Bionomics of leishmaniasis vector sand flies (Psychodidae:Phlebotominae) in Kurunegala District, Sri Lanka

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Abstract – Sand flies are responsible for the transmission of leishmaniasis, a disease caused by protozoan parasites of genus *Leishmania*. Control of the sand fly populations in disease endemic areas is a critical step in the effective disease management which in turn largely depend on the availability of the knowledge on sand fly bionomics. Therefore, this study focuses on the investigation of bionomics of sand flies in three selected disease endemic regions of Kurunegala District, Sri Lanka. Monthly entomological surveillance was conducted from May 2017 – February 2019 using standard entomological techniques. Collected specimens were identified using standard morphological identification keys. The meteorological data were collected for each month from Department of Meteorology, Colombo. A total of 37,955 sand flies were collected during the study. Majority of them were *Phlebotomus argentipes* (99.43%, n=37,740) while the rest was *Sergentomyia punjabensis*. Female: male sex ratio for *P. argentipes* was 0.18, while, it is 0.04 for *S. punjabensis*. Polpithigama MOH area had the highest abundance of sand flies with a total of 33,374 (87.93%), followed by Maho (9.90%, n=3756), and Galgamuwa (2.17%, n= 825). The variation of sand fly abundance is correlated with climatic variables to some extent. Wind speed has significant negative impacts (r= -0.670, P= 0.002) on the sand fly abundance while, the rainfall (r= 0.349, P= 0.155) and relative humidity (r= 0.107, P= 0.671) positively associated with sand fly abundance though not significant, indicating a possibility of an increased sand fly abundance under rainy, humid conditions with low wind velocities.

Keywords: sand flies, bionomics, leishmaniasis, Sri Lanka

Introduction

Leishmaniasis is one of the major neglected tropical diseases in the world with an estimated number of 700,000 to 1 million new cases and responsible for 26 000 to 65 000 per year. The disease is caused by flagellate parasites in the genus *Leishmania* (WHO, 2019). The parasite is transmitted from one host to another host through infected female sand flies (Diptera: Psychodidae). Approximately, 20 species of sand flies are reported from Sri Lanka so far. The only species that is known to harbour *Leishmania* parasites is *Phlebotomus argentipes* (Senanayake *et al.*, 2015; Wijerathna *et al.*, 2018).

Cutaneous leishmaniasis is the most common form of the disease worldwide and in Sri Lanka (Alvar *et al.*, 2012; Wijerathna *et al*, 2018). More than 1300 patients per year were reported from Sri Lanka until 2018. In 2018 a total 3271 cases has been notified. Kurunegala District had the second highest prevalence with more than 500 patients (Epidemiology Unit, 2008). This increase of the incidence indicates the importance of planning and implementing control activities. One of the main aspects in the control of leishmaniasis is the prevention of the transmission through vector control. In order to achieve a successful vector control, understanding of vector bionomics including distribution and population dynamics is critical.

In Sri Lanka, no systematic surveillance program is available for sand flies. Despite some taxonomical studies, no scientific studies have been conducted on a monthly basis to sesonality and and abundance

of vector sand flies. Thus the knowledge on how the sand fly populations differ throughout a long period, how the sand flies are distributed and what climatic factors affect the sand fly abundance still remain unclear. Therefore, the current study was conducted in order to understand basic ecological features of sand flies in three selected leishmaniasis endemic regions of Kurunegala District Sri Lanka.

Methodology

Study area

Kurunegala District is located in the North Western part of Sri Lanka. The area experience 1993 mm mean annual rainfall and the mean annual temperature fluctuates around 27.2 ^{0}C. Three sites known to be endemic regions for leishmaniasis namely; Maho, Galgamuwa and Polpithigama were selected for entomological investigation.

Monthly entomological surveillance was conducted from May 2017 – February 2019 using standard entomological techniques namely; Cattle Baited Net Trap (CBNT) collection, Indoor Sticky Trap (ST) collection and Hand collection (HC) using mouth operated aspirator. Specimens collected from each technique were identified separately using standard morphological identification keys (Lewis, 1978; Kalra and Bang, 1988). The meteorological data was collected for each month from Department of Meteorology, Colombo.

Collected data were entered to Epidata v4.4.3.1 (EpiData Association) data management software package and exported as CSV files. The correlation between sand fly abundance and climatic variables were assessed using Spearman's correlation coefficient considering the results of the Kolmogorov–Smirnov normality test. Basic calculations were done in Microsoft excel. Other statistical analyses were carried out using R statistics (R Core Team) software package.

Results and Discussion

A total of 37,955 sand flies were collected during the study. Majority of them were *Phlebotomus argentipes* (99.43%, n=37,740) while the rest was *Sergentomyia punjabensis* (Table 1). Female: male sex ratio for *P. argentipes* was 0.18, while, it is 0.04 for *S. punjabensis*. Highest number of sand flies were collected from CBNT (99.39%, n=37,722), followed by ST (0.55%, n=210) and HC (0.06%, n=23) (Table 1). Polpithigama MOH area had the highest abundance of sand flies with a total of 33,374 (87.93%). Only 3756 (9.90%) and 825 (2.17%) was collected from Maho and Galgamuwa areas respectively.

The sand fly population varied during the study period with a main peak in April, 2018 and another small peak in September, 2017. The number of sand flies collected monthly correlated only with the wind speed. That was a strong negative correlation (r= -0.670, P= 0.002). Other climatic variables, average temperature (r= -0.150, P= 0.553), relative humidity (r= 0.107, P= 0.671), rainfall (r= 0.349, P= 0.155) did not show a correlation to the sand fly abundance.

A high abundance of sand flies were reported in the area. The results of the current study suggest that this area is predominated by *P. argentipes* a known vector for *L. donovani*. Polpithigama MOH area had the highest abundance of sand flies predicting a high risk of infection in this area. Interestingly, Polpithigama Medical Officer of Health area had the highest number of cutaneous leishmaniasis patients among these three areas according to previous studies (Wijerathna *et al.*, 2018)

Furthermore, the sand fly populations showed a strong negative correlation with the wind speed indicating a lower abundance under windy climates. This is apparent in the graph, as there is a

considerable drop of the wind speed at the point where, sand fly abundance reached its peak (Figure 1). Rainfall and the relative humidity did not correlate with sand fly abundance. However, slight peaks of both relative humidity and the rainfall observed when the sand fly abundance reached its peak (Figure 1). This observed low abundance of sand flies under windy conditions might be due to two reasons; first one is that the wind makes it difficult for the small flies to fly around. Therefore, they may tend to be cryptic during that period. Another reason is that the low relative humidity associated with high wind speed may reduce the favourable conditions for the development of sand flies. For an instance, sand flies emerge when the relative humidity of their microhabitat reached 100% (Volf and Volfova, 2011). These conditions may not be available in their microhabitats during the periods of high wind speed.

Table 1. The summary of the entomological surveillance

Technique	Sampling unit	No. of units	Total No. collected	Species	
				P. argentipes	***S. punjabensis***
CBNT	Trap	54	37,722	37,716	6
ST	Trap	540	210	9	201
HC	Sites	540	23	15	8
Total			**37,955**	**37,740 (99.43%)**	**215 (0.57%)**

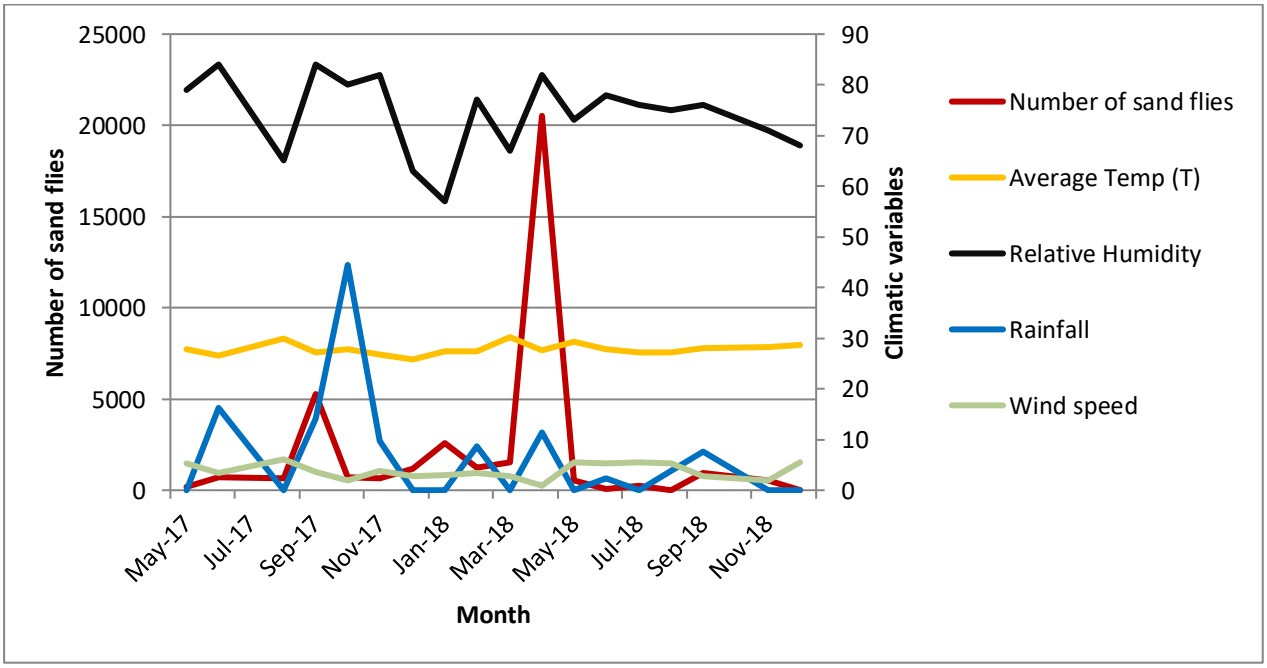

Figure 1. Variation of the sand fly abundance and climatic variables with time.

Conclusion

This study demonstrates the sand flies are found in high abundance in these leishmaniasis endemic areas and the variation of sand fly abundance is correlated with climatic variables to some extent. Wind speed has significant negative impacts on the sand fly abundance while, the rainfall and relative humidity positively associated with sand fly abundance.

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