild individuals) were dissected for determination of parity based on the condition of the tracheal system, as described by Detinova.[30] Parity of natural population of *Ae. aegypti* for each season and area was calculated as the number of parous divided by the total number of females captured.

Comparisons between sites and seasons. Differences in survival rates between study areas and seasons were evaluated by comparing the point estimates of survival rates by two-sample *t* test.[31] To evaluate the effect of study area (categorical variable: Tubiacanga/Amorim), season (categorical variable: dry/wet season), and days since release (continuous variable) on mosquito dispersal, we used generalized estimating equations (GEEs), which are linear regression models with a correction of variance caused by the blocking design (cohorts). The GEE model was fitted, assuming an exchangeable correlation structure.[32] In all analyzes, dispersal distances were log-transformed, because this variable presented non-normal distribution. All model fitting was performed using the R 2.0 program (package geepack, for GEE fitting).[25]

Parity rates observed in field populations were compared

TABLE 1

Number of dust-marked *Ae. aegypti* females released and captured per day in the two neighbors in Rio de Janeiro, using two capturing methods: backpack battery-power aspirator and BGS-Traps

Days after release	Tubiacanga wet season			Tubiacanga dry season			Favela do Amorim dry season			Favela do Amorim wet season		
	Cohort 1	Cohort 2	Cohort 3	Cohort 1	Cohort 2	Cohort 3	Cohort 1	Cohort 2	Cohort 3	Cohort 1	Cohort 2	Cohort 3
Released	821	676	893	851	712	619	731	698	707	652	703	729
1	28	25	30	19	17	20	15	8	10	10	13	12
2	19	17	22	8	11	10	10	6	9	13	10	10
3	14	14	20	11	9	9	13	8	11	15	8	13
4	12	12	16	8	6	9	12	11	6	9	14	9
5	9	9	11	4	3	4	8	9	5	13	12	10
6	7	6	8	3	3	5	11	5	8	9	10	6
7	3	4	6	3	3	3	6	3	7	6	8	7
8	4	2	3	1	1	1	6	6	4	7	9	3
9	2	1	2	0			2	4	6	8	7	6
10				1			3	1	4	3	5	5
11							5		4			2
12							5		2			
13							1					
Total	98	90	118	58	53	61	97	67	76	93	96	83
Recapture rate (%)	11.93	13.31	13.21	6.81	7.44	9.85	13.26	9.59	10.74	14.26	13.65	11.38

with χ^2 tests. The aim was to evaluate whether parity rates observed during MRR experiments were different regarding the study areas and seasons.

Ethical considerations. MRR experimental protocols were submitted to and approved by Fiocruz Ethical Committee (CEP/Fiocruz protocol no. 11591-2005).

RESULTS

Climate. In Tubiacanga, during the wet season, temperature varied from 23.3°C to 29.6°C, and month rainfall was 161.9 mm; during the dry season experiment, temperature varied from 18.3°C to 26.5°C, with 44.1 mm of rainfall. In Favela do Amorim, temperatures ranged from 19.8°C to 27.5°C during the dry season and from 23.8°C to 30.1°C during the wet season, and precipitation was 58.3 and 125.9 mm, respectively.

Release and recapture. During the whole study, 8,792 marked *Ae. aegypti* females were released. Capturing lasted 8–13 days, and the proportion captured in each experiment varied from 6.81% to 14.26% (Table 1).

Daily survival rates and longevity. Overall, the Buonaccorsi model provided higher estimates of daily survival (PDS) than the exponential model. This is expected because it corrects for the removal of individuals. Within each site/season, cohorts showed good agreement (Table 2). Mosquitoes released in Tubiacanga showed lower survival than those released in Favela do Amorim. This happened both in the dry and wet seasons (dry season: $t = 17.58$, $P < 0.001$; wet season: $t = 9.52$, $P < 0.001$). Survival differences between sites were found to be as great as 10% during the wet season and 13% during the dry season. Within each area, survival was higher during the dry season (Tubiacanga: $t = 2.28$, $P < 0.05$; Favela do Amorim: $t = 17.4$, $P < 0.001$).

Variation in PDS led to large variation in the ALE, which varied from 3 to 12 days in Tubiacanga and 4 to 16 in Amorim (Table 2).

Dispersal. In Tubiacanga, 60% of females were captured within a radius of 100 m from the releasing point in the wet season (93% in the dry season). The average distance traveled was 81–86 m, depending on the season, and the maximum distance traveled was 363 m. In Favela do Amorim, on the other hand, 96% (dry season) and 100% (wet season) of captured mosquitoes was found within 100 m from their release point, having traveled an average distance of 40 m in the wet summer and 53 m in the dry winter; no female was found beyond 200 m (Table 3). No significant differences were observed between distances traveled in the dry and wet seasons in both areas ($t = 0.16$, $P = 0.87$).

In Tubiacanga during the wet season, two marked (0.65% from the total of collections) and five unmarked females were captured, whereas in the dry season no marked and three unmarked females were collected in sticky ovitraps. In Favela do Amorim during the dry season, 5 marked (2.08%) and 1 unmarked females were collected, whereas in the wet season, 12 (4.41%) marked and 6 unmarked females were captured in stick ovitraps. Low numbers of captures in the surroundings of both areas suggests low emigration of mosquitoes. However, this information should be reviewed carefully, because spacing between sticky ovitraps could be considered too high, particularly in the Favela do Amorim area.

TABLE 2

Survival analysis for three *Ae. aegypti* female cohorts released in Tubiacanga and Favela do Amorim, Rio de Janeiro city, during wet and dry seasons, and captured with backpack battery-powered aspirators and BGS-Traps

Site/season	Cohort	Daily probability survival (95% CI)		ALE (days)
		Exponential	Buonaccorsi	Buonaccorsi
Tubiacanga wet season	1	0.73	0.76 (0.73–0.80)	3.2–4.4
	2	0.71	0.76 (0.73–0.78)	3.2–4.1
	3	0.71	0.75 (0.72–0.79)	3.1–4.3
Tubiacanga dry season	1	0.75	0.77 (0.73–0.80)	5.8–9.6
	2	0.72	0.75 (0.73–0.78)	5.8–14
	3	0.72	0.75 (0.72–0.79)	6.6–12
Favela do Amorim wet season	1	0.83	0.86 (0.81–0.92)	4.8–12
	2	0.85	0.88 (0.83–0.94)	5.3–16
	3	0.84	0.86 (0.82–0.90)	5.3–9.4
Favela do Amorim dry season	1	0.85	0.87 (0.84–0.90)	5.8–9.7
	2	0.87	0.88 (0.84–0.93)	5.8–14
	3	0.87	0.89 (0.86–0.92)	6.6–12

Daily probability of survival (DPS) was estimated by the exponential and Buonaccorsi models.
ALE, average life expectancy.

TABLE 3

Distances traveled by dust-marked *Ae. aegypti* females captured with backpack aspirators and BGS-Traps in a suburban neighbor (Tubiacanga) and a slum in the urban area (Favela do Amorim) in Rio de Janeiro during the dry and wet seasons

	Tubiacanga wet season	Tubiacanga dry season	Favela do Amorim dry season	Favela do Amorim wet season
MDT (m)	86.87	80.94	53.15	39.49
FR_{50} (m)	51.13	72.33	52.80	38.50
FR_{90} (m)	151.09	137.89	91.44	71.33
MAX (m)	248.28	363.09	151.92	99.53
Females flying up to 100 m (%)	60.13	93.38	96.45	100.00
Females flying beyond 200 m (%)	2.28	8.72	—	—

When a multivariate linear model was fit to the data (Table 4), "time since release" and "study area" had significant effects on dispersal. In Tubiacanga, marked mosquitoes were found significantly far away from the release point than in Amorim. No significant effect of season was found. Within-cohort correlation was estimated as 0.1, which is marginally non-significant ($P = 0.065$). Assuming that cohort effect is negligible, we may use R^2 to measure goodness-of-fit. We found $R^2 = 0.34$.

Ovarian development stages. In Tubiacanga, during the wet season, almost 60% of recovered mosquitoes in the first day after release were in stage N. This proportion tended to decrease in the following days (Figure 1A). Stages 3–4 and gravid females started to appear at days 3 and 4 after release, respectively. A similar pattern of ovarian development was observed during the dry season (Figure 1B).

In Favela do Amorim, during the dry season, 40% were at stage N at the first day, and we observed a steep decrease in this frequency in subsequent collections (no females at stage N were found after day 4). Females at stages 3–4 first appeared in the second day after release, whereas gravid females were collected on day 3 (Figure 2A). Similar patterns of ovarian development were observed in the wet season (Figure 2B).

Parity. In Tubiacanga, parity rates of 53.8% ($N = 405$) and 48.7% ($N = 316$) were observed in the captured wild population during the wet and dry seasons, respectively. In Favela do Amorim, during the dry season, the parity rate was 62.6% ($N = 297$) among unmarked captured females and 68.5% ($N = 476$) during the wet season. In both areas, parity rate did not vary significantly between seasons (Tubiacanga: $\chi^2 = 2.13$, $P > 0.05$; Amorim: $\chi^2 = 2.51$, $P > 0.05$). Parity rate observed in Favela do Amorim was significantly higher than in Tubiacanga in both seasons (wet season: $\chi^2 = 16.83$, $P < 0.05$; dry season: $\chi^2 = 6.02$, $P < 0.05$).

TABLE 4

Generalized estimating equations (GEE) model for log (dispersal) of marked *Ae. aegypti* females released in Tubiacanga and Favela do Amorim in both dry and wet seasons and captured with BGS-Traps and backpack aspirators

Variable	Effect	SE	Wald	*P*
Intercept	2.961	0.244	146.9	< 0.0001
Area (Tubiacanga)	0.650	0.137	22.4	< 0.0001
Season (wet)	0.029	0.217	0.019	0.89
Time after release	0.168	0.032	28.5	< 0.001
Correlation*	0.10	0.05	3.39	0.06

* Correlation structure used was the "exchangeable."

DISCUSSION

This report provides substantial information about *Ae. aegypti* ecology and vectorial potential under the natural conditions of Rio de Janeiro city. It was the first time that survival rate of dengue vector was evaluated locally, in a city with intense history of dengue transmission during the last 20 years. Besides survival, longevity, dispersal, ovarian development, and parity of the natural population were studied in two areas in different seasons. Our findings suggest that both localities have appropriate conditions for elevated dengue transmission. In Favela do Amorim, a poor community with extremely high human density and disordered occupation, ecological conditions showed to be more adequate for mosquito survival, and consequently, dengue transmission. High daily survival rates increase the chance of a mosquito to blood feed in a viremic person, become infective, and transmit the virus. Indeed, almost one half of living females could live for periods longer than the extrinsic incubation

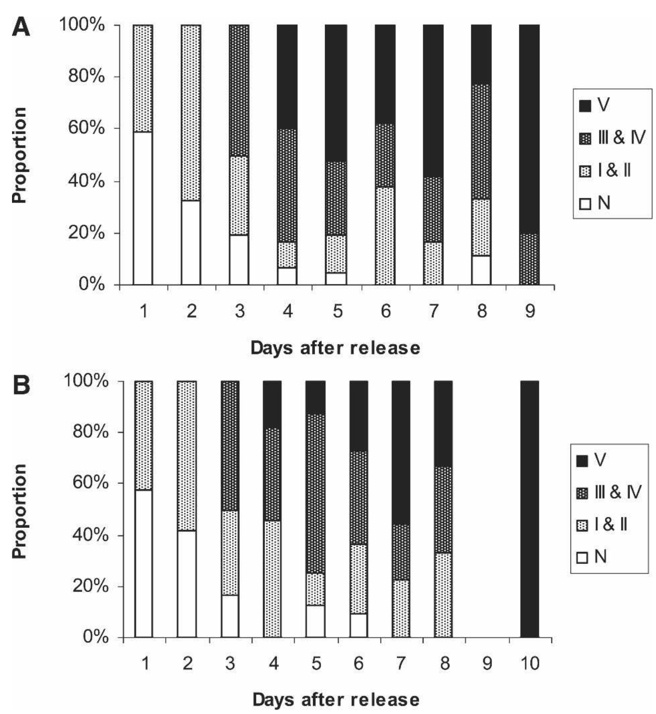

FIGURE 1. Ovarian development stages of dust-marked *Ae. aegypti* females released in the suburban area (Tubiacanga) and recaptured with backpack aspirators. (**A**) MRR conducted in the wet season, where 210 females were dissected. (**B**) MRR performed in the dry season, where 118 females were collected.

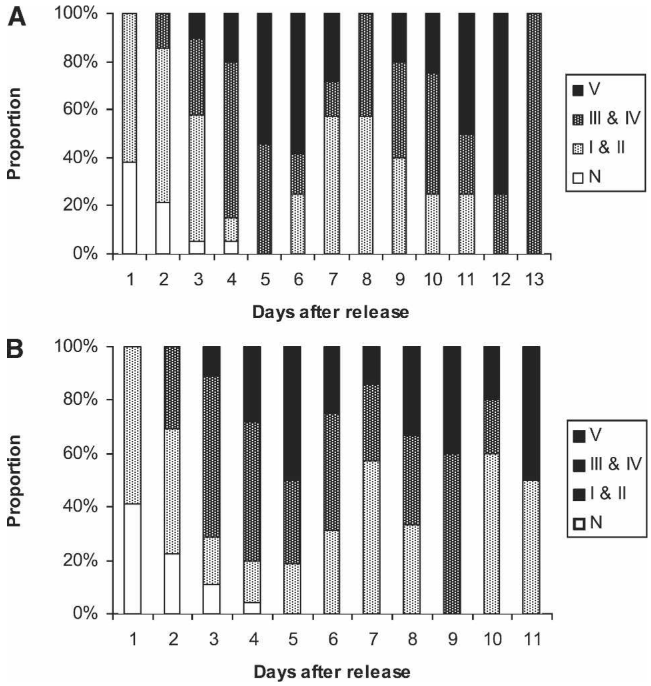

FIGURE 2. Ovarian development stages of dust-marked *Ae. aegypti* females released in the urban area (Favela do Amorim) and recaptured with backpack aspirators. (**A**) MRR conducted in the dry season, where 107 females were dissected. (**B**) MRR performed in the wet season, where 201 females were collected.

period of dengue virus in the urban area of Favela do Amorim during the dry season and 33.3% during the wet season. Life expectancy estimated for Favela do Amorim is long enough to allow four or even five gonotrophic cycles. Thus, because *Ae. aegypti* females usually takes multiple blood feedings during a single gonotrophic cycle and rarely feed on sugar,[33,34] pathogen transmission could be enhanced there. Even with a lower life expectancy, Tubiacanga also has suitable conditions for dengue transmission, because ~10% of females could live longer than the extrinsic incubation period (i.e., 10 days). However, because of its higher survival rates, dengue transmission seems to be more feasible in Favela do Amorim. Therefore, everything else been equal, it would be reasonable to expect a higher number of dengue cases in Favela do Amorim than in Tubiacanga.

During 2005, 983 dengue cases were reported in Rio de Janeiro, 7 in Favela do Amorim, and 3 in Tubiacanga. Up to the 18th entomological week of 2006, 9,408 dengue cases were confirmed in Rio de Janeiro city, with 66 cases in Favela do Amorim and 21 in Tubiacanga.[35,36] Thus, differences in mosquito survival are concordant with dengue incidence in both areas, although the incidence of a disease in an area is dependent of several factors (e.g., vector and host densities and number of susceptible individuals).

Estimates of daily survival probabilities agree with previous studies, which show values ranging between 0.70 and 0.90.[24,37,38] We found a tendency toward longer survival during the dry winter. Possibly, weather conditions during the wet and hot season were less favorable to adult mosquitoes; the mean temperature during tropical summer can be ~30°C and reach a maximum temperature of > 40°C at midday. On the other hand, the dry season generally presents more suitable climatic conditions, with mean temperatures rarely exceeding 28°C in a single day. Therefore, the unfavorable weather conditions during the wet season possibly constrained *Ae. aegypti* survival rate. The assumption that adult daily survival is constant over the year, despite seasonal trends in rainfall and temperature, was used in simulation models describing vector population dynamics and the epidemiology of dengue viruses in urban environments.[39–41] The seasonal variation in survival rates observed in this report can add accuracy to current models.[39–41]

Regarding dispersal, we found differences between areas but not seasons. This result agrees with previous studies.[5] Females released in Tubiacanga dispersed more than those released in Favela do Amorim. Tubiacanga and Amorim share approximately the same density of water-holding containers (R. Maciel-de-Freitas, unpublished data), but human density in Favela do Amorim is almost three times greater. It is possible that the diversity of obstacles posed by the irregular and dense constructions in Favela do Amorim, associated with high availability of blood sources, constrained mosquito dispersal in this area, where very few or none mosquito flew beyond 100 m from the release site. Because mosquito capturing was performed in houses randomly selected rather than in concentric circles from the release point, dispersal rate estimations may be biased. However, dispersal distances found in this study agrees with similar studies performed by in other countries.[5,42]

Dispersal has important consequences for dengue control. Usually, the first action after the identification of a new dengue case is the implementation of source reduction activities and larvicides applications within a ring area centered at the identified case. Our results suggest that a ring with radius = 200 m would be appropriate in both Tubiacanga and Favela do Amorim areas. Indeed, a smaller ring could be established in the slum area, because mosquitoes displaced less there.

Data on ovarian development of marked females in Tubiacanga and Favela do Amorim showed important differences. Mainly, the continuous appearance of females at stage N in Tubiacanga and the appearance of gravid females 3 days after release in Favela do Amorim (in Tubiacanga gravid females were collected just 4 days after release) reinforce the idea that females can complete a gonotrophic cycle earlier in more densely human populated areas, where the probability of a blood-seeking female encounter a host is higher.

Parity rate in Favela do Amorim was higher than in Tubiacanga in both dry and wet seasons. However, with the study design reported in this paper, the authors are not confident to state if higher parity was a consequence of higher human density or higher mosquito survivorship, which was also higher in Favela do Amorim.

Recapture rates varied between the MRR experiments. Lower recapture was observed during dry season (mean of 7.88% and 11.23% for Tubiacanga and Favela do Amorim, respectively), when the highest survival rates were observed. Low rates can lead to a bias in results concerning mortality rate and dispersal, although observed recapture rates were similar or even higher than several prior reports.[9,37]

In summary, this study assesses several aspects of mosquito ecology in two distinct neighbors in Rio de Janeiro, a city where vector density and dengue transmission have shown to be highly heterogeneous[1] and mosquito control faces several drawback to be surpassed, such as insecticide resistance and reduced effectiveness in mosquito control because of the inaccessibility to some areas such as slums because of criminality.[43–45] Other field evaluations concerning daily survival rates, longevity, dispersal, ovarian development, and parity in different areas and seasons would give more light for the understanding of dengue transmission pattern in Rio de Janeiro and improve mosquito control.

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