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Microhabitats and Pathogens of Houseflies (*Musca domestica*): Public Health Concern

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Research Article

Abstract

A study to assess the effects of microhabitats on pathogens of *Musca domestica* and also assess *Musca domestica* health related diseases was carried out in Maiduguri, Borno state, Nigeria. A total of 400 hundred houseflies were randomly sampled by using sweep net from four sites namely: refuse dumps, toilets, tomato/vegetable shops and soft drink shops in two localities, Shuwari III and Maduganari wards. The external and internal parasites were isolated and recorded. Chi-square and percentage prevalence of external and internal parasites were calculated and recorded. There was no significant difference in the prevalence of external parasites sampled from the different sampling sites as $x^2cal\ (14.68) < x^2_{df15}$ tab (24.99) at 5% level of significance. The hind gut showed the highest parasites percentage prevalence of 48.45% while the fore gut recorded the least prevalence of 23.71%. Chi-square analysis showed no significant difference as $x^2cal\ (13.75) < x^2_{df10}$ tab (18.31) at 5% level of significance. Assessment of housefly related diseases in the two communities revealed that diseases of public health significance like diarrhoea/abdominal cases, dysentery/abdominal pains and Eye sore/infection were prevalent in the health facilities with the month of August recording the highest disease cases and chi-square analysis showed no significant difference in the prevalence of housefly related diseases between the two communities. $x^2cal\ (0.99) < x^2_{df5}$ tab (11.07) at 5% level of significance.

The harbouring of more parasites by the hindgut than any other part of the gut is an indication that contamination of foods could be through faecal means than by regurgitation. Furthermore, with the collections of a lot flies around human vicinity and the implications of the contamination of such flies with parasites, adequate control measures must therefore be taken to control their numbers and to avoid transmission of houseflies related diseases to humans.

Keywords: *Musca domestica*; Microhabitats; Parasites load; Health related diseases; Public health.

1. Introduction

According to Mike, of the about 18,000 species of true flies, four families are of human importance viz: Glossina, Muscidae and Fanniidae [1]. While the houseflies and stable flies belong to the family Muscidae, the Latrine flies belong to the family Fanniidae. Houseflies (*Musca domestica*) are the most common of all domestic flies, accounting for about 90% of all flies in human habitation all over the world [2]. Hussein and John noted that housefly is a cosmopolitan pest of farm, home and is synanthropic to humans [3]. Their availability in the tropics has been noted by Graczyk et al. [4] to be abundant in areas with substandard environmental sanitary conditions. Houseflies are mostly active and live longest in temperatures between 10-26.5°C, but are inactive at low temperatures below 7.2°C and could die in extreme temperatures below 0°C [5] or above 44.4°C. The ecological monitoring of their flight range showed that individual flies can travel as far as 20 miles, although, vast majority of flies (more than 88%) do not travel more than 2 miles and their movement is oriented towards unsanitary sites [6]. In a related development, Lam et al. [7] noted that houseflies' ecological movement are drawn majorly to high densities of human wastes and garbage which constitute their food which they take in as fluids and tiny materials and coincidentally as noted by, these feeding sites are the breeding sites of houseflies which have been reported to include horse manure, human excreta, cow manure, fermenting vegetables and fruits, garbage and kitchen wastes and commonly exposed human foods [3,5,8]. At the course of their breeding, the females have been reported to be able to lay up to 500 eggs [5].

Due to houseflies indiscriminate mode of feeding, they have been described as potential vectors of more than 100 serious pathogens which includes virus; bacteria like Vibro cholera, Staphylococcus and Rota virus; fungi; enteric protozoans cyst and trophozoites like *Entamoeba histolytica*, *Cryptosporidium parvum* and *Entamoeba coli*, Sacrocystis species, *Taxoplasma gondii*, Isospora species, Giardia species, Trichomonas species, Hymenolepis species, Dipylidium species and Diphyllobothrium species;

and nematodes like helminth eggs, *Toxocara* spp.; *Ascaris lumbricoides*, *Trichiuris trichiura*, *Enterobius vermicularis*, *Ancyclostoma caninum, Strongyliodes stercoralis*, Larvae of *Harbronema musca* and Taenia species which they transport on their feet and hairy legs [3-5,9-11]. These pathogens have been reported to cause serious health implications as they could lead to diseases like typhoid, cholera, polio, eye inflammation, salmonellosis, diarrhoea, dysentery, tuberculosis and anthrax and polio in man and his animals. With the abundant multiple recorded role of flies as potential vectors, dearth information still exists in their role as mechanical transmitters of parasitic diseases and the increase health care attendants by residents of Maiduguri metropolis (an area with the highest number of internally displaced persons in Africa according to the World Health Organization), which would have added to a new approach on how to increase health care surveillance to enrich already existing information [5,8,12-14].

In view of the above stated importance of *Musca domestica*, this research was carried out to study the effects of different microhabitats on pathogens of *Musca domestica* in Maiduguri metropolis, Nigeria. Other objectives include determining the types and prevalence of parasites of *Musca domestica* associated with the different microhabitat; ascertaining the prevalence of parasites in the gut sections of the houseflies; and in addition assessing and relating the prevalence of housefly related diseases from two communities within the metropolis.

2. Materials and Methods

2.1 Study area

This study was conducted in Maiduguri metropolis, Borno state-Nigeria (Figure 1). Maiduguri is the headquarters of Borno state located in the far North Eastern part of Nigeria between 11°50'42" North, 13°9'36" East. It shares international borders to the North with Niger and Chad and Cameroon to the East, whereas it's Southern and Western borders are shared with Adamawa, Gombe and Yobe states in Nigeria. Maiduguri happens to be metropolis with the highest number of Independent Displaced Persons (IDPs') in Africa due to the continuous operation of the insurgents called Boko Haram within that region.

2.2 Morphology of adult *Musca domestica*

As described in literature, House fly is an arthropod which belongs to the Phylum Arthropoda; has chitinous exoskeleton; metamerically segmented and bilaterally symmetrical [1,5,13-16]. It is light to dark grey in colour with four dark stripes along the back; Adult measures 6-9 mm long; has one pair of membranous true wings with the second pair of wings modified into drum stick-like appendages called halters used in air balance; reddish and large Compound eyes; sponge–sucking like mouthparts which are adopted for feeding on liquids where it ejects saliva to break down solid foods; have short antennae. Females are slightly larger than males having 9 abdominal segments compared to 8 in males. The last four abdominal segments in females are normally retracted but they extend to make the ovipositor when the female lays eggs.

2.3 Sampling techniques

A total of four hundred (400) houseflies were randomly collected from two localities namely, Shuwari III and Maduganari wards with the aid of a sweeping net from four sites: Refuse dumps, Toilets, Tomatoes/ vegetable shops and Soft drink shops. At each site, 50 flies were collected by random method using a sweep net over the surfaces where flies visited. The flies were released into labelled constructed boxes

Figure 1. Map of Nigeria with Borno state in golden colour.

made up of plywood and wire gauze and were transported to the laboratory for further processing.

In addition, data on disease cases associated with parasites of housefly within the periods from July to December, 2014 were collected from two (2) hospitals namely, Bolori Comprehensive Health Centre (BCHC) and Yerwa Metropolitan Council Hospital (YMCH) both in Maiduguri Metropolis.

2.4 Isolation of external and internal parasites of houseflies

The method used by Nmorsi and Adiku were used to isolate external parasites [2,17,18]. Houseflies collected from each site were transferred into labelled specimen bottles carrying information such as date, location and type of sites. The flies were washed thoroughly with 5 ml of normal saline by vigorous shaking to dislodge the parasites from the exoskeleton (body) especially hair of the flies. The solution was transferred into a conical tube and centrifuged at 3000 rev/min for 5 min using manual centrifuge machine. The various supernatants were then discarded and precipitates were placed on cleaned greased free glass slides. The glass slides were viewed under binocular microscope using 10x and 40x magnification for presence of any parasites. The external parasites isolated from houseflies sampled from different sites were recorded.

Dissection of the houseflies gut was done using method described by Trigunayate18 under dissecting microscope. The various guts were removed and separated into foregut, midgut and hindgut by the use of sharp surgical blades. Each of the gut parts was crushed and washed in normal saline. The solution was centrifuged, supernatant was discarded and precipitate examined on labelled cleaned greased free glass slides under binocular microscope using 10x and 40x magnification for presence of parasites, parasites eggs and cysts. Total gut parasites in the three gut parts was then recorded.

2.5 Isolation and identification of parasites

The parasites were isolated and identified by consulting diagrams from Arora and Brij [11].

2.6 Statistical analysis

The prevalence percentages of parasites isolated from the external body/surface of the houseflies were determined and recorded. Chi-square was also used to analyze the prevalence of parasites from the respective sampling sites. Percentages of parasites prevalence in foregut, midgut and hindgut of the houseflies were calculated and recorded. Chi square analysis was also used to analyze the data.

2.7 Data taking of house fly related diseases

Housefly related diseases from two communities were assessed and the disease cases were recorded. Chi-square and simple percentages were used to analyze the data.

3. Results

Table 1 showed the prevalence of external parasites isolated from houseflies sampled from Shuwar III and Maduganari wards. Six (6) different types of parasites were isolated from the external surfaces of houseflies. This consists of three Phyla, Protozoa (*Entamoeba histolytica* cysts and adults; Platyhelminthes (*Taenia solium* and *Taenia saginata* cysts and adults and *Hymenolepsis nana* cysts and adults; and Nematoda (*Ascaris lumbricoides* and *Trichuris trichiuria* eggs and adults).

Individually, *E. histolytica* was most prevalent accounting for 35.43% of the total parasites isolated, followed by *G. lamblia* being 23.62% then Taenia species (15.75%), *Ascaris lumbricoides* (12.60%), whereas *Hymenolepis nana* recorded the least prevalence accounting for 5.51% of the total parasites isolated.

Table 1. Prevalence of external parasites of houseflies trapped from Shuwari III and Maduganari Wards.
$x^2 cal\ (14.68) < x^2_{df15}$ tab (24.99).

	Various parasites/number encountered (%)							
	No. of flies	***Entamoeba histolytica***	***Giardia lamblia***	Taenia species	***Ascaris lumbricoides***	***Trichuris trichiura***	***Hymenolepis nana***	Total (%)
Refuse dumps	100	26 (10.24)	26 (10.24)	10 (3.94)	10 (3.94)	4 (1.57)	4 (1.57)	80 (31.50)
Toilets	100	44 (17.32)	20 (7.87)	16 (6.30)	16 (6.30)	8 (3.15)	4 (1.57)	108 (42.52)
Tomato/ Vegetable shops	100	12 (4.72)	8 (3.15)	8 (3.15)	2 (0.79)	2 (0.79)	4 (1.57)	36 (14.17)
Soft drink shops	100	8 (3.15)	6 (2.36)	6 2(.36)	4 (1.57)	4 (1.57)	2 (0.79)	30 (11.81)
Total	400	90 (35.43)	60 (23.62)	40 (15.75)	32 (12.60)	18 (7.09)	14 (5.51)	254 (100)

A comparison of the houseflies caught from various sites indicated that Houseflies sampled from toilet recorded the highest percentage prevalence of external parasites being 42.52%, followed by houseflies collected from Refuse dumps recording 31.50%, then those from Tomato/vegetable shops with 14.17%, while houseflies collected from Soft drink shops had the least percentage prevalence of 11.81%. Percentage prevalence difference was not significant as (14.68)<tab (24.99) at 5% level of significance.

Tables 2 revealed the prevalence of internal parasites in the foregut, midgut and hindgut of sampled houseflies from Shuwari III and Maduganari wards. Six (6) different types of parasites, cysts and eggs were also isolated from the gut of the houseflies viz: *E. histolytica*, *G. lamblia*, Taenia species, *Ascaris lumbricoides*, *Trichuris trichiuria* and *Hymenolepsis nana*. *E. histolytica* showed the highest percentage prevalence in the gut of the sampled houseflies accounting for 38.14%. It was followed by *Ascaris lumbricoides* having 21.65%, then Taenia species with 18.25%. *Hymenolepsis nana* had the least percent prevalence of 4.12%. The hindgut recorded the highest prevalence of parasites accounting for 48.45%, followed by the midgut, 27.84%, while 23.71% is the least percent prevalence recorded in the foregut. Chi-square analysis showed no significant difference in the prevalence of parasites in the three gut parts as tab (18.31) at 5% level of significance.

Table 2. Prevalence of internal parasites in the gut of houseflies sampled from Shuwari III and Maduganari Wards.

$x^2 cal\ (13.75) < x^2_{df\,10}$ tab (18.31)

	Various parasites/number encountered (%)			
Parasites	Foregut	Midgut	Hind gut	Total (%)
Entamoeba histolytica	16 (8.25)	22 (11.34)	36 18.56	74(38.14)
Gairdia lamblia	4 (2.06)	2 (1.03)	10 (5.15)	16 (8.25)
Taenia species	8 (4.12)	12 (6.19)	16 (8.25)	36 (18.56)
Ascaris lumbricoides	8 (4.12)	12 (6.19)	22 (11.34)	42 (21.65)
Trichuris trichiura	4 (2.06)	4 (2.06)	10 (5.15)	18 (9.28)
Hymenolepsis nana	6 (3.09)	2 (1.03)	0 (0.00)	8 (4.12)
Total	46 (23.71)	54 (27.84)	94 (48.45)	194 (100)

Table 3 revealed the assessment of housefly related diseases in two communities from July to December, 2014. Analysis of the data revealed that there was no significant difference in the prevalence of housefly related diseases between the two communities. Tab (11.07) at 5% level of significance. At Bolori Comprehensive Health Centre (BCHC) which serves most people from Shuwari III ward, diarrhoea/ abdominal cases recorded the highest number of 201 with percent prevalence of 38.51%, followed by abdominal pains/dysentery which consisted of 171 cases making 32.76%. Abdominal pains was third with 85 cases making 16.28%. Vomiting cases was fourth with 61 cases making 11.69% followed by eye sore/infection being the least which comprised 4 cases with 0.77% prevalence. Monthly prevalence of disease cases at BCHC showed that the month of August had the highest of 132 cases, accounting for 25.29%. July was second with 102 cases making up 19.54% of the total disease cases. September was next with 96 of the disease cases which formed 18.39%. This was followed by October which had 79 disease cases amounting to 15.13%. November recorded 65 cases amounting to 12.45%, while December had the least disease cases with a total of 48 cases, representing 9.20%. A total of all the five disease cases amounted to 522 for the months July to December. At Yerwa MCH which serve most people from Maduganari ward and is also a WHO/ UNICEF Centre for drug collections, a total of 706 housefly related disease cases was recorded. Diarrhoea/abdominal pains had the highest of 276 cases, amounting to 39.09%. Dysentery/abdominal pain were second with 201 reported cases accounting for 28.47%. Abdominal pains came third with 112 cases amounting to 15.86% followed by vomiting cases, with 106 which formed 15.01%. The least was eye sore/infection, 11 cases which made up 1.56%. Monthly wise, the month of August recorded the highest disease cases of 187 which constituted 26.49%. July was second recording 156 cases, amounting to 22.09%, while September recorded 141cases making 19.97% of the total disease cases. It was followed by October which had 92 cases, representing 13.03% and November was next with 75 cases accounting for 10.62%. The least was December which recorded 55 disease cases which amounted to 7.79% of the total disease cases.

4. Discussion

4.1 Parasite types and parasitic load on both external and internal parts and sites of study

The study revealed that houseflies play important role in transmission of diseases as evidenced from the pathogens carried on their body parts. Most importantly, Houseflies sampled from toilets and refuse dumps were found to contain more parasites compared to those sampled from tomato/vegetable

Table 3. Assessment of housefly related diseases in two communities between July to December 2014.

$x^2 cal\ (0.99) < x^2_{df\,5}$ tab (11.07)

	Bolori (BCHC)								Yerwa MCH								
Disease cases	July	Aug	Sept	Oct	Nov	Dec	Total	%	July	Aug	Sept	Oct	Nov	Dec	Total	%	Average %
Diarrhoea/ Abdominal pains	36	44	41	32	28	20	201	38.51	71	81	37	35	30	22	276	39.09	39.57
Dysentery/ abdominal pains	34	45	28	26	20	18	171	32.76	24	41	64	28	24	20	201	28.47	29.85
Abdominal pains	21	23	15	11	9	6	85	16.28	24	39	20	13	10	6	112	15.86	16.07
Vomiting		19	11	9	7	4	61	11.69	33	26	17	14	10	6	106	15.01	13.35
Eyesore/ Infection	0	1	1	1	1	0	4	0.77	4	0	3	2	1	1	11	1.56	1.17
Total	102	132	96	79	65	48	522	-	156	187	141	92	75	55	706	-	
Percentage total	19.5	25.3	18.4	15.1	12.5	9.2	-	100	22.1	26.5	20.0	13.03	10.6	7.79	-	100	-

shops and soft drink shops. Of great significance is the revelation that both the external and internal parts of the flies carried the same type of pathogens such as *Entamoeba histolytica*, *Giardia lamblia*, Taenia species, *Ascaris lumbricoides*, *Trichuris trichiuria* and *Hymenolepis nana* and that the hindgut carried most of these parasites than the others.

This result is in agreement with the findings reported by Adeyeba et al. [19] in Ibadan, Nigeria and Mohammad et al. [6] in Shiraz, Southern Iran where their individual studies reported *Musca domestica* as mechanical vectors for transmission of some parasite species like *Entamoeba histolytica*, *Giardia* spp., *Ascaris lumbricoides*, *Trichuris trichiura*, *Enterobius vermicularis, Ancyclostoma caninum*, *Strongyloides stercoralis* and Taenia speices. Consequently, the abundance of more of the parasites in the hindgut as compared to the foregut and midgut agrees with the findings of Dipeolu as cited by Adiku who conducted a study of field and laboratory investigation into role of Musca species in the transmission of intestinal parasites cysts and eggs in Nigeria, and discovered that the hindgut and rectum harboured more parasites than the foregut and midgut of houseflies [10,17]. This could mean that food contamination may likely occur more by faecal matters than by regurgitation which concurred with the findings of Mohammad et al. [6] and Sanchez – Arroyo and Capinera [5] who both studied the likely pattern of transmission of parasites by houseflies through faecal deposition, mechanical dislodgement or through the regurgitation of ingested particles.

The flies caught from toilets incidentally had the highest form of contamination with parasites which agrees with the reports by Akogun and Badaki in Adamawa and Oghale et al. [12] in Umuahia who conducted a study to assess the level of parasitic load of parasitic load in dry and rainy seasons from different environment in their metropolis of study and uncovered that houseflies caught in pit latrines had the highest form of contamination with parasites as compared to those from eateries [20,21]. This might not be unconnected with the feeding pattern of the flies which majorly could be human faeces. The inability to obtain a significant difference in the various sites of study could be linked to the range of movements of these flies as they have been discovered to feed and breed in unsanitary environments which range within a distance of 2 km and above.

4.2 Health related centres

Assessment of housefly related diseases in the two communities from July to December, 2014 took into cognisance houseflies related diseases that included diarrhoea/abdominal pains, dysentery/abdominal pains, abdominal pains, vomiting and eye sore/ infection and the month in which the highest form of these diseases occurred. Results indicated that diarrhoea/abdominal pains, dysentery/abdominal pains and abdominal pains were of higher percentage in occurrences while vomiting and eye sore/infection showed low percent occurrences from both centres. Again, in both health centres, the month of August recorded the highest disease cases, followed by July, then September, October, November and December which recorded the least cases. The month of August coincidentally records the highest rainfall in Maiduguri and it is within this period that the environment is highly contaminated due to water floods and the water loggings with waste also serve as breeding sites for houseflies thereby increasing the population of the houseflies. This is in line with observation made by Oghale et al. [12] who noted that houseflies multiply and develop in their dirty environments more during rainy season (between July to September) than during the dry season (October to April).

5. Conclusion

It was observed from this study that there was no significant difference in the percentage prevalence of parasites of houseflies sampled from different sites; the observed percentage prevalence of parasites, parasite cysts and eggs in the foregut, midgut and hindgut and in the percentage prevalence of housefly diseases identified in the two communities. It is the view of the researchers that the different sites where houseflies were sampled had no marked boundaries which could have warranted the free movement of the flies in and out of the sampling sites carrying the pathogens with them. It could also mean that there is equal chance of food contamination by parasites in the hindgut and foregut by defecation, vomiting or regurgitation. However, the authors are of the opinion that apart from parasites on the external bodies of houseflies, faecal contamination of human food by the vector occurs more than contamination of food through regurgitation or vomiting by the houseflies since parasites, parasites cysts and eggs are more in the hindgut than the foregut and midgut.

The authors concluded that diseases identified might not have been transmitted by houseflies alone but by other medically important insects like cockroaches. In addition, houseflies have no limited boundaries between the two communities; therefore, houseflies in either of the communities could be responsible for the transmission of diseases identified in either of the two communities. However, differences in population density, environmental and hygienic conditions of the communities where these health centres are situated could be contributory factors for the percentage prevalence differences.

6. Recommendations

Based on findings from this study, the following recommendations are made: Enlightenment campaign by Government and Non-Governmental Organizations (NGOs) to enlighten the general public on the significant role of *Musca domestica* as mechanical vector of diseases; Encouraging the populace to maintain high level of personal hygiene and clean environment; the need for both Local and National Social media to design special programmes on the dangers of houseflies and other medically important insects to human health and how to control them; and finally, the need for Government to ensure the provision of adequate and effective healthcare systems, educate and encourage the people to visit hospitals for treatment of any diseases.

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