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Bionomics of Sandflies (Diptera; Psycodidae) in Some Remote Communities in Ezinihitte Mbaise, South Eastern, Nigeria

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Abstract:

Studies on the bionomics of sandflies (Diptera;Pyscodidae) were conducted in 9 remote communities in Ezinihitte Mbaise, south eastern Nigeria, between June 2013 and May 2014 to estimate the relative abundance, biting rate and spatial variation in the biting densities of sandflies. Sticky traps with lights and human baits were used to collect the sandflies. Sticky trap captures with light were carried out between 7.00 hrs and 21.00hrs once a month for a period of one year while fly catches using human baits were carried out between 07.00hrs and 19.00hrs twice a month for one year. A total of 2,793 flies were captured to estimate the seasonal relative abundance and calculate the biting rates. More flies (2,254) were caught during the rainy season accounting for 79.5% than during the dry season (974). The lowest peeks of 461 occurred in the dry season between November 2013 and February 2014. Sand flies were relatively absent during the months of December 2013 to February 2014, and a little number were obtained in November and December in 2 sites. There was a significant variation ($p < 0.05$) in the seasonal punctual and peripheral pattern of distribution. Seven hundred and eighty one biting sand flies were captured by 2 fly collectors from June 2013 to May 2014. A total annual biting rate of 11,877.7 was established. Daily biting cycle showed a peak during the late afternoons and evenings of the rainy season between 13.00hrs and 19.00hrs, the highest monthly biting rate (MBR) of 2,025 was recorded in June 2013. The study has established the existence and biting activities of Sand fly vectors of human leishmaniasis in Ezinihie Mbaise. The public health implications of the existence and biting activity of Sand flies are obvious. Constant global climatic change, may lead to outbreaks of some neglected diseases such as leishmaniasis. A timely intervention by Government and health care providers in the area will be of immense benefits saving the vulnerable population from possible infections and disease outbreak. An improved understanding of sandfly bionomics and ecology should facilitate the implementation of control strategies of sandflies vectors of leishmaniasis.

Keywords:

Bionomics, Sandflies, Remote Communities, Mbaise Nigeria

1. Introduction

Phlebotomine sand flies (Diptera: Psychodidae) consist of small-sized hairy gnats or midges, measuring from 1.5 to about 4mm in length (Ready, 2013). They occur throughout the tropics and sub-tropical countries as well as in temperate zone. They are vectors of leishmaniasis, a vector borne disease endangering some 350 million people in 88 countries, most of them in poorer region of the globe (Orshan, *et al.*, 2010). There are about 700 known species, but only 30% transmit leishmaniasis to humans (Arid *et al,* 2012). They differ from other members of the family Psychodidae because the wings are held upward and outward such that the coastal margins form angle of about 60^0 with each other and with the body (Kellick, 2002).

Sand flies are known to breed where vegetation and climate favour their breeding sites (Hoel *et al.,* 2007). They require a humid micro climate for their eggs to develop, and larvae need a cool moist habitat with decaying debris (Muller, *et al.,* 2011). Adult flies often inhabit rock crevices, caves, rodent burrows and domestic settings. They rest in cool, dark and humid corners of animal shelters or human dwelling (De Oca-Aguilar *et al.,*2013, Alexander, 2000). Rodent burrows and domestic settings provide ready access to blood meal in addition to shelter (Rebelo *et al.,* 2001).

Male and female sand flies feed on plant juices and sugary secretions. In addition, females feed on blood meal to produce and/or facilitate eggs production. Sandflies use their mouth parts to probe exposed skin, leading to blood flow from which they draw blood meal (Kellick, 2002; Galati, *et al.,* 2017). The saliva of Sand fly contains pharmacologically active components that aid in feeding processes (Kamhaw, 2002). Feeding activity is influenced by temperature, humidity and air movement. They are weak flies and light wind inhibits their flight and reduces biting.

They feed on wide range of vertebrate hosts such as humans, livestock, dogs and birds. The choice of hosts is influenced by the presence and proportion of each host (Asimery, 1990). Previous studies (Boakye, 2001; Okwori, *et al.,* 2004; Kimutai, 2009; Igbe *et al.,* 2008) have been carried out on leishmaniasis in West Africa particularly in Ghana, and Northern Nigeria (Kaduna and Jos). These studies established the prevalence and endemicity of the disease in the tropics. However much has not been done on the prevalence of sand flies in South East Nigeria. A pilot study by Mbagwu and Udoye, (2014) in Ohaji, South Eastern Nigeria revealed the occurrence of diffuse cutaneous leishmaniasis in the area. The present study was carried out to determine the relative abundance and biting habits of sand flies based on their ecology and habits in a remote community un South Eastern Nigeria. The study will form a baseline for population density of sand flies and determine the effectiveness of control measures of sand flies which are vectors of leishmaniasis. This will help to determine the extremes of distribution of sand flies in the rural communities using Ezinihitte Mbaise as a pilot center to provide data on the distribution pattern of this vector in the rain forest region Nigeria.

2. Materials and Methods

2.1. Study Area

Ezinihitte Mbaise is one of the rural Local Government Areas in Imo State, South Eastern Nigeria. It is located between latitude $5^0$28’ 1.34 N, and it longitude $7^0$19’ 28.01’E. The vegetation is typical rainforest characterized by tall trees and soil that is rich in humus. It has a mean annual rainfall ranging from 19,000 to 20,000 mm.

Climate is characterized by two seasons; wet seasons starting from April to October and dry season from November to March. The months of these seasons may vary slight sometimes due to climate change.

2.2. Study Design and Collection Sites

For effective study, the study area was divided into 3 blocks of communities comprising of randomly selected clans within each block.

Table 1. *Randomly Selected Communities within the Study Area*

S/N	Community	Villages	Co-ordinates
1	Ezi-East	(a) Udo (b) Eziudo (c) Obizi	Lat $5^0$30’33.48’’ long $7^0$22’ 14.88’ $5^0$28 ’59.99, 90 21’ 0’’ $5^0$29’24.72, 7^0 20’49.42’’
2	Ezi-West	(a) Obeama (b) Ihitte (c) Amumara	$5^0$28’5.09’’, 7^0,6’16.36’’ $5^0$29’ 10.54’’, $7^0$16’53.83’’ $5^0$285’ 53.47’’,7^0 18’ 53.1’’
3	Ezi-Centre	(a) Okpofe, (b) Akpodim (c) Ife	$5^0$28’26.87,7^0 18’1.^{0}8’’ $5^0$26’33.83’’,$7^0$17’4.34 $5^0$24’46.19’’, 7^0 18’37.12’’

2.3. Sample Collection

Two types of collections were made:

a) Sticky trap with light for the purpose of estimating the relative abundance of sand flies.

Flies were collected using sticky traps between 6pm and 9 pm for a period of 1 year. The sticky paper traps were made from sheets of paper 20cm x 20 cm, coated with castor oil and with lights. The traps were placed in and near houses, pens, poultry yards and other livestock homes. On each catch night 15 to 20 sticky paper and light traps were set in each of the selected catch point. The lights were placed about 30m from human dwelling which were hooked at 1.5m above the ground.

The specimens collected using sticky papers were first immersed in 90% ethanol to remove oil, and transferred to 70% ethanol. They were labeled, kept humid and cool in cold box preserved in refrigerator.

b) Human bait for establishing the biting rates of sand flies.

Use of human baits was carried out by 2 trained volunteer entomological scouts for the purpose of estimating the biting rate. The catching points were selected in the communities mapped for the study. The volunteers were trained on how to bait and catch sand flies on landing to feed on the host. Catches were made between 0.7am hours and 7.am twice a month, from June 2013 to May 2014. The flies were captured immediately they land on the host by inverting specimen tubes over them.

2.4. Data Analysis

The monthly relative abundance was expressed in simple percentage of the total number of flies collected. Chi-square statistics was used to evaluate the relationship between dry and wet season abundance and biting rates of sand flies in the study area.

3. Results

3.1. Prevalence of Sand Flies

Table 2 shows the monthly abundance of sandflies in the various study sites. As shown, a total of 2,267 sand flies were captured using light trap, from June 2013 to May 2014. Four hundred and sixty one (461) flies were captured during the dry season while 1,806 flies were captured during the wet season. The highest number of sandflies 301 (13.3%) were collected in August while the lowest number 56 (2.5%) were collected in the month of November. Statistical analysis of the data using Chi square showed significant difference ($p < 0.05$) in the abundance of sand flies between the dry season and the rainy season. The numbers of sand flies were more in the rainy season and decreased during the dry season. Density of Sand flies show peaks from June to October with 1,233 flies. The lowest peeks of 461 were occurred between November 2013 and February 2014 (dry season).

Sand flies were collected throughout the study period in the study sites. However, sand flies were relatively absent during the months of December 2013 to February 2014, and a little number in November and December, 2014 in sites 3A and B.

3.2. Biting Habits of Sand Flies

Table 3 shows the monthly biting rate of sand flies determined per hour at the study sites. A total of 771 were captured by 2 sand fly collectors for the months of June 2013 to May 2014. Biting activity was higher in the early afternoon to the evening hours than the morning hours during the months of the rainy season (April to September). No flies were captured between 0.700 hours and 10.00 hours in the months of July 2013 to April 2014. Fewer biting sand flies were collected in January to May 2014 than in June to December 2013. No biting sand fly was collected in the month of February. There was a remarkable break in the biting activities during the early morning 7a.m and 12noon in the dry seasons.

3.3. Comparative Analyses

Fig. 1 shows the comparative analysis of the monthly biting rates of sand flies in the study area. As shown, the highest monthly biting rate of 153 (18.3%) was recorded in the month of August which was in the rainy season. The lowest monthly biting rates 9 (1.1%) was in the month of January which was the peak of dry season. Statistical analysis of the data using Chi square showed significant difference ($p < 0.05$) in the biting rate of sand flies between the rainy season and the dry season. Biting activities were higher in the rainy season than the dry season.

Fig. 2 shows the comparative analysis of the hourly biting rates of sand flies in the study area. As shown, the highest hourly biting rate (66.7%) was observed between 16.00 t0 17.00 hours in the month of January. The lowest biting rate of sand flies (0.7%) was observed between 0.9 to 10.00 hours in the month of June, Generally, all the pea biting hours in all the months were observed between 12.00 to 17.00 hours. Statistical analysis of the data using Chi square showed significant difference ($p < 0.05$) in the biting rate of sand flies between the morning hours and the afternoon / evening hours, with biting activity being higher in the afternoon / evening than morning hours.

Fig. 3 relates abundance of sand flies to biting activity of sand flies in the study area. As shown, the highest abundance of sand flies 301 was in the month of August and the highest monthly biting rate (MBR) of sand flies (18.3%) was also in August. The lowest abundance of sand flies (56) was in November and the lowest monthly biting

rate (1.1%) was in June. Statistical analysis of the data using Analysis of variance (ANOVA) shows strong positive correlation ($p < 0.05$) between sand fly abundance and biting rate of sand flies. As sand fly abundance increases, the biting rate of sand flies increases.

Table 2. *Monthly abundance of sand flies in the various study sites.*

Study Area	Monthly Abundance of Sandfly (%)												Total
	June	July	August	September	October	November	December	January	February	March	April	May	
Site 1A	26	15	41	23	48	15	23	18	10	32	40	20	311
Site 1B	16	37	62	15	30	6	15	25	7	22	22	37	294
Site 1C	23	45	38	25	39	8	6	6	11	20	41	69	331
Site 2A	36	28	37	10	40	5	10	13	2	26	52	30	289
Site 2B	25	20	40	28	15		9	2	5	11	16	67	239
Site 2C	18	40	11	18	22	11		3	11	13	24	31	211
Site 3A	31	18	30	26	16			6	5	15	21	8	176
Site 3B	45	19	25	18	18			5		16	20	19	201 `
Site 3C	37	32	17	23	17	11	13	18	12	5	26	4	215
Total	**257** (11.3)	**254** (11.2)	**301** (13.3)	**186** (8.2)	**245** (10.8)	**56** (2.5)	**86** (3.8)	**96** (4.2)	**63** (2.8)	**160** (7.1)	**265** (11.7)	**285** (12.6)	**2,267**

($p < 0.05$) *$p = 7.81$*

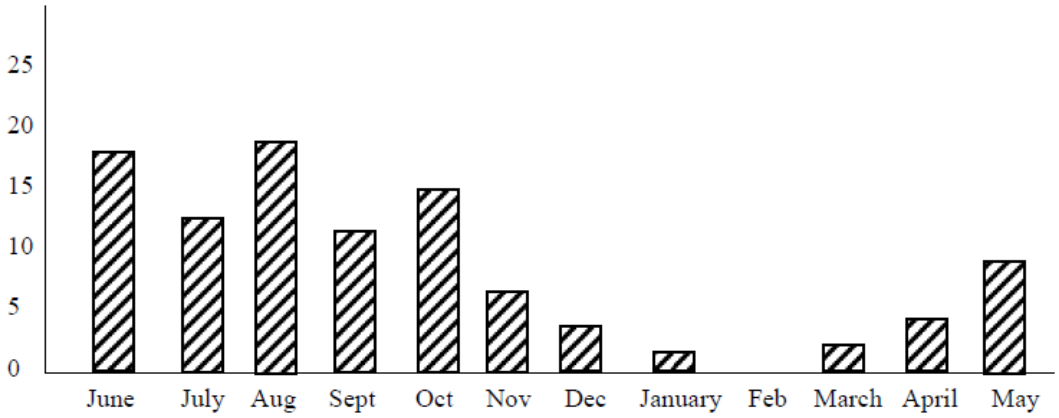
NOTE: *Highest Monthly Abundance 301 (13.3%) = August*
Lowest Monthly Abundance 56 (2.5%0 = November

Table 3. *Monthly biting rate of sand flies determined per hour at the study sites.*

Biting Time	Monthly Biting Rate (%)											
	June	July	August	September	October	November	December	January	February	March	April	May
07 – 08	_	_	_	_	_	_	_	_	_	_	_	_
08 – 09	_	_	_	_	_	_	_	_	_	_	_	4 (5.5)
09 – 10	1(0.7)	_	_	_	_	_	_	_	_	_	_	2 (2.7)
10 – 11	2 (1.3)	_	_	1 (1.0)	_	_	1 (4.2)	_	_	_	_	1 (1.4)
11 – 12	_	1 (0.9)	5 (3.3)	_	_	1 (1.9)	_	_	_	_	3 (10.3)	1 (1.4)
12 – 13	14 (9.4)	_	6(3.9)	2 (2.0)	8 (6.4)	_	_	_	_	_	2 (6.9)	_
13 – 14	12 (8.1)	18 (16.8)	55 (35.9)	11 (11.2)	16 (12.8)	_	3 (12.5)	_	_	_	1 (3.4)	_
14 – 15	14 (9.4)	7 (6.5)	13 (8.5)	_	14 (11.2)	_	_	_	_	_	_	15 (20.5)
15 – 16	25	10	10	15	17	2 (3.8)	_	_	_	2	1	1

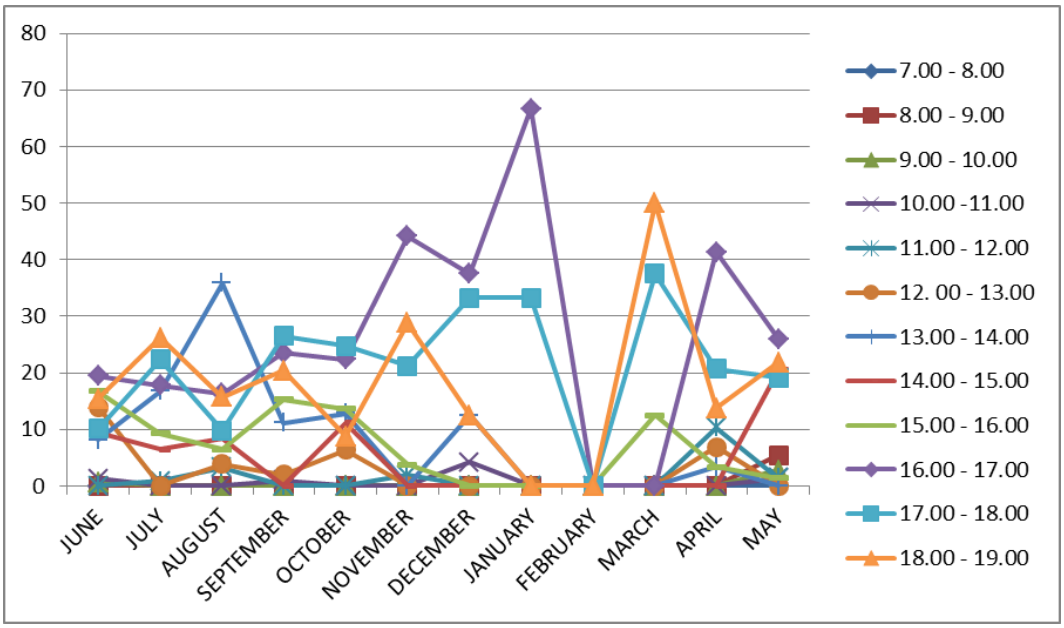
	(16.8)	(9.3)	(6.5)	(15.3)	(13.6)					(12.5)	(3.4)	(1.4)
16 – 17	29 (19.5)	19 (17.8)	25 (16.3)	23 (23.5)	28 (22.4)	23 (44.2)	9 (37.5)	6 (66.7)	–	–	12 (41.4)	19 (26.0)
17 – 18	15 (10.1)	24 (22.4)	15(9.8)	26 (26.5)	31 (24.8)	11 (21.2)	8 (33.3)	3 (33.3)	–	6 (37.5)	6 (20.7)	14 (19.2)
18 – 19	23 (15.4)	28(26.2)	24 (15.7)	20 (20.4)	11 (8.8)	15 (28.5)	3 (12.5)	–	–	8 (50.0)	4 (13.8)	16 (21.9)
Total	**149**	**107**	**103**	**98**	**125**	**52**	**24**	**09**	**-**	**16**	**29**	**73**
MBR	(17.8)	(12.8)	(18.3)	(11.7)	(15.0)	(6.2)	(2.9)	(1.)	-	(1.9)	(3.5)	(8.5)

NOTE: *Total Biting Sandfly = 835*
Highest monthly Biting Rate = August 153 (18.3%)
Lowest monthly Biting Rate = January 9 (1.1%)



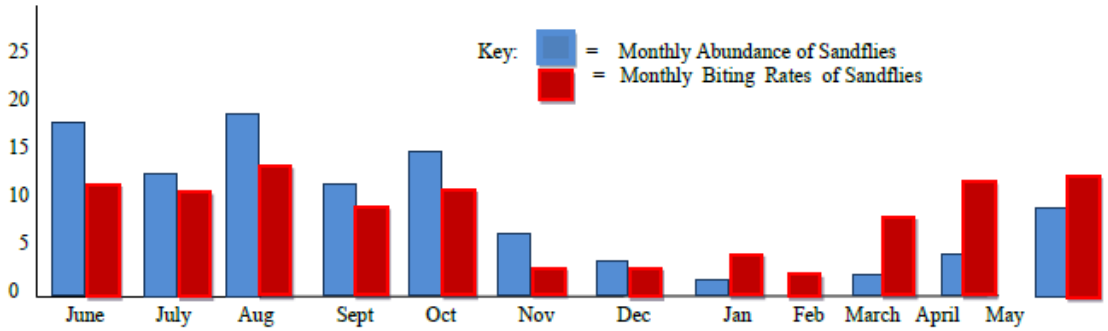
P = 5.784 *(p < 0/05)*

Figure 1. *Analysis of monthly biting rate of sandflies.*



P = 6.451 *(p < 0/05)*

Figure 2. *Hourly Biting Rates of Sand flies in the different months.*



P = 9.438 (p < 0/05)

Figure 3. *Relationship between monthly abundance of sand flies and their biting rates.*

4. Discussion

4.1. Abundance of Sand Flies

In this study, the overall pattern of distribution of sandflies in the various study sites shows that they have representatives of individuals throughout the year. However, there is a clear variation in the number of flies encountered in both seasons (dry and wet). This result is frequently found in the subtropical areas where the insects tend to appear in hotter and humid months Hopsehe *et al.,* (2008), (Nwoke, 1986). The extent to which sand fly population increases throughout the year depends on the local climate with significant seasonal changes in temperature and precipitation. This is similar with the results of studies carried out in Brazil, Egypt Castellon, in 1999 and in Northern Nigeria. From the result of the present study, there is a peak in the seasonal abundance of sand flies during the rains when the temperature and humidity are higher. This is inconsistence with laboratory studies of haematophagus insects which have shown that temperature, moisture and oxygen are the most important stimuli for initiating properly in feeding activity through a substrate membrane whether natural or artificial as reported by previous studies, Surcliffe and Mclever, 1975; Nwoke, 1986; Nwoke *et al.,* 1992; Depaquit, *et al.,* 2016.

Sand flies were trapped in pens and other animal houses where they feed on the animals. Previous studies have shown that sand flies feed on a wide variety of vertebrate hosts including humans, livestock, dogs and wild rodents, reptiles, amphibians and birds (Muller *et al.,* 2011; Lawyer, *et al.,* 2017). Most of the traps were set in humid wall cracks, pens and moist area with large quantity of decaying organic matter. These are microclimates when the sand flies prefer to lay their eggs. Larvae as well need cool and moist habitat with decaying debris (Kimutai *et al.,* 2009, Depaquit, *et al.* 2016).

4.2. Biting Activities of Sand Flies

The biting activities observed during the period of study could be attributed to the high level of human activities in the area hence a high concentration of flies seeking blood meals. Factors such as height of growing vegetations, cracks and crevices and high decaying organic matter may affect or influence the densities at the various sites thus making comparison between sites difficult. Females that suck blood are generally active at dusk and throughout the night (14.00 hrs to dawn). This may account for the high density of biting flies collected during the hours of 14 and 19. Sand flies were very rare during the early hours throughout the study period.

It was observed that in the days without rainfall during the rainy season, a large amount of sand flies were found, as observed in June to October. However, the long term rainfall period activity varies greatly on the sand fly population, forcing them to remain in sheltered conditions. The nuisance caused by the bites of sand flies has negative impact on the economic growth of the local community. This may reduce the development of some potential tourists' areas. Although very little is known about leishmaniasis in South Eastern Nigeria; the high abundance of sand flies in the study area suggests a high risk of outbreak of leishmaniasis. This speculation is supported by the potential environmental factors favouring the presence of the insects. Previous studies (Montes de Oca-Aguilar, 2013) stated that surveillance of sand flies is important since they are vectors of human leishmaniasis and sand fly fever caused by Phlebo-viruses.

5. Conclusions

The present study has established the abundance of sand flies, vectors of leishmaniasis in South Eastern Nigeria. Also these insect vectors were observed to be biting humans and other animals in the study area. However little or no attention is given to the menace of this vectors in the study area. The vector and its grave consequences are neither recognized nor given adequate attention by health workers and individuals living in the area. Government and health care providers in the area should take advantage of the present study to set up infection / disease surveillance as well as vector control measures. Public enlightenment, health education and co-ordinated community action will be of immense benefit to prevent disease outbreak in the area and the entire south eastern Nigeria. Control measures for sand flies require integrated approach tailored to the local situation. Insecticides such as pyrethroids can be used as residual spraying of houses and animal shelters. Use of protective clothing, insect repellents and insecticide-impregnated bed nets are effective in reducing human - sand fly contact. Other methods may include habitat reduction, modification and reservoir control.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References

[1] Allexander, B. Sampling methods for Phlebotomine Sandflies. *Med Vet Etomol.* 2000, 14(2), 109-122.

[2] Avlad, Moncax A.; Faiman, R.; Kirstein, O.; Warburg, A. Breeding sites of Phlebotomus seyenti, the sand fly vector of cutaneous Leishmaniesis in the Judean Desert. *Plos Depl Trop. Dis.* 2012, 6(7), 1725.

[3] Boakye, D.A.; Wilson, M.D.; Kweu, M. A Review of Leishmaniasis in West Africa. *Ghnan Medical Journal,* 2001, 94, 52-55.

[4] Cabanillas, M.R.; Castellon, E.G. Distribution of sandflies (Dpitera: Psychodidae) on Tree-trunks in a non-flodded area of the Ducke forest reserve, Mananus, AM, Brazil. *Mem. Inst. Swaldo Cruz.* 1999, 94(3), 289-296.

[5] Depaquit, Jérôme; Pesson, Bernard; Augot, Denis; Hamilton, James Gordon Campbell; Lawyer, Phillip; Léger, Nicole. Proceedings of the IX International

Symposium on Phlebotomine Sandflies (ISOPS IX), Reims, France. June 28th–July 1st, 2016. *EDP Sciences.* 2016, 23(E1), 1-68.

[6] Galati, Eunice A.B.; Galvis-Ovallos, Fredy; Lawyer, Phillip; Léger, Nicole; Depaquit, Jérôme (2017). "An illustrated guide for characters and terminology used in descriptions of Phlebotominae (Diptera, Psychodidae)". Parasite. 24: 26. doi:10.1051/parasite/2017027. ISSN 1252-607X. PMID 28730992.

[7] Hoel, D.F.; Butter, J.F.; Fawazl, E.U.; Watamyl, N.; El-Hossary, S.S.; Villins, J. (): Response of Phlebotomine Sandflies to light- emitting diod-modified light traps in southern Egypt J. *Vector Ecol.* 2007, 13, 302-307.

[8] Hogsehe, J.A.; hanafi, H.A.; Bermer U.R.; Kline, D.L.; Fawaz, E.Y.; Furman, B.D.; Hoel, D.F. Discovery of Diurial Resting sites of Phlebotomus Sandfiles in a village in Southern Egypt. *Journal Am Mosg. Control Association,* 2008, 24(6), 601-3.

[9] Kellick, R. Phlebotomine sandflies; Biology and control. *World uess-Parasites.* 2002, 4, 33-34.

[10] Kimutai, A.; Ngure, P.K.; Tonus, W.K.; Gicheru, M.M.; Nyamowamu, L.B. leishmaniasis in Northern and Western Africa: Review. *African Journal of Infectious Disease,* 2009, 3(1), 14-25.

[11] Lawyer, Phillip; Killick-Kendrick, Mireille; Rowland, Tobin; Rowton, Edgar; Volf, Petr. Laboratory colonization and mass rearing of phlebotomine sand flies (Diptera, Psychodidae). *EDP Sciences.* 2017, 24(42).

[12] Miller, G.C.; Kravuchenk, V.D.; Rybolove, L.; Beiver, J.C.; Schlein, Y. Characteristics of resting habitats of Adult Phlebotomus papatasis in Neot Hakikar, an oasis south of Dead Sea. *Journal of Vector Ecol.* 2011, 36, 5179-5186.

[13] Mon de Oca-Aguilar, A.C.; Moo-Llanes, D.; Rebablar-Tellez E.A. Adult sandfly species from Diurnal Resting Sites on the Peninsula of Yucatan, Mexico. *Entomological News.* 2013, 123(3), 191-200.

[14] Nwoke, B.E.B. Studies on the field epidemiology of human Onchoerciesis in Jos, Plateau, Nigeria Ph.D Dissertation. Unpublished University of Jos, Nigeria 1986, 343.

[15] Nwoke, B.E.B.; Onwuliri, C.O.E.; Ufomadu, G.O. Onchocerciosis in Plateau State Nigeria. Ecological background, local Disease Perception and Dynamics. *Journal of Hygienic, Epidemiology Microbiology and Immunology,* 1992, 2, 153-6.

[16] Orshal, Szekely, D.; Khalfa, Z.; B, Hon, S. Distribution and seasonality of Phlebotomus Sandflies in Cutaneous leishmaniasis foci, Judean Desert Israel. *J. Med Entomol.* 2010, 47, 319-328.

[17] Ready, P.C. Biology of Phlebotomine sandflies as vectors of disease agents: Annual Rev. *Entomol.* 2013, 58, 227-50.

[18] Rebelo, J.M.M.; Oliveria, S.T.; de, Silva, F.S.; Barros, V.L.L; Costa, J.M.L. Sandflies (Dipter: Psychodidae) of the Amazoma of Maranhao. V., Seasonal Occurrence in Ancient colourization Area and Endemic for cutaneous Leishmeniesis. *Rev. Bras. Biol.* 2001, 61(1).

[19] Setcliffe, J.F.; Mclver, S.B. Artificial feeding of simuliids (Simulium venustum): factors associated with probing and gorging. *Experimentia*, 1975, 31, 695-6.