SEASONAL DISTRIBUTION OF MALARIA VECTORS (DIPTERA: CULICIDAE) IN RURAL LOCALITIES OF PORTO VELHO, RONDÔNIA, BRAZILIAN AMAZON

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SUMMARY

We conducted a survey of the malaria vectors in an area where a power line had been constructed, between the municipalities of Porto Velho and Rio Branco, in the states of Rondônia and Acre, respectively. The present paper relates to the results of the survey of Anopheles fauna conducted in the state of Rondônia. Mosquito field collections were performed in six villages along the federal highway BR 364 in the municipality of Porto Velho, namely Porto Velho, Jaci Paraná, Mutum Paraná, Vila Abunã, Vista Alegre do Abunã, and Extrema. Mosquito captures were performed at three distinct sites in each locality during the months of February, July, and October 2011 using a protected human-landing catch method; outdoor and indoor captures were conducted simultaneously at each site for six hours. In the six sampled areas, we captured 2,185 mosquitoes belonging to seven Anopheles species. Of these specimens, 95.1% consisted of Anopheles darlingi, 1.8% An. triannulatus l.s., 1.7% An. deaneorum, 0.8% An. konderi l.s., 0.4 An. braziliensis, 0.1% An. albitarsis l.s., and 0.1% An. benarrochi. An. darlingi was the only species found in all localities; the remaining species occurred in sites with specific characteristics.

KEYWORDS: Anopheles; Rondônia; HBR; Hydroelectric power plant.

INTRODUCTION

Although cases of malaria have decreased in Brazil since 2005, the disease remains an important public health problem in the country. In 2012 alone, approximately 240,000 cases were recorded here, of which more than 90% occurred in the Amazon region1.

Anopheline mosquitoes are the only vectors of Plasmodium spp. parasites to humans. These mosquitoes are found in tropical and neotropical regions. As of 2004, 476 species had been recorded2, of which approximately 100 are considered vectors or potential vectors of Plasmodium spp. to humans22,38. In the Amazon region, the main disease vector is Anopheles darlingi, although other species such as An. deaneorum, An. triannulatus, and An. nuneztovari may play important roles in the epidemiology of the disease35,36,41. The occurrence of an anopheline species in an endemic area is associated with the environmental characteristics of the region.

South America is currently among the regions most affected by environmental changes, mainly because of the great pressure caused by humans in the area. The construction of hydroelectric power plants, family farming, and selective logging, among many other activities, has become common in the region44. The changes caused by these activities can drastically influence the population dynamics of malaria vectors, thereby increasing malaria cases in the region. Thus, the assessment of mosquito population density and species occurrence in areas where these activities take place or will take place is essential for evaluating the risk of malaria transmission and for designing and implementing effective measures of control and/or prevention.

Therefore, our study aimed to assess the changes in the number and composition of anopheline species along the construction corridor of a power transmission line.

MATERIALS AND METHODS

Mosquito capture was conducted along a 380 km stretch of the BR 364 highway, between Porto Velho (RO) and Rio Branco (AC). Six distinct localities with the highest population densities along the stretch were selected. These localities were Extrema (09°45’29.1”S 66°21’34.3”W), Vista Alegre (09°39’39.8”S 65°43’57.2”W), Abunã (09°41’48.9”S 65°22’15.8”W), Mutum Paraná (09°37’01.3”S 64°56’24.4”W), Jaci Paraná (09°15’37.2”S 64°23’44.1”W), and Porto Velho (08°48’35.5”S 63°56’30.3”W) (Fig. 1). Vegetation in these areas predominantly consists of open rain forest with a high degree of human disturbance, as evidenced by the removal of native vegetation and its replacement by pasture.
Captures were performed at three sites in each locality during the months of February, July, and October 2011. Three dwellings were selected at each site, and protected human landing catches were performed simultaneously inside and outside of each dwelling. The collection sites remained the same throughout the whole study for posterior comparison. Mosquitoes were stored in plastic cups and identified using dichotomous keys for females. The species compositions of the distinct areas were compared using PERMANOVA, followed by PERMDISP and scored on NMDS. For these analyses, the vegan package was used in R. The comparison of An. darlingi density among localities and between indoor and outdoor dwellings was adjusted to correct overdispersion problems. All analyses were performed at a significance level of 5%.

**RESULTS**

We collected 2,185 anopheline mosquitoes belonging to seven species in the six localities. Of the mosquitoes collected, 95.1% were identified as *An. darlingi*, 1.8% as *An. triannulatus* l.s., 1.7% as *An. deaneorum*, 0.8% as *An. konderi* l.s., 0.4% as *An. braziliensis*, 0.1% as *An. albitoris* l.s., and 0.1% as *An. benarrochi* l.s. *Anopheles darlingi* was collected in all localities. The remaining species were found in sites with unique characteristics (e.g., *An. braziliensis* was predominantly found in areas of secondary growth, such as forest clearings and pastures) (Table 1). Mutum Paraná, Porto Velho, and Jaci Paraná exhibited four of the seven collected species, whereas only two were found in Extrema, Vista Alegre do Abunã, and Vila Abunã. Moreover, although these areas had the same number of species, their species composition (i.e., species found in the area) significantly differed (PERMANOVA S.S = 1.37; Pseudo-$F < 0.001$). However, no significant differences in *Anopheles* spp. community homogeneity were observed among the study areas (Permdisp $p = 0.34$; Fig. 2). Analysis of the distribution patterns of the main malaria vectors showed that the number of *An. darlingi* differed significantly among localities (ANOVA $\chi^2 = 44.35, p < 0.001$), with Porto Velho exhibiting the highest mean number of individuals of this species (144.55 ± 59.81) and Vila Abunã exhibiting the lowest (5.66 ± 1.04). The mean distribution of *An. darlingi* among the localities is summarized in Table 2. With the exception of Vista Alegre do Abunã, *An. darlingi* numbers were significantly higher in outdoor than indoor dwellings (ANOVA $\chi^2 = 27.79, p < 0.001$; Fig. 3).
DISCUSSION

In Brazil, six species of anopheline mosquitoes play significant roles in the transmission of Plasmodium spp., parasites to humans. Three of these species were collected in our study: An. darlingi, An. triannulatus, and An. braziliensis. Other species such as An. albittarsis l.s. may be secondary or specific vectors in particular areas. The prevalence of An. darlingi has remained consistently higher than that of other species since the first studies of malaria vectors in Rondônia, even amid the environmental changes that have taken place over the last few decades. The high prevalence of Anopheles darlingi in this study was expected, as this species presents the most anthropophilic behavior among the sample collected. Furthermore, many of the environmental changes in this region (e.g., flooding of areas and the creation of water reservoirs for human use) have increased the number of breeding sites for this species.

The peak number of species occurred in July. Anopheles darlingi showed two distinct population peaks, the first in March/May (during the rainy season) and the second in August/September (end of the dry season). The peak in July may be explained by the environmental changes in the area due to the implementation of two hydroelectric power plants, or a delay in the response of An. darlingi to the rainy season.

The susceptibility of anopheline mosquitoes to infection by the predominant Plasmodium species recorded in the region, P. falciparum and P. vivax, has been previously reported. Although the highest number of mosquitoes occurred around dwellings, the results highlight that An. darlingi exhibits highly anthropophilic behavior. Moreover, although we did not find a higher number of mosquitoes inside dwellings, these species are highly endophilic, making the study region a high-risk area for the transmission and prevalence of malaria.

New farming frontiers in areas where malaria is endemic require more public policies for mosquito control. Climate change, urbanization, and new settlements for agriculture and the rearing of livestock are among the factors that can lead to epidemics of malaria and other vector-borne diseases.

Because anopheline mosquitoes are key determinants in the transmission of Plasmodium, which can infect and cause malaria in humans, the regular monitoring of the disease transmission of these vectors in relation to regional climate cycles is of paramount importance. Moreover, scientifically-based joint and coordinated action between public authorities and construction entrepreneurs should be conducted to control malaria transmission in the Brazilian Amazon.

RESUMO

Distribuição sazonal de vetores da malária (Diptera: Culicidae) em localidades rurais de Porto Velho, Rondônia, Amazônia brasileira

Foi realizado levantamento de vetores de malária na área que compreende a construção da linha de transmissão entre os municípios de Porto Velho e Rio Branco, estados de Rondônia e Acre, respectivamente. Os dados aqui apresentados mostram os resultados do levantamento da fauna dos Anopheles realizado em Rondônia. As capturas foram realizadas no município de Porto Velho em seis aglomerados populacionais ao longo da rodovia federal BR 364, denominados Porto Velho, Jaci Paraná, Mutum Paraná, Vila Abunã, Vista Alegre do Abunã e Extrema. As capturas ocorreram em três diferentes pontos de cada uma das localidades nos meses de fevereiro, julho e outubro de 2011, seguindo uma metodologia de coleta por atração humana protegida em dois ambientes, sendo no intradomicílio e no peridomicílio simultaneamente com duração de seis horas. Nas áreas amostradas foram capturados 2.185 anofelinos pertencentes a sete espécies de Anopheles sp. Os quais 95,1% foram identificados como Anophels darlingi, 1,8% An. triannulatus l.s., 1,7% An. deaneorum, 0,8% An. konderi l.s., 0,4 An. braziliensis, 0,1% An. albittarsis l.s., e 0,1% An. bararrochi. Anopheles darlingi foi a uma espécie amostrada em todas as localidades enquanto as demais espécies, ocorreram em locais com características singulares.

FINANCIAL SUPPORT

This study received financial and logistical support from Cepemar Serviços de Consultoria em Meio Ambiente Ltda.

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Received: 26 March 2014
Accepted: 30 September 2014