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Bionomics of phlebotomine sandfly species in west Alexandria, Egypt

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Abstract
A Longitudinal entomological survey was carried out in four demographically different provinces at West of Alexandria governorate, Egypt from May to November 2010. Oiled paper "sticky traps" was employed during the breeding season to determine monthly trends in species composition, density and sex ratio. Temperature and relative humidity were recorded by manual thermo-hygrometer once per month in each province. *Phlebotomus papatasi* (Scopoli) was the only anthropophagic species found. One hundred and forty three *p. papatasi* were collected; the highest prevalence was 44.8% in Al-Hawareya while Marakya was free of sandflies, with male to female sex ratio 1:1.6 and two peaks of abundance in both July and September. Out of the collected sandflies, 51.7% were from interior traps while 48.3% were from exterior traps. The highest number of sandfly was recorded in both July and September while the lowest monthly abundance was in November.

Keywords: Phlebotomus papatasi (Scopoli), Sticky traps, Internal and external traps, Temperature and Humidity

1. Introduction
Leishmaniasis is the collective name for a number of diseases caused by protozoan flagellates of the genus *Leishmania*, which is transmitted by Phlebotomine sandfly, it is a worldwide disease, affecting 88 countries, it is estimated that about 350 million people are at risk of leishmaniasis [1]. Overall prevalence is 12 million people with annual mortality of about 60,000 [2] Phlebotomine sandfly belongs to order *Diptera*: Family *Psychodidae*, sub-family *Phlebotominae*. Five genera are recognized; *Phlebotomus*, *Lutzomyia*, *Sergentomyia*, *Warileya* and *Brumptomyia*. [3] The genus *Chinius* was added later for a total of 6 genera [4] 3 in the old world *Phlebotomus*, *Sergentomyia* and *Chinius* and 3 in the new world *Lutzomyia*, *Brumptomyia* and *Warileya*. [5]. The sandfly species *Phlebotomus. papatasi* (Scopoli) is a common peridomestic species throughout Lower Egypt and is probably the vector of *L.major* there as it is in neighboring Israel. Furthermore, *P. papatasi* was the only *Phlebotomus* species caught in a survey in Sinai (30 50'N, 34 20'E) where cutaneous leishmaniasis is common among members of the Multinational Peacekeeping Forces. On the other hand, visceral leishmaniasis primarily affects children in age group 1-4 years and was discovered during the period 1982-1990 with an average number of 6 cases per year in Alexandria Governorate. The insect vector is *P. langeroni* and dogs are the main animal reservoir. [6]
Temperature and humidity are the two most important climatic factors for sandfly survival, development and activity [7]. Global warming will probably increase the geographic distribution to include provinces that currently do not have temperatures warm enough to permit a sufficiently large sandfly population to maintain endemicity. Likewise, the seasonal distribution could be extended in most locations and could result in year-round transmission. In addition, higher temperatures are likely to accelerate maturation of the protozoan parasite, thereby increasing the risk of infection. However, if the climate becomes too hot and dry for the vector to survive, the disease may disappear from some localities. [8] Changes in the habitat of the natural host and the vector contribute to the changing leishmaniasis landscape, therefore regular epidemiological studies to address risk factors and present sandfly species are necessary in order to integrate information on the current situation into control strategies.

2. Material
Study setting
Alexandria is an elongated coastal city, bordered from the northern side by the Mediterranean Sea, and Lake Mariout from the south-Western side. It extends along the seashore from

Abo-Kir to 71 km away of Alexandria Cairo desert road, with width not more than 5km south to the sea. Alexandria is considered the second largest city in Egypt and is one of the best summer resorts on the Mediterranean Sea, with its beaches extending to the length of 40 km. In summer, Alexandria is overpopulated by those who come to enjoy their summer holidays on the beach, most of them prefer the north-western coast. However there is always a threatening of increase in the prevalence of diseases especially those transmitted by vectors.

The study province is located at West of Alexandria governorate. Four different provinces representing different demographic situations were chosen, the chosen locations are: Al-Agamy, Marakia, old King Mariout and the fourth province is also in King Mariout and is called Al- Hawareya.

Al-Agamy

Samples were collected either from El Bitash or Abo youssef. In El Bitash urbanization is obvious, the whole province is over populated, crowded with high buildings, the main streets are paved and there is drainage system, however the selected streets for sticky traps application were narrow, covered with sand, some of the buildings in which traps were applied consist of few floors only and surrounded by a yard in which some trees are cultivated. On the other hand in Abo-youssef the randomly selected streets for the study consist of villas of modern and beautiful appearance, those villas are closed most of the year and among those villas, there are pockets of Bedouin living in randomly built houses with poor sanitary conditions which are a suitable microclimate for breeding of sand flies including poultry houses, cracks and burrows which most probably is a shelter for rodents, in addition, there are cats and stray dogs which may act as a reservoir host for sand fly. These houses usually have a garden or a yard in which vegetations and trees are cultivated. The soil is cement covered with sand and the construction material is limestone.

Old King Mariout

It represents the area where Bedouin live in poor houses with poor hygienic measures. Most of the houses are surrounded by a yard with a sandy soil, in which they raise cattle and poultry and sometimes dogs are present.

Al-Hawareya

which is the new king mariout, it is considered an area of higher social standards and richer population than the old King Mariout, it consists of villas, some of them are inhabited all the year, but most of the villas are inhabited few months a year and the rest of the year it is guarded by one of the Bedouins.

Marakya

It's an attractive summer resort; located about 51 kilometers away from Alexandria, its area is about 240 feddans. It consists of a beach, housing units and public service units. The beach is 1500 m long and there's a pedestrian road that separates it from the housing units. The middle of the resort and its main entrance, including administrative, emergency, communication, commercial and entertainment services. The houses are inhabited by summer visitors. The entertainment facilities including restaurants, cinemas, clubs, four swimming pools and an open theater.

Study design

The study is a longitudinal entomological survey conducted during the period from May to November 2010.

Study procedures

Sandfly collection was carried out during the breeding season from May to November 2010 by oiled sticky traps, which were made of paper sheets 20cm x 30cm impregnated with castor oil held upright on wooden frames of the same size of the paper sheet, each trap carried two sheets of paper. [9,10] In each province, sticky traps were employed once each month for 12 h dusk to- dawn period during the seven months of the study period. In every province, ten stations were randomly selected for application of the sticky traps. Ten sticky traps were placed in each station, five are exterior and the other five are interior, with a total of 200 papers in each area a month. Traps hung at floor level perpendicular to the wall, whether they were interior traps placed inside the houses to sample intra-domiciliary activity of sandflies or exterior traps at the entrances and within backyards.

Meteorological factors such as temperature and relative humidity were recorded by manual thermo-hygrometer once per month in each province, during application of sticky traps.

3. Results

Phlebotomine sandfly collection

Species and sex of the phlebotomine sand flies which were collected in the present study revealed that, *Phlebotomus papatasi* (Scopoli) was the only species recovered by sticky traps in West Alexandria, species identification was done according to classification of Lane R.P (1986) [11], with a total number of 143 sandfly. Fourty two which represent 29.4% of the total number were caught from Al-Agamy, 64(44.8%) in Al- Hawareya, and 37(25.8%) in Old king mariout while Marakya was free of sandflies during the seven months of the study. Among the total sample 55(38.5%) sandfly, from the 143 were males, while 88 (61.5%) were females (Table I). The monthly distribution of phlebotomine sandfly in west of Alexandria in the four selected provinces of the study was as follows; the highest number of sandfly was collected in July which is 40 (28%) followed by September 29 (20.3%), May 20(14%), June 18 (12.6%), August 13 (9.1%), October 12(8.4%) respectively, and the smallest number collected was in November 11 (7.7%) (Table II).As for the distribution of sandflies in interior and exterior traps, the interior traps recovered 19 sandfly (13.3%) out of the total in Al-Agamy, 35(24.5%) in Hawareya, and 20 (14%) in Old king mariout. On the other hand, the exterior traps revealed 23(16.1%) in Al-Agamy, 29(20.3%) in Al-Hawareya and 17(11.9%) in Old king mariout, with a total number of 74(51.7%) sandflies in the interior traps and 69(48.2%) n the exterior traps. (Table III)

The monthly temperature and humidity recorded during the study period from May to November was as follows; temperature varied from 20 C to 34 C, while relative humidity varied from 50% to 73%, the highest number of sandflies was recorded in both July and September at a temperature of 29-30 C and RH was ranging from 60% to 73%, while the lowest monthly abundance of sandflies was in November at a temperature of 23-25 C and RH was ranging from 55% to 60%. (Table IV)

Table 1: Species identification of phlebotomine sandflies in Alexandria west.

Locality	P. paptasi				P. langeroni				Total	
	Male		Female		Male		Female			
	No	%	No	%	No	%	No	%	No	%
Agamy	20	14.0	22	15.4	0	0.0	0	0.0	42	29.4
Hawareya	22	15.4	42	29.4	0	0.0	0	0.0	64	44.8
OldKing Mariout	13	9.1	24	16.8	0	0.0	0	0.0	37	25.8
Marakya	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	55	38.5	88	61.5	0	0.0	0	0.0	143	100.0

Table 2: Monthly variation of phlebotomine sandflies in Alexandria west.

Month	Agamy		Hawareya		Old King Mariout		Marakya		Total	
	No	%	No	%	No	%	No	%	No	%
May	6	4.2	5	3.5	9	6.3	0	0.0	20	14.0
June	5	3.5	7	4.9	6	4.2	0	0.0	18	12.6
July	14	9.8	14	9.8	12	8.4	0	0.0	40	28.0
August	6	4.2	7	4.9	0	0.0	0	0.0	13	9.1
September	9	6.3	13	9.1	7	4.9	0	0.0	29	20.3
October	2	1.4	10	6.9	0	0.0	0	0.0	12	8.4
November	0	0.0	8	5.6	3	2.1	0	0.0	11	7.7
Total	42	29.4	64	44.7	37	25.9	0	0.0	143	100.0

Table 3: Distribution of sandflies in interior and exterior traps.

Locality	No. of sandflies in				Total	
	Interior traps		Exterior traps			
	No	%	No	%	No	%
Agamy	19	25.7	23	33.3	42	29.4
Hawareya	35	47.3	29	42	64	44.8
Old King Mariout	20	27	17	24.6	37	25.8
Marakya	0	0.0	0	0.0	0	0.0
Total	74	51.7	69	48.2	143	100.0

Table 4: Monthly variation of temperature and relative humidity during the study period May- November 2010.

Month	Agamy		Hawareya		Old King Mariout		Marakya	
	Temp. (C)	RH (%)	Temp. (C)	RH (%)	Temp. (C)	RH (%)	Temp. (C)	RH (%)
May	22	66	20	60	26	64	26	60
June	25	71	29	68	28	70	30	68
July	29	73	30	70	29	72	32	70
August	32	65	31	68	31	66	34	66
September	29	60	30	63	30	62	30	60
October	28	60	27	61	28	60	25	50
November	25	58	24	60	23	55	24	54

4. Discussion

Leishmaniasis includes two major diseases, cutaneous leishmaniasis and visceral leishmaniasis, caused by more than 20 different *leishmania* species. Cutaneous leishmaniasis (CL) causes skin ulcers, while visceral leishmaniasis (VL) causes a severe systemic disease that is usually fatal without treatment. Mucocutaneous leishmaniasis is a rare but severe form affecting the nasal and oral mucosa. [12] Sandflies of the genus *Phlebotomus* transmit the protozoan parasites responsible for leishmaniasis and a number of viruses known to cause human illness. Of 500 known phlebotomine species, only some 30 of them have been positively identified as vectors of the disease. Both VL and CL occur in Egypt although the prevalence is relatively low. Visceral leishmaniasis due to *L. infantum* was not confirmed in Egypt until 1983, [13] one of the suspected vectors of *L. infantum* is *Phlebotomus langeroni*. [14] On the other hand CL has primarily been identified in northern Sinai [15] and was attributed to *L. major*, *P. papatasi* is the proven vector of *Leishmania major* in North Africa and Middle East. [16]

In the present study sticky traps were applied in four demographically different provinces of west Alexandria to study the bionomics of sandflies. As regards the species of the collected sandflies, *P. papatasi* was the only species identified. Sawaf BM, *et al*, 1984[17] as well as Doha S *et al* 1990 [18] revealed two species in Alexandria, *P. papatasi* and *P. langeroni*, to our best knowledge, the current study is the only one in which the sandfly collection in Alexandria revealed *P. papatasi* alone. Fahmy *et al*. 2009 stated that dominance of one or two species of sand flies is the feature of many areas in Egypt. [19] The presence of *P. papatasi* in west of Alexandria could be explained by the fact that *P. papatasi* is reported by most investigators to be a peridomestic species, widely distributed in peridomestic and domestic habitats. [17, 20, 21] Sand flies require a sugar meal, taken from plant material; therefore, they would be expected to be less abundant in areas with little or no vegetation, such as a barren desert. [22]

These conditions matches well with the findings in both provinces Al-Agamy and old King Mariout, as regards Al-Hawareya, villas are surrounded by gardens cultivating trees or vegetations which is a very appealing sandfly resting habitat, and although none of the inhabitants interviewed for our questionnaire in Al-Hawareya raise poultry or cattle, which is an important attractive reservoir in old King Mariout, the random sample of inhabitants of Al-Hawareya interviewed in the current study all admitted presence of rodents and stray

dogs in the neighboring streets. Rodents which are known as the preferred reservoir host for *P. papatasi*, together with the vegetations can explain the presence of sandfly in an area with high hygienic conditions. The absence of sandflies in Marakya could be explained by the fact that Marakya is a summer resort, the highest attendance of the village by guests occurs during the summer vacation which coincides well with the season of sandfly breeding and activity, but the daily fumigation done along the whole village to control insects and prevent them from disturbing the visitors may account for the disappearance of sandflies in this area especially because sand flies are known to be highly susceptible to insecticides. [23]

In the present study, similar to trends reported by Schmidt *et al*., 1971 [24] for Cairo, Beier *et al*., 1986 [22] for Alexandria, and El Said *et al*., 1985 [25] for Upper Egypt, populations of sandfly began to increase in April, then became more intensive between May and October, with two peaks, one in July and the other in September, and significantly decline in November, many authors agreed with the result of the current study among them Morsy TA. [26] 51.7% of the totally collected sandflies in the four provinces of the study were in interior traps while 48.3% were in exterior traps. This indoor preference of *P.papatasi* was recorded by many authors, among them, Hanafi A.Hanafi *et al*. [9] The possible explanation for this is that the indoor hours of activity of *P. papatasi* start early and end late than the outdoors one, this behavior of *P. papatasi* was noticed by el Okbi LM *et al*. [27] 1989. In addition, the females of *P. papatasi* prefer mainly human blood which is available mainly indoors.

As regards monthly variation of temperature and relative humidity in Alexandria west during the study period May-November 2010, the temperature and relative humidity in the four provinces under study were almost in the same range. Temperature varied from 20 C to 34 C, while relative humidity varied from 50% to 73%, with two peaks in number of sandfly in both July and September at a temperature of 29-30 C and RH ranging from 60% to 73%, while the lowest monthly abundance of sandfly was in November at a temperature of 23-25 °C and RH ranging from 55% to 60%. Temperature influences the survival of immature stages. Both sandfly adults and larvae are sensitive to high temperatures and low humidities. In laboratory experiments, all adult sandflies died within 2 hours at temperatures above 40 °C, and temperatures below 10 °C are unfavorable for survival. Besides temperature, laboratory studies have demonstrated that as the relative humidity increases, the number of sandfly survivors increases. Studies also have shown that the larvae, pupae and adult sandflies must have a habitat with a constant, relatively high humidity, among them those of Theodor O and Eleanor R. [28, 29]

5. Conclusion & Recommendations

Phlebotomine sandflies of the genus *Phlebotomus* transmit the protozoan parasites responsible for leishmaniasis and a number of viruses known to cause human illness, among the different sampling methods of sandflies, sticky traps were proven to be a successful method in collection. The present study is a longitudinal entomological survey in which sticky traps were applied in four different provinces representing different demographic situations in West Alexandria; one hundred and forty three *p. papatasi* were collected, with male to female sex ratio 1:1.6 and two peaks of abundance in both July and September. Out of the collected sandflies, 51.7% were from interior traps while 48.3% were from exterior traps. During the study from May to November 2010, adult sandflies showed increased activity during months of high humidity and relatively high temperature; the highest number of sandfly was recorded in both July and September at a temperature of 29-30 C and RH ranging from 60% to 73%, while the lowest monthly abundance of sandfly was in November at a temperature of 23-25 °C and RH ranging from 55% to 60%.

In light of the results, the present study recommends that further studies should be implemented to examine sandfly in Alexandria for presence or absence of *leishmania* protozoa, moreover, environmental sanitation should be given more attention in areas of infestation of sandflies, regarding rodent control, removal of dump places and waste management to decrease sandfly density.

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