DYNAMICS OF MALARIA TRANSMISSION UNDER DISTINCT LANDSCAPE FRAGMENTATION THRESHOLDS

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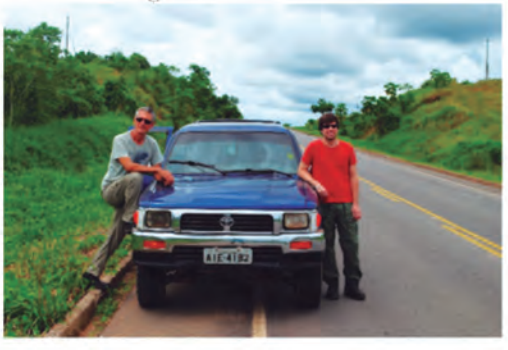
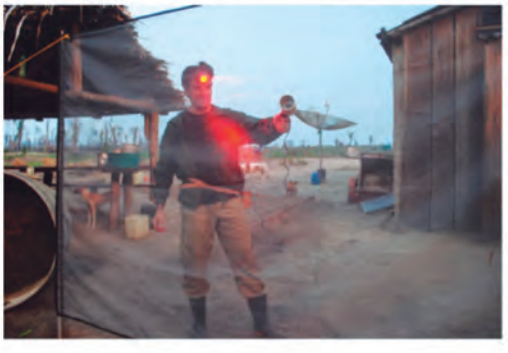
On the road. To Cruzeiro do Sul, Acre state.
Eduardo Bergo. Leonardo Chaves.



On the collections of host-seeking females.
In Machadinho D'Oeste, Rondônia.
Gabriel Laporta.



Malaria is the most prevalent vector-borne parasitic disease in the Americas, and Brazil has the highest regional malaria incidence. The most aggressive and effective Neotropical malaria vector, particularly in the Amazon Basin, is *Anopheles darlingi*. This species' impact is facilitated by its rapid exploitation of the novel environments provided by whole ecosystem alteration via factors associated with deforestation, e.g., so-called frontier malaria outbreaks. There are more than 2,700 recent agricultural settlements in Amazonian Brazil, accounting for over 63,000 malaria cases in Brazil in 2012. The Frontier Malaria Hypothesis postulates that malaria incidence peaks early following settlement and declines with settlement age. The present proposal is linked to a Research Project (n 1R01 AI110112-01A1, Project Title: 'Latitudinal landscape genomics and ecology of *Anopheles darlingi*', Principal Investigators: Jan E. Conn - USA, M. Anice M. Sallum - Brazil) funded by the National Institutes of Health (NIH), USA, 2014-2019. Herein, we will examine understudied aspects of dynamics of malaria transmission in Brazil. We will test the Frontier Malaria Hypothesis (FMH), by explicitly separating the effects of settlement age and landscape fragmentation. We will use a state-of-the art ecologically based experimental design that compares environmental variables in three levels of landscape fragmentation and two habitat types in both new and old settlements in two regions (east and west) of Amazonian Brazil. Entomological metrics and the dynamics of malaria transmission will be compared among 12 settlements, by applying mixed effect regression models. Three mathematical models that represent the dynamics of malaria transmission will be employed to understand malaria emergence under distinct landscape fragmentation thresholds. The first model is the Ross-Macdonald (H_0), the second is a biodiversity-oriented model (H_1) and the third is a food-web model (H_2). These models will be calibrated with primary data acquired in the field and their R_0 (Basic Reproductive Number) values will be compared to epidemiological data provided by the Ministry of Health. Simulations using these models in hypothetical scenarios will be performed to identify the main mechanisms responsible for the success in malarial transmission. Expected results are that a modified FMH, that accounts for both age and fragmentation, will provide stronger predictive power for the invasiveness of *An. darlingi* and other vectors causing malaria emergence in a wide range of fragmented landscape types.

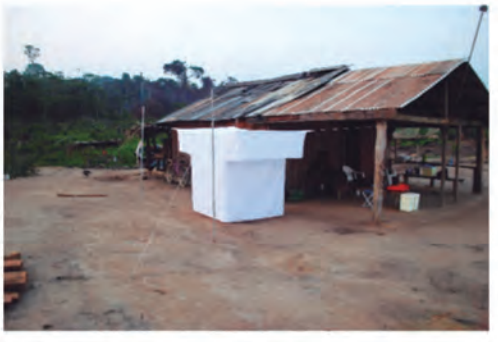
SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

Field collections were performed in all the following Amazonian states: Acre, Rondônia, Pará, and Amazonas, Jan. 2015 – Nov. 2016. Municipalities with high malaria transmission were chosen: Cruzeiro do Sul-AC, Mâncio Lima-AC, Acrelândia-AC, Machadinho D'Oeste-RO, Lábrea-AM, Humaitá-AM, Manaus-AM, and Pacajá-PA. Inside each municipality, rural and/or peri-urban human settlements with the highest malaria transmission were selected. In each settlement, a gradient of forest clearing was determined by remote sensing and a 5-km^2 landscape with replicate was determined in either mature forest (100-65% forest cover), fragmented forest (64-30% forest cover) or cleared forest (29-0% forest cover). In each landscape, a one-night mosquito collection was carried out with Shannon traps, interception nets and small aspirators (Figures 1, 2).

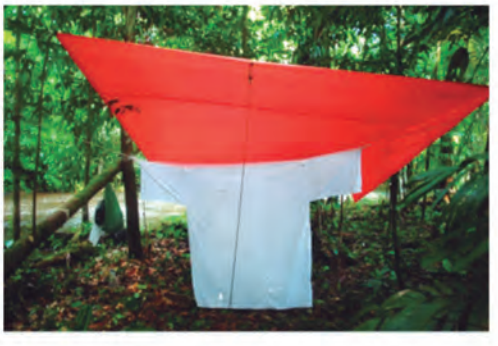
Samples were taken to the laboratory. Species were identified. Specimens of *Anopheles darlingi* species have been tested for the presence of infection by malaria parasites (*P. vivax* and *P. falciparum*). Origin of the ingested blood has been also employed with these specimens.

Landscape analyses have started. There are two aims. The first is to estimate forest cover in each of the 48 landscapes by utilizing Landsat 8 satellite imagery. The second is to estimate time of colonization for each of these landscapes. An undergraduate student with a CNPq fellowship is currently working with the second aim. A second undergraduate student is at the present developing a research proposal to study associations between forest cover and malaria incidence in up to 30 municipalities in the Amazon, in the last 10 years.

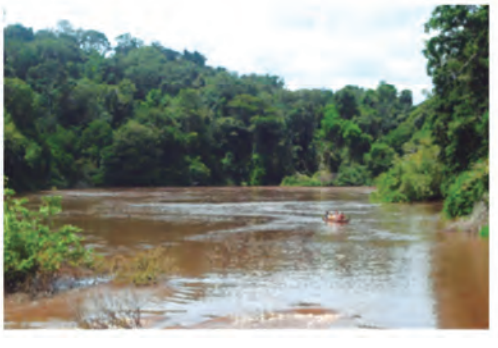
Shannon trap. In the peridomicile.
Machadinho D'Oeste, Rondônia.



Shannon trap. In the forest.
Cururuí settlement, Pacajá, Pará.



Cururuí river.



MAIN PUBLICATIONS

Laporta GZ, Linton YM, Wilkerson RC, Bergo ES; Nagaki SS, Santana DC, Sallum MAM. 2015. Malaria vectors in South America: current and future scenarios. *Parasites. Vectors.* 8: 426. DOI: 10.1186/s13071-015-1038-4.

Laporta GZ, Burattini MN, Levy D, Fukuya LA, Oliveira TMP, Maselli LMF, Conn JE, Massad E, Bydlowski SP, Sallum MAM. 2015. *Plasmodium falciparum* in the southeastern Atlantic forest: a challenge to the bromeliad-malaria paradigm? *Malaria J.* 14: 181. DOI: 10.1186/s12936-015-0680-9

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