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

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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

ABSTRACT

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
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 papataci 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 Phlebotamea 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. papataci (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 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 <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
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*

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-MajarahAlkabeer   | 27               | 10.07 |
| Qal’at Saleh         | 34               | 12.69 |
| Total                | 268              | 100  |

Fisher exact test = 6.323, df=8, P<0.05*

Table 2. Distribution of sandflies according to sex

| Sex      | No. of sandflies | %   |
|----------|------------------|-----|
| Male     | 121              | 45.15 |
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| Total    | 268              | 100  |

Fisher exact test = 3.788, df=4, 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. papatasii* 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 الفصود (الحرمس الواح) يعاني بشكل طبيعي من وعاء العوامل الأولية مثل الطفيليات البكتيريا، تزداد حالة التخزين في جنوب العراق بسبب ارتفاع درجة الحرارة، مما يسبب نمو الفصود في الأماكن المفتوحة. تم الكشف عن توزيع ذبابة الرمل في المحافظة في الفترة من فبراير إلى يوليو 2020، حيث تم توثيق توزيع ذبابة الرمل في الأماكن المفتوحة والمناطق الحضرية. تم استخدام GIS (جي إس إس) لتجسيد التوزيع الجغرافي للذبابة الرملية في المحافظة، حيث تم استخدام تقنيات الاتصالات المتطورة لتحديد مساحة التوزيع والمناطق المتغيرة. تكونت الذبابة الرملية في الطرق والمناطق الحضرية ومستوى الماء، مما يؤثر على توزيعها. العوامل الجوية، مثل الرياح والطقس، تؤثر بشكل كبير على توزيع ذبابة الرمل، حيث يتغير توزيعها بناءً على هذه العوامل. في حالة الطقس، يسود الفصود في الأيام الماطرة، بينما فيعرض الطقس الجاف، تكون الكثافة أقل.

الكلمات المفتاحية: ذبابة الرمل، العوامل المناخية، المقادس الصودية

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