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Population dynamics of Sand flies (Diptera: Psychodidae) in Hanifah Valley Riyadh, Saudi Arabia

[1]Abdulrahman S. Aldawood, [1]Azzam M. Alahmed, [1]Salah M. Kheir and [2]Saied M. Hussein
[1]Department of Plant Protection, College of Agriculture, P.O. Box 2460,
King Saud University, Riyadh 11451, Saudi Arabia
[2]Ministry of Health, Riyadh 11451, Saudi Arabia

Abstract: A survey of sand flies was conducted in the Hanifah Valley, Riyadh city, Saudi Arabia. Four species of sand flies were identified, *Phlebotomus papatasi*, *P. beregeroti*, *P. sergenti* and *Sergentomiya antennatus*. Among those species, *P. papatasi* accounted for 97% of the total catch. Sand flies had two peaks, one in the middle of July and the other in the middle of October. More sand flies were caught in the southern part of the Valley compared to the northern one due to the presence of water stream in the southern part. However, numbers of sand flies are more positively correlated to temperature than to relative humidity.

Key words: Sand flies, leishmaniasis, Psychodidae, Hanifah Valley, Riyadh, Saudi Arabia

INTRODUCTION

Insect Vectors play a vital role in the transmission of various major human diseases such as leishmaniasis, which have a direct impact on human health. Sand flies are widely distributed in almost all parts of the world including Saudi Arabia, which have a highly diversified geographical landscape and environment. Rodents play an important role as reservoir for the protozoa of cutaneous leishmaniasis; certain species of the genus *Meriones* are important reservoir in Riyadh region[1,2]. The presence of *Meriones* spp in Hanifah valley, Riyadh[3] represents a threat to the spread of cutaneous leishmaniasis transmitted by *P. papatasi*.

Surveys of sand flies of Saudi Arabia showed the presence of twenty-five species[4,5]. The most abundant species was *Phlebotomus papatasi*[6], which is considered an important vector of cutaneous leishmaniasis disease in Saudi Arabia[7,4,1,22]. The disease has been reported from different cities of Saudi Arabia including Riyadh city, the capital of the country[8,4,9], where the most cases for the years 1994-1996 were registered[10].

In spite of the fact that Hanifah valley is an important valley of Riyadh, it is still unexplored for sand flies. The valley is long enough that it runs for more than 300 Km and a portion of about 100-Km is considered an important picnic area for dwellers of Riyadh city. Moreover, Hanifah valley is a valued natural passage of rainwater and leaking water coming from Riyadh city and leading to Hair region in the south part of the city[11]. The availability of water and farms on both sides of the valley provide an ideal breeding place for sand flies that is a health threat to inhabitants of Riyadh city as sand flies transmit cutaneous leishmaniasis to them.

The present study was under taken to record the number of sand flies species and their peak activity period in different sites in Hanifah valley, Riyadh.

MATERIAL AND METHODS

The valley was divided into two sections, a northern section (A) in regard to Riyadh city and a southern one (B). In Each section three sites were selected. Section (A) consisted of three farms in Ammariyah, Diriyah and Irgah towns, about 15 km apart. Section (B) had two farms, one in Almasanea part of Riyadh city and the other in Dar Albidhah town, while the third site was an open area by the end of the valley in Alhair town. Section (A) has no running water; leaking water coming from Riyadh city starts from the most southern part of this section, Irgah town. However, Section (B) has running water combined with the treated sewage water coming from the sewage treatment plant, located in the beginning of this section in Almasanea part of Riyadh city.

Survey plots within each site were selected according to the presence of favorable breeding places for sand flies[12]. Traps, then, were randomly distributed in these plots.

Sand flies were surveyed using light traps and sticky paper traps. The battery operated light/suction traps (CDC type) were used for collection of live specimens of sand flies in the three sites of section (A) and in two sites

Corresponding Author: Dr. Abdulrahman Aldawood, Assistant Professor, Department of Plant Protection, College of Agriculture, King Saud University, Riyadh 11451, Saudi Arabia. E-mail: aldawood@ksu.edu.sa

of section (B). In Alhair site light trap was not used, because of the difficulties of leaving a light trap in such open site. Light traps consisted of a source of light that attracts flies and a rotating fan fixed to the trap drives sand flies towards a muslin bag. Light traps were set before sun set and collected in the following morning.

In second method, sticky traps consisted of white paper sheets 20*14 cm coated with castor oil on both sides were used and placed vertically 30 cm above ground level[13]. Rodent burrows were used as collecting sites when present[14]. Twenty sticky traps were fixed in each site from noontime till the following morning.

Traps then were processed in King Saud Univ. Entomological labs, where sand flies were sorted, identified, sexed and counted. Sand flies were picked from traps with entomological pins and mounted in Puris medium on glass slides for identification and incubated at 38°C for few days. Identification was done through the British museum of natural history. Data were reported as sand fly index (flies per square meter)[12].

All values were analyzed using a 1-way analysis of variance (ANOVA) and mean separation using least significance difference test in SAS/STAT[15]. All values were considered significantly different at $P < 0.05$.

RESULTS

The collection of sand flies from study sites using light traps and sticky traps is presented in Table 1. Data citation exhibits a gradual increase in number of sand flies catches from north to south (site 1-5). A detail scan of statistical results on collection of sand flies with light traps revealed a significant difference between site 1 in section (A) and site 5 in section (B), where the numbers of sand fly catches were 0.33 and 3.25, respectively. The number of sand flies catches within the same section remained statistically at par with each other. However, the numbers of sand fly catches between sections were statistically different (Table 2).

The number of sand flies catches with sticky traps presented an increasing trend like that in light traps catches within each section but more sand flies catches were obtained in section (A). The results within (Table 1) and between sections (Table 2) were found statistically similar. Sand fly total numbers caught by light traps are greater than those caught by sticky traps (Table 1).

A positive, but weak, correlation between sites and the number of sand fly catches for light catches was shown, were the r value was 0.28. Sections correlation was also present with an r value of 0.22. Sticky catches showed different correlation to light catches with sites and sections were the r values were -0.14 and -0.20, respectively.

Table 1: Number of sand flies caught by light and sticky traps per sites

	Light traps		Sticky traps	
Sites	Mean [a]	Total	Mean [a]	Total
Site 1	0.33±0.26a	4	0.42±0.19a	5
Site 2	1.08±0.29ab	13	0.58±0.19a	7
Site 3	1.42±0.47ab	17	0.67±0.26a	8
Site 4	1.58±0.93ab	21	0.29±0.18a	4
Site 5	3.25±1.75b	43	0.25±0.18a	4
Site 6	-	-	0.29±0.20a	5
Total		98		33

[a] data in column followed by different letter are significantly different at 0.05 α level, ± SE

Table 2: Number of sand flies caught by light and sticky traps per section

	Light traps		Sticky traps	
Sections	Mean [a]	Total	Mean [a]	Total
Section A	0.94±0.21a	34	0.56±0.12a	20
Section B	2.42±0.98b	64	0.28±0.10a	13

[a] data in column followed by different letter are significantly different at 0.05 α level, ± SE

Table 3: Number of sand flies catches/month from both section using light and sticky traps

	Light traps		Sticky traps	
Dates	Mean [a]	Sand fly index	Mean [a]	Sand fly index
April, 2000	0.0±0.00c	0	0.17±0.17bc	1
May	0.5±0.25c	2	0.00±0.00c	0
June	1.4±0.51c	7	0.50±0.34bc	3
July	1.6±0.75bc	8	0.66±0.42bc	4
Aug.	5.2±3.73ab	26	0.33±0.21bc	2
Sept	5.4±2.18a	27	1.50±0.34a	9
Oct.	3.4±0.51a-c	23	0.83±0.21ab	6
Nov.	0.6±0.25c	3	0.50±0.22bc	5
Dec.	0.0±0.00c	0	0.17±0.17bc	1
Jan. 2001	0.0±0.00c	0	0.00±0.00c	0
Feb.	0.0±0.00c	0	0.33±0.33bc	2
Mar.	0.4±0.25c	2	0.00±0.00c	0

[a] data in column followed by different letter are significantly different at 0.05 α level, ± SE

The number of sand fly catches per month with light and sticky traps in sections (A) is shown in Fig. 1. Light trap data depicts a significantly higher number of sand flies catches in the month of October as compared to rest of the months, whereas in sticky traps, number of sand flies catches during the month of September was found significantly higher than the months of April and December.

The number of sand fly catches per month with light and sticky traps in sections (B) has been presented in Fig. 2. A detail probe of light traps data depicted that significantly higher number of sand flies catches were made in the months of August and September as compared to other months, whereas sticky traps showed that sand flies during the months of September, October, November and February just showed their presence as compared to the rest of months; however, September had the highest number.

When data of both sections (A and B) are pooled, data in Table 3 is the result. Data shows the same trends

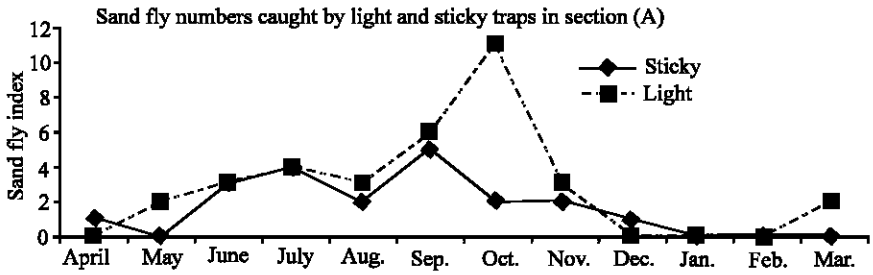

Fig. 1: Number of sand fly catches/month from section (A) using light and sticky traps

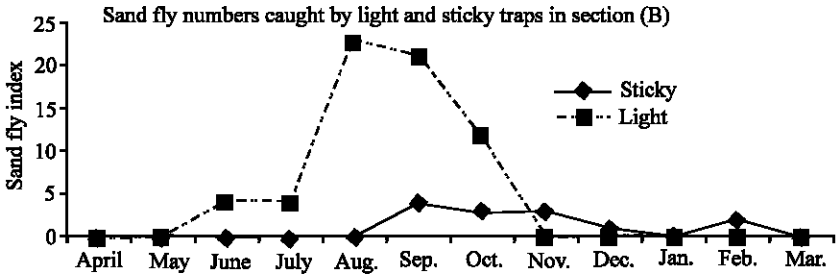

Fig. 2: Number of sand fly catches/month fromsection (B) using light and sticky traps

collected in both sections separated, but confirm the fact that the fall months; August, September and October; are the months with the highest sand fly numbers in both methods of collection; were September month is statistically the highest.

For light catches, a weak positive correlation between RH and the number of sand fly catches was shown, were the r value was 0.01. A greater correlation was shown with Temp and the number of sand fly catches with an r value of 0.34. Sticky catches showed a correlation similar to light catches with RH and Temp where the r values were 0.04 and 0.24, respectively. In respect to date (months), a positive correlation with the number of sand fly catches for light and sticky trap catches was shown, where the r value were 0.26 and 0.30, respectively.

DISCUSSION

Results presented show two peaks for sand flies (a weak one in July and a strong one in September-October months) which are similar to previous finding[1]. Numbers are lower in this study compared to previous studies; which might be related to the extensive urbanization of the studied sections, hence, the intensive use of insecticides[1,16]. Ground and Arial insecticide application affect the population dynamics of sand flies drastically to the level of eradication[[1]. Also, habitat degradation of sand fly populations is another possible factor involved[17,18].

Phlebotomus papatasi is the main insect vector for cutaneous leishmaniasis[4] and is considered to be a vector of cutaneous leishmaniasis in Riyadh region. In the present study *P. papatasi* was the most dominant species, accounting for more than 97% of the total catch. Other sand fly species, *P. beregeroti*, *Sergentomiya antennatus* and *P. sergenti*, were much less abundant. These finding are similar to other research findings[16]. It was found that urban areas had only *P. papatasi* while peri-urban had different other species of sand flies[1]. Furthermore, in different valleys of Saudi Arabia, 14 species of sand flies were caught[4]. These surveys indicate the more presence of different species of sand flies the more the area is less urbanized.

Light trap results for sand flies in this research show a biological meaning for the rise of cutaneous leishmaniasis in Saudi Arabia, where population numbers of sand flies increase is followed by an increase in reported cutaneous leishmaniasis cases in hospitals[1,10,9]. An incubation period of about 4-12 weeks was reported[1] explaining the lag in time between the increase of sand fly population and the incidence of cutaneous leishmaniasis.

Number of sand flies showed an increase towards the southern part of the valley. This might be related to the water stream escaping from underneath Riyadh area, where it is a product of under ground water and sewage runoff from water pipes and Riyadh houses sewage containers, respectively. Southern sites (4, 5 and 6) are located in a part that receives that same stream and furthermore, the excess treated sewage water from treatment plant joins this stream and continues towards the end of the valley in Alhair area where a farm receives that water and uses it for irrigation. However, site 1, 2 and

3 are in an area without this running stream. The mere presence of moisture all year around creates a suitable area (banks of streams) for rodents to be there, hence, suitable breeding site for sand fly adults. This is shown in the early increase of population numbers of sand flies in section (B) compared to section (A).

Horses seem to attract sand fly populations followed by cave sites[20]. In this research numbers of sand fly were greater in site 3, though not statistically different, where a horse-breeding farm is located. Sand flies in less inhabited areas are better caught by light trap, but in more inhabited areas sticky traps are better than light traps, because sand flies are less scattered there. It was reported that CDC light trap was more effective in catching members of the genus *Phlebotomus* followed by sticky paper traps[21], which is similar to the findings of this research. However, sticky trap is less expensive and easier to handle. Also, sticky traps seem to be more effective in low populations where light trap catch is lower as shown in this study.

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