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The Effects of Some Climate Factors upon Frequency Distribution of Local Sandflies Breed in Misan Province, Iraq

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A B S T R A C T

The genus *Phlebotomus* is naturally responsible for the transmission of many protozoal parasites like *Leishmania*. The study was conducted to determine the effect of some climate factors on sandflies distribution over a year from December 2019 to November 2020. A total of 268 sandflies of both sexes were collected from different areas in Misan province, Iraq. Sandflies were collected using light traps and stick oil paper, then placed in cups or Petri dishes containing sterile normal saline for examination. The current study showed an inverse relationship between the presence and number of sandflies with temperatures. Rainfall had a significant impact on parasite distribution, while wind speed had a potential impact on sandfly activity. The percentage of female sandflies was significantly ($P<0.05$) higher than that of males (54.85% for females versus 45.15% for males). In conclusion, heavy precipitation is the main climate factor that affects the frequency distribution of local breed sandflies followed by rising temperature degrees that are seen in the summer season. The climate can affect the activity, spreading, and distribution of sandflies with detected one peak of their activity in December.

Keywords: Sandflies, Phlebotomus, Climate factors, Light traps

INTRODUCTION

Lutzomyia, *Phlebotomus*, and *Sergentomyia* are three genera in the *Phlebotomidae* family, which some authors split into three genera(1-3). The genus *Phlebotomus* is the most important species that attack humans and mammals (4). Scopoli in 1786 described *Phlebotomus* sandflies for the first time, and the genus *Phlebotomus* was classified by Rondani (1840) in Italy (4-6).

The life cycle of *Leishmania* starts when a parasitized female sandfly takes a blood meal from a vertebrate host (7). After taking blood, sandflies become infected by ingesting macrophage infected cells with amastigotes during blood meals. In sandflies, the ingestion of parasitized cells ends with a burst of these cells and amastigotes transform into promastigotes, develop in the midgut for organisms into the *Leishmania* subgenus (8). In the midgut of the sandflies, the promastigotes are phagocytosed by macrophages then metamorphose into amastigote forms. The reproduction and division are done by binary fission. They increase in number until the cell eventually bursts and then infect other phagocytic cells (7). At the end, the promastigotes migrate to the proboscis, then meanwhile sandflies take a blood meal from vertebrates either human or animals, they inject promastigote stage into the skin, phagocytized by macrophages and the cycle continues (8).

The main medical importance resulted from that *Phlebotomine* sandflies are the only known vectors of leishmaniasis (cutaneous, and visceral) in man, wild and domesticated animals (8-10). Apart from that, sandflies may constitute a serious, but usually localized, biting discomfort. They caused moderately severe sensitization of skin reaction and irritation in sensitive people by their bites, this may result in a severe condition called "Harara" (11). On the other hand, in Peru, Ecuador, and Colombia, sandflies (*Lutzomyia*) play a role in the transmission of *Bartonella bacilliformis* bacterium, which causes Oroya fever (Peruvian warts) or Carrion's disease or Bartonellosis (12). Also, sandflies sometimes transmit a strain of virus that causes papatasi fever or three-day fever (13). The skin lesion begins when sandflies bite the exposed area as a single, asymptomatic, pink, or red papule, with skin crease orientation (14). Then, the papule slowly evolves to a firm, inflamed, smooth nodule with a dusky violaceous hue and an "iceberg" configuration (11, 15). The nodule enlarged progressively and eventually ulcerated, becoming crusted in the center (16).

Sandflies' abundance in tropical areas is documented in both dry and wet seasons of the year, while the main activity is found in the summer season in temperate regions (17). Temporal distribution of sandflies in different Provinces in Iran showed that the activity of sandflies is almost stopped in the cold season, while during May–September there is at least one record of sandflies from almost all provinces (18). In East Africa, a review of the ecology of *Phlepotamea* found in the seasonal species have a close association with meteorological factors (19). In Morocco, some authors reported bi-model distribution (present throughout the year) of *P. papatasi* (20). There was a positive relationship between sandflies density with temperature, while the relation with humidity was negative (21). In turkey, researchers have reported activities of sandflies in May, a peak aggregation found in August, and disappearance in October (22). The negative association of sandflies with wind speed was documented in Brazil (23). This study was conducted to investigate the effect of some climate factors on sandflies distribution in Misan province, Iraq.

MATERIALS AND METHODS

Setting and Regions of the Study

The samples were collected from six regions in Misan province, Iraq (Figure 1), including: Ali Al-Gharbi, Al-Amarah, Al-Kehlaa, Al-Maymouna, Al-Majar Alka beer, and Qal'at Saleh for a period extended from December 2019 to November 2020.

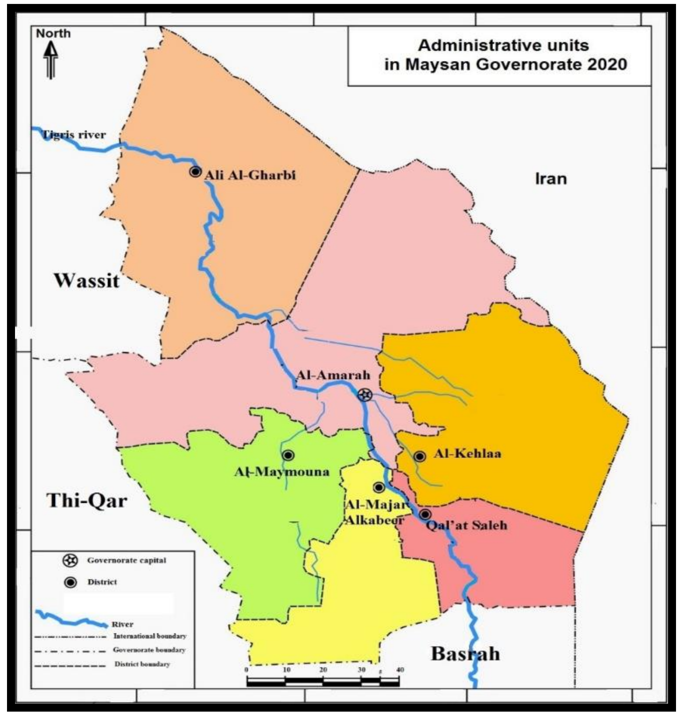

Figure 1. Map of the study regions

Sandflies

Two hundred and sixty-eight of both sexes of sandflies were collected from different areas of leishmaniasis confirmed infected patients by local medical authorities in Misan province. Pooled collection method was used from various places in the area of investigation. The light traps, and stick oil paper (Insect Glue Snare) were used for the collection of whole insects, which were put in cups or Petri dishes contained sterile normal saline for examination and diagnosis. Identification and differentiation of sandflies from other insects based on shape, morphology, and size, according to (14) (Figure2 A-D).

Climate data

Meteorological data on mean temperatures (C), precipitation rate (mm), mean humidity (%), wind speed (m/s), and direction in Misan province from December 2019 to November 2020 were obtained from Misan branch of the Iraqi Meteorological Organization and Seismology, Iraq, to estimate the effect of local weather elements on the seasonal dynamics of sandflies.

Statistical analysis

All data were analyzed by Statistical Package for Social Sciences version 24 (SPSS v24) (SPSS Inc., Chicago, Illinois, USA). The mean and standard deviation were used to describe continuous numerical data. Categorical data were presented by frequencies and percentages. Fisher exact test

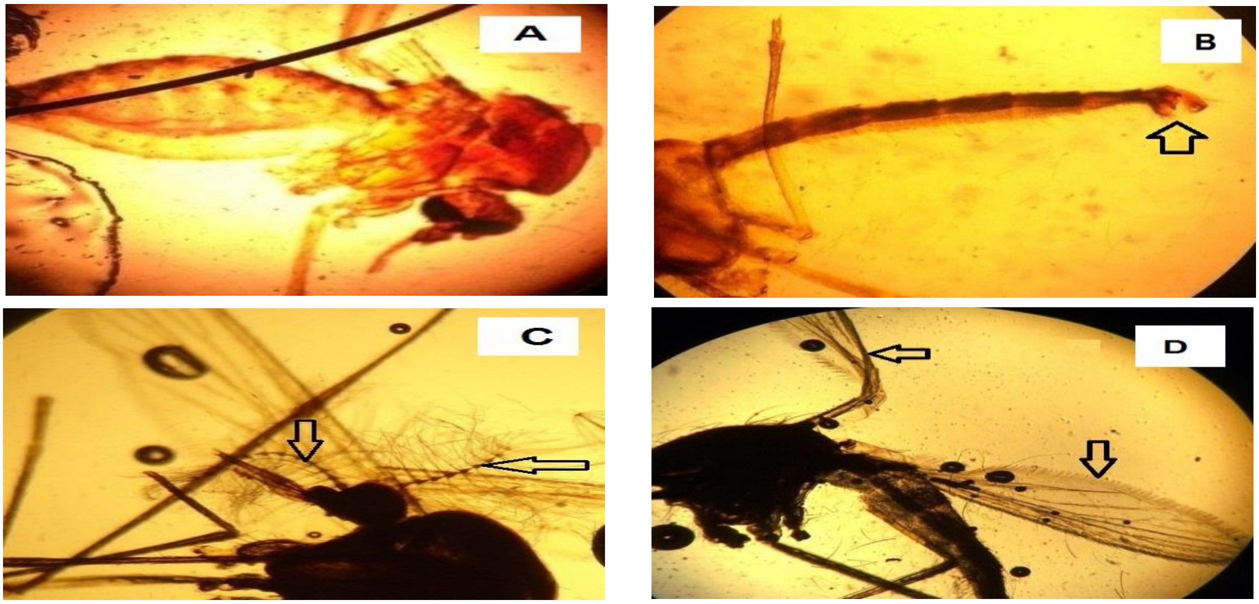

Figure 2. Adult sandfly female: large black eyes, head, thorax, and abdomen (rounded). (A) Adult sandfly male: abdomen terminates in a prominent pair of claspers which give the end an upturned appearance (arrow). (B) The antennae (arrows) are long and composed of small bead-like segments with short hairs. (C) Hairy wings (arrows) are lanceolate in outline

was used to describe interaction in the categorical variables. Logistic regression was used for more appropriate and incorporate multiple variables as well as their interactions in a single analysis. A P-value equals to or less than 0.05 was considered significant.

RESULTS

This study showed an inverse relationship between the presence and the number of sandflies with high temperatures. In moderate temperatures, the sandflies were active and abundant, with a significant decrease in numbers in the hot months (P<0.05). The rainfall affected the numbers and the presence of sandflies with a highly significant difference (P<0.05). Also, this study revealed that wind speed had a potential effect on the activity and presence of the sandflies (P<0.05), on the other hand, the wind direction had no effect, as shown in Table 1. The study showed a significant difference (P<0.05) between the frequency of males and females of the sandflies number (45.15% versus 54.85) (Table 2).

This study revealed differences in sand flies' numbers over regions of the province (Table 3). Al-Amarah city was the most common area of sandflies distribution (32.46%), with significant differences among other cities (P<0.05).

Table 1. Distribution of sandflies according to climate factors during months of the study

Months	Mean Temperature (°C)	Precipitation rate (mm)	Mean humidity (%)	Wind speed (m/s	Wind direction	No. (%)
December 2019	20	37.1	78	2	NW	58 (21.64)
January 2020	18.6	33.9	71	1.9	EE	51 (19.03)
February	20.7	44.5	66	2.6	EE	39 (14.55)
March	27.1	24	57	2.8	EE	12 (4.48)
April	32.1	6.6	44	2.9	EE	9 (3.36)
May	39.9	0	29	3.5	N	0
June	44.9	0	23	3.9	NW	0
July	48.3	0	22	2.9	NW	0
August	45.7	0	23	3	NW	5 (1.87)
September	40.2	0	25	2.2	NW	25 (9.33)
October	37.5	0	34	1.5	NW	33 (12.3)
November	26.6	65.3	60	2.3	EE	36 (13.43)
Total (mean±SD)	33.88±11.072	21.73±17.617	44.33±20.986	2.625±0.657		268
P-value*	<0.05	<0.05	<0.05	<0.05	NS**	

*Logistic regression test; **NS=non-significant; mm=millimeter; m/s=meter/second; SD=standard deviation; NW=north-west; EE=east; N=north

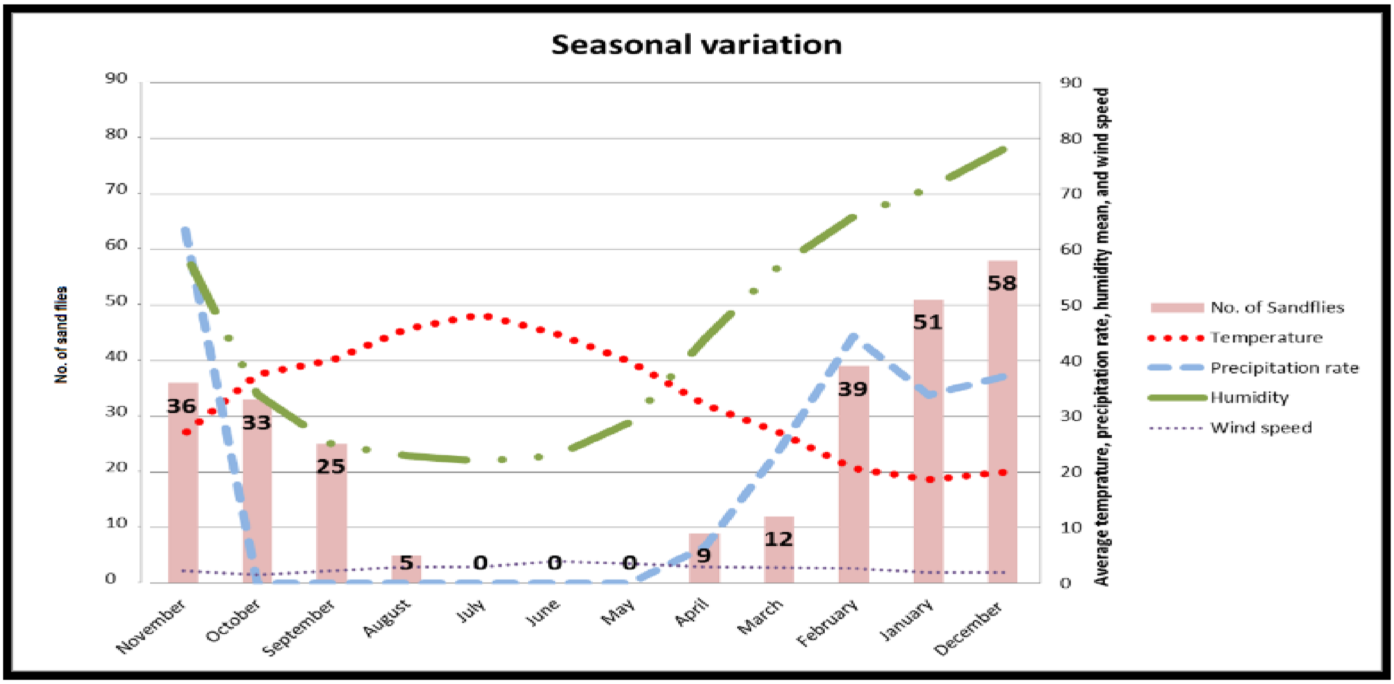

Figure 3. Seasonal variation and number of sandflies in months of the study

DISCUSSION

The highest numbers of sandflies were recorded in December, January, and February where the amount of rain and humidity rate was very high with moderate wind movement. These conditions are appropriate for the growth and activity of sandflies (17, 18). While we did not collect any sandflies in July, June, and August. This is because of high temperatures, lack of rain, low humidity, with high wind speed, all of these conditions affected the presence, growth, and reproduction of the sandfly (22, 23).

Table 2. Distribution of sandflies according to sex

Sex	No. of sandflies	%
Male	121	45.15
Female	147	54.85
Total	268	100
Fisher exact test = 3.788, df=4, P<0.05*		

*Significant

These percentages are closely related to other studies in Iraq that showed moderation of temperature, humidity, and wind speed suitable to be an appropriate environment for the emergence of sandflies. The population density of these insects decreases in hot months of the year, where the high temperature does not allow these insects to distribute (3, 4, 24, 25). Coleman et al. (2007), concluded that sandfly numbers were low in April, high in May, highest from mid-June to September, and dropped rapidly in late October (26).

Table 3. Distribution of sandflies according to Misan region

Districts	No. of sandflies	%
Ali Al-Gharbi	43	16.04
Al-Amarah	87	32.46
Al-Kehlaa	46	17.16
Al-Maymouna	31	11.57
Al-MajarAlkabeer	27	10.07
Qal'at Saleh	34	12.69
Total	268	100
Fisher exact test = 6.323, df=8, P<0.05*		

*Significant

Studies on the nocturnal activity of sandflies estimated that the activity was mostly high in the evening during the cooler months, whereas the activity was more in the night of the hotter months (26).

A previous study in Diyala governorate showed that the seasonal distribution of cutaneous leishmaniasis from 2012 to 2016 had the highest rate in winter (68.3%) followed by spring (19.3%) then declined in summer months (7.3%), and autumn (5.1%) (25). This could be related to the sandflies' abundance and breeding activity in the cooler months compared with hot months.

The results were comparable with the study by AL-Obiadi (2000) in Tikrit (27) but incomparable with those reported in Iran (28) and Afghanistan (29-31). This variation in monthly peak could be due to the activity of the sandflies. The differences in the distribution of leishmaniasis patients might be promoted by the development of female insects and their supplement of blood through their life cycle for the maturation and production of eggs, especially in the spring season (32). The study data disagree with Coleman et al. (2007), who found that *P. papatasi* was predominantly abundant in the hot season (August and September) (26).

The peak activity time corresponded with the highest temperature and humidity indicating that these two factors play a role in the environmental dynamics of an ecosystem for the sandflies to survive (23). The positive correlation of humidity and temperature with the population abundance of sand flies has been confirmed by other researchers (33, 34). However, several studies reported a negative association of humidity with the sandfly population, like studies in Turkey (35), Italy (36), Egypt (37), Morocco (21), and Portugal (38).

A Survey was conducted in Pakistan throughout the year, and sandflies were observed only from May to October, whereas peak activity (highest abundance) was seen in August (17). In addition, the aggregation of sandflies population was in the wet season of the year and had a negative correlation with wind speed (17).

The hot climate and heavy precipitation could affect the activity, spreading, and distribution of sandflies. The study detects one peak of sandflies activity in December. The study supplies information about the sandflies' activity period and clarifies the association between sandflies' abundances and climate factors in the province. Thus, these data may be helpful to contribute in a preventive planning program against *Leishmania* vectors.

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N/A

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

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تأثير بعض العوامل المناخية على التوزيع التكراري لتكاثر ذبابة الرمل المحلية في محافظة ميسان، العراق

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الخلاصة

جنس الفصد (الحرمس الواخز) مسؤول بشكل طبيعي عن انتقال العديد من الطفيليات الأولية مثل طفيليات الليشمانيا. أجريت الدراسة لتحديد تأثير بعض العوامل المناخية على توزيع ذبابة الرمل على مدار عام (من شهر كانون الاول 2019 الشهر تشرين الثاني 2020). تجمع 268 ذبابة رمل من كلا الجنسين ومن مناطق مختلفة من محافظة ميسان. وقد استخدمت المصائد الضوئية وورق الصمغ اللاصقفي التجميع ثم وضعت الحشرات في أكوابا وأطباق بتري تحتوي على محلول ملحي معقم لفحصها. أظهرت الدراسة لحالية وجود علاقة عكسية بين تواجد واعداد ذباب الرمل مع درجات الحرارة. في حين كان هنالك تأثير قوي للمطر على انتشار الطفيلي. أيضًا، كان لسرعة الرياح تأثير محتمل على نشاط ذباب الرمل. أعداد الإناث ذبابة الرمل التي جمعت أكثر من الذكور مع وجود اختلاف معنوي (P<0.05)، (45.15٪ للذكور مقابل 54.85٪ للإناث). نستنتج من ذلك، ان هطول الأمطار الغزيرة يعتبر عاملا مناخيًا رئيسيًا يؤثر على توزيع تواتر السلالة المحلية من ذباب الرميلية في ذلك ارتفاع درجة الحرارة التي تسجل في فصل الصيف. يؤثر المناخ على نشاط وانتشار وتوزيع ذباب الرمل مع اكتشاف ذروة نشاطها في ديسمبر.

الكلمات المفتاحية: ذبابة الرمل، الفاصدة، العوامل المناخية، المصائد الضوئية