The Influence of moon light and lunar periodicity on the abundance of *Phlebotomus (Larroussius) orientalis* (Diptera: Psychodidae) from light trap collections in Ethiopia

Araya Gebresilassie[1], Solomon Yared[4], Essayas Aklilu[1], Oscar David Kirstein[3], Aviad Moncaz[3], Habte Tekie[1], Meshesha Balkew[4], Alon Warburg[3], Asrat Hailu[5], & Teshome Gebre-Michael[4]

[1]Department of Zoological Sciences, Addis Ababa University, Addis Ababa, Ethiopia;; [3]Department of Microbiology and Molecular Genetics, The Kuvin Center for the Study of Infectious and Tropical Diseases, Faculty of Medicine, The Hebrew University, Hadassah Medical School, Jerusalem, Israel; [4]Aklilu Lemma Institute of Pathobiology, Addis Ababa University, Addis Ababa, Ethiopia; [5]Department of Microbiology, Immunology and Parasitology, School of Medicine, Addis Ababa University, Addis Ababa, Ethiopia

Introduction

In Ethiopia, visceral leishmaniasis (VL) caused by *Leishmania donovani*, is considered an emerging disease with an estimated incidence that ranges from 3,700 to 7,400 cases per year (Alvar et al., 2012). This disease is prevalent in the north and northwest of the country with *Phlebotomus orientalis* being its vector.

CDC light traps and sticky traps are commonly used for monitoring sandfly populations. However, their trapping efficiency is largely influenced by lunar illumination (Colacicco-Mayhugh et al., 2011; Gaglio et al., 2014).

In view of that, the current study assessed the effect of moon light and lunar periodicity on the performance of light traps in collecting *P. orientalis* during the active periods in northern Ethiopia.

Materials and Methods

Study Area

Entomological study was conducted in the rural district of Tahtay Adiyabo (14°23'41"N/ 37°46'15"E) in Tigray Regional State, Northern Ethiopia. The district is located 1,117 km north of Addis Ababa and 402 km northwest of Mekelle, the capital of Tigray Regional State.

Sandfly Sampling Methods

Trapping of *P. orientalis* and other *Phlebotomus* spp. was conducted during December 2012 to June 2013. They were collected from peri-domestic and agricultural fields using CDC light traps and sticky traps on 28 nights, divided among each of the 4 lunar phases (i.e. New Moon, First Quarter, Third Quarter and Full moon).

Traps were installed at 18:00, and collected around 07:00 the next morning and sandfly specimens were transported to the laboratory and preserved in 70% ethanol for later identification to species level.

Sandfly Identification

Species were identified based on the morphology of the external genitalia of males and the pharynx and spermathecae of females, using keys (Abonnenc and Minter, 1965).

Data on moon phases and percent illumination

Timings of moonrise and moonset, tables of moon-phases, and the percent illumination of the moon corresponding to each night of moon phase were downloaded from the Astronomical Applications Department of the US Naval Observatory: http://aa.usno.navy.mil/cgi-bin/aap/ap.pl.

Statistical Methods

Mean number of *P. orientalis* caught during the different lunar phases was compared using one-way ANOVA. Also, the non-parametric equivalent test (Kruskal-Wallis) was used when trapping data did not conform to the normal distribution.

Linear regression analysis was also applied to determine the relationship between sandfly density/light trap and the percentage of moonlight available for the corresponding day

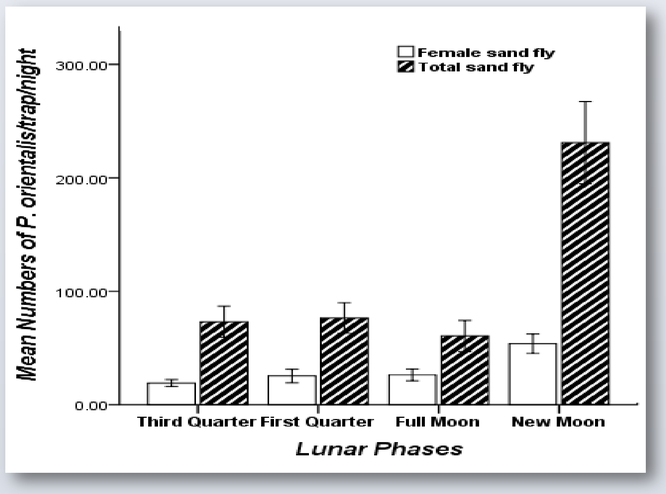

Fig. 1 Mean numbers (±SEM) of total and female *P. orientalis*/trap/night captured during different lunar phases with CDC light traps from compounds and agricultural fields.

Results

Sand fly species composition

13,533 sandfly specimens belonging to eight species of the genus *Phlebotomus* were collected; 11,667 in light traps and 1,866 on sticky traps (Table1). Abundant species was *P. orientalis* (97.78%) followed by *P. bergeroti* (0.75%).

Effect of lunar phases on the abundance of *P. orientalis*

Light trap catches showed a highly significant difference in the attraction response of *P. orientalis* in different lunar phases (ANOVA, F (df=3) = 13.96; P < 0.05, Fig. 1). Mean abundance of *P. orientalis* collected in light traps in moonlit nights was around 25% of the catch during non-moon phase.

The mean density of *P. orientalis* females captured during new moon phases was higher than other lunar cycles. In particular, the density of female *P. orientalis* was substantially reduced during the moonlit nights around the full moon (Fig.1).

Conversely, different lunar phases had no significant effect on the abundance of *P. orientalis* caught by sticky traps in both trapping sites (Kruskal-Wallis test, *P* >0.05, Fig. 2). Also, no statistical difference was observed for the abundance of female *P. orientalis* intercepted by sticky traps during the four lunar cycles.

Table 1. *Phlebotomus* species captured using CDC light traps and sticky traps in compounds and agricultural fields in Tahtay Adiyabo district, December 2012-June 2013

Sand fly Species	Collection Sites					
	Compound		Agricultural Field			
	CDC Traps	Sticky Traps	CDC Traps	Sticky Traps	Total	RF(%)
P. orientalis	5,943	1,175	5,546	569	13,233	97.78
P. bergeroti	72	9	11	9	101	0.75
P. rodhaini	9	8	41	8	66	0.49
P. duboscqi	7	1	3	0	11	0.08
P. papatasi	3	2	2	2	9	0.07
P. martini	0	0	3	0	3	0.02
P. lesleyae	11	21	9	57	98	0.72
P. heischi	2	2	5	3	12	0.09
Total	6,047	1,218	5,620	648	13,533	100

Relationship between moonlight and light trap catches

A significant inverse linear relationship between the % of moonlight illumination and light trap catches of *P. orientalis* was observed (R2 = 0.560, df = 27, P <0.05) (Fig.3).

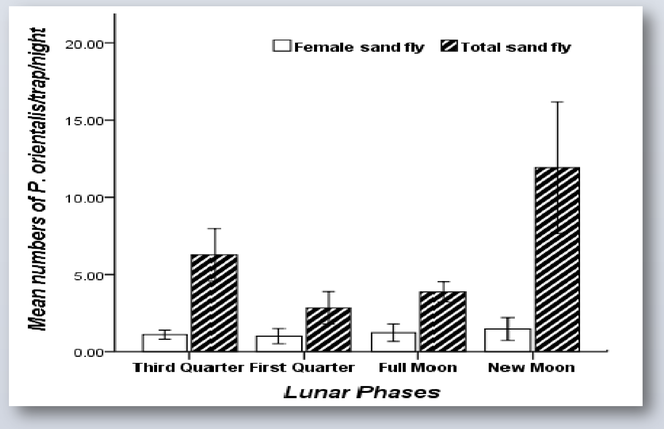

Fig. 2 Mean numbers (±SEM) of total and female *P. orientalis*/sticky trap/night captured in different lunar phases with from compounds and agricultural fields.

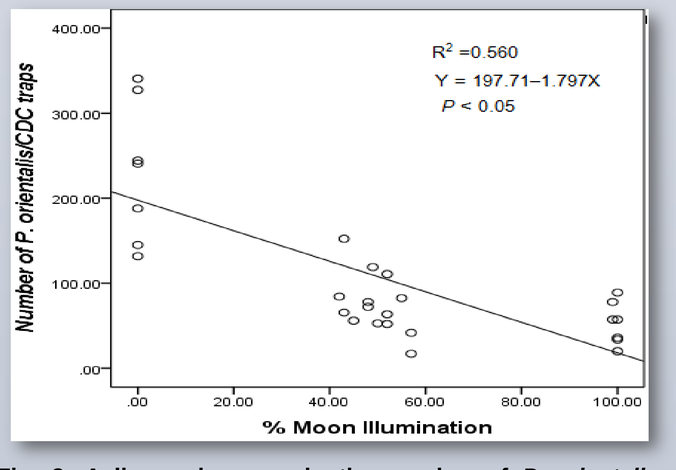

Fig. 3. A linear decrease in the number of *P. orientalis* collected/light trap/night with the increase in the percentage of moonlight

Conclusions

The results of the study clearly showed that lunar cycles and illuminations have adverse effect on the trapping efficiency of light traps for sampling disease vectors in the field.

By contrast the total number of *P. orientalis* collected in sticky traps appeared to be unaffected by the lunar cycles

Acknowledgements

This study was supported by the Bill and Melinda Gates Foundation Global Health Program (grant number OPPGH5336).