
HUMAN PARASITES MECHANICALLY TRANSMITTED BY COCKROACHES AND HOUSEFLIES IN OWERRI MUNICIPALITY AND ITS ENVIRONS

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Abstract

*This study examined the human parasites that are mechanically transmitted by cockroaches and houseflies in Owerri Municipality and its environs in Imo State from May, 2019 to April, 2020. Three major areas were considered and they were Owerri Municipality, Owerri West and Owerri North. The sample procedure used in the study was simple random sampling. In each area, three major communities/locations/streets were randomly selected and sampled. Sampling was done two times in a week in the wet season and dry season. The sampled sources of cockroach spp collected were toilets and kitchens while sampled sources of housefly spp collected include refuse dumps, kitchens, toilets and household baits. The cockroach species were collected using Vessel Container method while housefly species were collected using sweep net. The cockroach species collected were as following: *Periplaneta americana*, *Supella longipalpa*, and *Blatella germanica* while housefly spp collected include: *Musca domestica*, *Musca sorbens*, *Calliphora vomitoria*, *Chrysomya rufifacies* and *Chrysomya megacephala*. The parasite ova of cockroaches and housefly species isolated were picked up through sedimentation process and identified. Statistical Package for the Social Sciences (SPSS) version 20.0 was used to run the analysis. Data obtained in this study were subjected to simple percentage, frequency table and Chi-square test at $\alpha = 0.05$. The result found that the identified parasites were Hookworm egg, *Taenia* egg, *Trichuris trichiura* egg, and *Ascaris* egg of the total cockroaches examined. The identified parasites were hookworm eggs, *Hymenolepis nana* eggs, *Taenia* species eggs, *Trichuris trichiura*, and *Ascaris* eggs of the total houseflies examined. Houseflies had a higher prevalence of parasites than cockroaches in the study area. *Ascaris* egg had the highest percentage prevalence of cockroaches than housefly parasites. The result found no significance difference in the prevalence of parasites of cockroach and housefly species, recovered from the collection sites at 0.05 alpha level of significance. Therefore, trash including manure, garbage and decaying animal materials should be properly disposed into sealed containers; and emptied regularly away from buildings.*

Keywords: Insects, Peri-domestic insects, human parasites, cockroaches, houseflies

Introduction

Domestic insects are insects that constantly live, feed and breed in homes or houses, as distinct from other insects which just pass through buildings or venture in and out of buildings through open doors and windows (Breitwart, 2008; Hughes *et al.*, 2012). Some of these include flies, mosquitoes, bugs and fleas as well as ants, cockroaches and other household pests. These insects are attracted to the house by the presence of food and shelter in our homes. Common knowledge shows that rooms with moisture, food, or clutter are most likely to attract ants, cockroaches, flies and other common household pests. These household pests can also be found in the kitchen, bathroom and living room. Apart from regular domestic insects, there are also a wide range of peri-domestic insect pests.

Peri-domestic insects are insects found in and around homes. They are most likely to occur when they are in search of food or shelter (James *et al.*, 2006; Okere, 2018). Peri-domestic insects comprise flies and non-fly species. Flies are insects with a pair of functional wings for flight and a pair of vestigial hind wings called halteres for balance. They belong mainly to the order called Diptera, with the name derived from the Greek words di- two and pteron- wings. The order Diptera is divided into two sub orders (although one suborder is non-monophyletic), with about 110 families divided between them. The families contain an estimated 1,000,000 species, including the familiar housefly, crane fly and hover fly (James *et al.*, 2006), although only about 125,000 species have species-description published (Kolb *et al.*, 2009). Many insects such as butterfly contain the word fly in their name, but are not Dipterans. The word fly is also used colloquially and non-scientifically as a name for or any small flying insect. This is however, not scientifically correct. The term true fly is used to make clear distinction that the insect being referenced is a Dipteran. Non-fly peri-domestic insects include termites, beetles, cockroaches, fleas, lice, bed bugs, butterflies, moths, ants and wasps. Irrespective of the category of insect (i.e. whether fly or non-fly), the medical importance of some peri-domestic insects have relationships with the health of man since they live in association with man. This is part of the investigations by the present study with respect to cockroaches and houseflies.

Cockroaches have survived on the earth for more than 300 million years virtually without involving change (Zurek and Schal, 2004). They are considered one of the most successful groups of animals because of their adaptability in various environmental conditions. There are approximately 3500 species of cockroaches worldwide (Kopanic, 1994). Among these species, thirty are associated with human habitations (Kinfu and Erko, 2008). The majority of these species lives in tropical and subtropical areas where they are not recognized as pests (Vazirianzadeh, Mehdinejad and Dehghani, 2009). In these areas, they are abundantly found in areas with frequent stagnant water bodies or with a constant and high moisture availability such as toilets, kitchens, sewages, and drainages where water serves as migration routes from place to place (Siachua, Pinmai, Somrithipol and Tor-Udom, 2008). In addition to their repulsive and annoying characteristics, they eat and contaminate food and leave a persistent offensive odor in infested places (Zurek and Schal, 2004). Cockroaches frequently feed on human faeces, garbage, and sewage (Uc,kay, 2009). Therefore they have copious opportunities to disseminate pathogenic agents on food resources. They are nocturnal and have filthy habits which coupled with their feeding mechanisms make them efficient vectors of pathogens like bacteria (*Klebsiella pneumonia*, *Enterobacter cloacae*, *Enterobacter aerogenes*, *Salmonella spp.*, *Shigellasonnei*, *Vibrio cholerae*, *Citrobacter freundii*, viruses (*Poliomyelitis*), protozoa (*oocysts of Isospora belli*, *Cryptosporidium parvum*, *Cyclospora cayetanensis*, cysts of *Entamoeba histolytica*, *Balantidium coli*, and *Giardia lamblia*), fungi

(*Candida sp.*, *Rhizopus sp.*, *Aspergillus sp.*, *Mucor sp.*), and eggs of some pathogenic intestinal worms (*Ascaris lumbricoides*, *Trichuris trichiura*, Hookworm, *Enterobius vermicularis*, *Hymenolepis nana*, *Toxocaracanis*, and *Strongyloides stercoralis larvae*) (Iboh, Etim, Abraham and Ajang, 2014). Cockroaches not only contaminate food with their droppings or by pathogens but they also cause food poisoning. According to Tatteng et al. (2005), some people are allergic to antigens and faeces of cockroaches which may result in asthmatic-related health problems.

Studies have been carried out in several countries of the world in order to evaluate the risks of parasitic infestation associated with the presence of cockroaches in households. In Owerri Municipality and its environs, to the best of our knowledge, no or few epidemiological data on this risk factor associated with the presence of cockroaches in the households are available. The present study was therefore designed to identify cockroach species while examining the occurrence of medically important parasites they carried in the study area. The findings may be of immense benefit to the local residents and for others within and outside Owerri Municipality as it would serve as an educational tool for the potential dangers they might face with the presence of cockroaches in their houses.

The houseflies are the most synanthropic and cosmopolitan flies found in the tropics (Balla, Usman and Muhammad, 2014). They are commensal on humans, poultry, and animals, and spread food-borne illness (Iqbal et al.; 2014; Barreiro, Albano, Silva and Teixeira, 2013). They are considered as important mechanical vector for a number of pathogenic bacteria, protozoa, metazoan, fungi and viruses (Manandhar and Gokhale, 2017). Pathogens are picked-up by the flies from garbage, sewage and other sources of filth on their mouthparts and other body parts, and then transferred to human and/or animal food (Al-Aredhi, 2015). Houseflies faecal, sponge feeding and regurgitating behavior facilitates food-borne diseases transmission (Oghale, Ebube and Oluchi, 2013). The most common diseases that are transmitted mechanically by the houseflies include, but not limited to poliomyelitis, cholera, typhoid fever, parasitic worms, bacillary dysentery, trachoma virus, epidemic conjunctivitis, Shigellosis, Salmonellosis and enteric infections (Lau et al., 2016). Most of these pathogens may live inside and on *Musca domestica* external surface for 5-6 hours and to 35 days post-infestation (Lau et al., 2016). Transmission takes place when the housefly makes contact with people or their food. Most of the diseases can also be contracted through contaminated food, water, air, hands and person-to-person contact (Collinet-Adler et al., 2015). The role of house flies as mechanical vectors of infectious diseases in humans has been suggested by the results of many experimental and field studies (Balla et al., 2014; Iqbal et al., 2014; Barreiro et al., 2013). This study is necessary to determine the human parasites that are mechanically transmitted by cockroaches and houseflies in the study area.

Aim and Objectives

The purpose of this study is to investigate the human parasites that are mechanically transmitted by cockroaches and houseflies in Owerri Municipality and its environs in Imo State, Nigeria. The specific objectives of this study are as follow:

- i. To identify the medical importance of some peri-domestic insects (PDI) in the study area.
- ii. To determine the human parasites that are mechanically transmitted by Cockroaches and Houseflies in the study area.

Research Questions

The following research questions guided the study:

1. What is the medical importance of some peri-domestic insects (PDI) in the study area?
2. What are the human parasites that are mechanically transmitted by Cockroaches and Houseflies in the study area?

Hypothesis

The following hypothesis was tested in this study at $p < 0.05$ alpha level:

1. There is no significance difference in the prevalence of parasites recovered from the collection sites.

Materials and Methods

This study was carried out in Owerri Municipality and its environs in Imo State, Nigeria. Medical importance of some peri-domestic insects were collected in Owerri Municipality and its environs from April year 2019 to March year 2020. Three major areas were considered and they were Owerri Municipality, Owerri West and Owerri North. In each area, three major communities/locations/streets were randomly selected and sampled. Sampling was done two times in a week in the wet season and dry season. Different sampling regimes were used to determine effect of season on the relative abundance of the medical importance peri-domestic insects in the area. Sweep nets, insecticides, water retaining containers and baits of different kinds were employed in sampling peri-domestic insects. Captured insects were sorted and identified using morphological characteristics as guided by Imms (1967), Gillies and Coetzee (1987), Suleiman *et al.*, (1988). Immature stages were reared in the laboratory to adulthood before they were identified too. Identified species of peri-domestic insects by the researchers was authenticated by an expert Entomologist. Statistical Package for the Social Sciences (SPSS) version 20.0 was used to run the analysis. Data obtained in this study were subjected to simple percentage, frequency table, and Chi-square test at $\alpha = 0.05$.

Results

This section presents the summary of analysis of data of the study based on the three locations in Owerri Municipality, Owerri West and Owerri North Areas. The results of the data analysis are presented according to the objectives of the study.

Table 1: Distribution of the kind of parasites (from cockroaches) on the studied locations

Sample Sources	Species of Cockroaches Trapped	No. of examined Species	No. of infested Species (%)
Toilet	<i>Periplaneta americana</i>	307	76 (24.8)
	<i>Supella longipalpa</i>	17	7 (41.2)
	<i>Blattela germanica</i>	63	23 (36.5)
Total (%)		387	106(27.3)
Kitchen	<i>Periplaneta americana</i>	193	61 (31.6)
	<i>Supella longipalpa</i>	13	5 (38.5)
	<i>Blattela germanica</i>	119	49 (41.2)
Total (%)		325	115 (35.4)

Parasites identified—*Hookworm egg, Taenia egg, Trichuris trichiura egg, Ascaris egg.*

Table 1 shows the distribution of the kind of parasites (from cockroaches) on the studied locations. Out of the 387 cockroach species collected from the toilet and examined, 27.3% were infested ($n = 106$) while a total of 325 cockroach species collected from the kitchen and

examined with 35.4% infected (n = 115). The identified parasites were *Hookworm egg*, *Taenia egg*, *Trichuris trichiura egg*, and *Ascaris egg* of the total cockroaches examined.

Table 2: Distribution of the kind of parasites (from housefly) on the studied locations

Sample sources	Species of housefly Trapped	No. of Examined Species	No. of infested Species (%)
Toilet	<i>Musca domestica</i>	121	38 (31.4)
	<i>Musca sorbens</i>	16	7 (43.8)
	<i>Caliphora vomitoria</i>	76	29 (38.2)
	<i>Chrysomya rufifacies</i>	86	27 (31.4)
	<i>Chrysomya megacephala</i>	183	51 (27.9)
Total (%)		482	152 (31.5)
Kitchen	<i>Musca domestica</i>	110	45 (40.9)
	<i>Musca sorbens</i>	17	7 (41.2)
	<i>Caliphora vomitoria</i>	63	28 (44.4)
	<i>Chrysomya rufifacies</i>	82	22 (26.8)
	<i>Chrysomya megacephala</i>	126	41 (32.5)
Total (%)		398	143 (35.9)
Refuse Dump	<i>Musca domestica</i>	123	36 (29.3)
	<i>Musca sorbens</i>	17	7 (41.2)
	<i>Caliphora vomitoria</i>	120	34 (28.3)
	<i>Chrysomya rufifacies</i>	100	26 (26.0)
	<i>Chrysomya megacephala</i>	175	36 (20.6)
Total (%)		535	139 (25.9)
Home baits	<i>Musca domestica</i>	91	23 (25.3)
	<i>Musca sorbens</i>	15	6 (40.0)
	<i>Caliphora vomitoria</i>	95	32 (33.7)
	<i>Chrysomya rufifacies</i>	80	25 (31.2)
	<i>Chrysomya megacephala</i>	90	27 (30.0)
Total (%)		371	113 (30.5)

Parasites identified—*Hookworm egg*, *Hymenolepsis nana egg*, *Taenia species egg*, *Trichuris trichiura egg*, *Ascaris egg*.

Table 2 shows the distribution of the kind of parasites (from houseflies) on the studied locations. Out of the 482 housefly species collected from the toilet and examined, 31.5% were infected (n = 152), 398 collected from the kitchen and examined, 35.9% were infected (n = 143), 535 collected from the refuse dump and examined, 25.9% were infected (n = 139) while a total of 371 housefly species collected from home baits and examined, 30.5% were infected (n = 113). The identified parasites were *Hookworm egg*, *Hymenolepsis nana egg*, *Taenia species egg*, *Trichuris trichiura*, and *Ascaris egg* of the total houseflies examined.

Table 3: Parasites of some PDI (cockroaches/houseflies) collected during the period from April 2019 to March 2020 in the study area

PDI	No. of Species	No. of Parasites	Individuals (N)	Prevalence
Cockroaches	<i>Periplaneta americana</i>	137	500	27.4%
	<i>Supella longipalpa</i>	12	30	40.0%
	<i>Blattella germanica</i>	72	182	39.6%
	Total	221	712	31.0%
Houseflies	<i>Musca domestica</i>	142	424	33.5%
	<i>Musca sorbens</i>	27	45	60.0%
	<i>Caliphora vomitoria</i>	123	334	36.8%
	<i>Chrysomya rufifacies</i>	100	327	30.6%
	<i>Chrysomya megacephala</i>	155	554	27.9%
	Total	547	1,684	32.5%

Table 3 compares the prevalence of parasites of some PDI (cockroaches and houseflies) in the collected during the study period. The result revealed that out of Seven Hundred and Twelve (**712**) cockroach species examined, 221 were infected with prevalence of 31% while out of One Thousand, Six hundred and eighty four(**1,684**) housefly species examined, 547 were infected with prevalence of 32.5%. Thus, houseflies had a slight higher prevalence of parasites than cockroaches in the study area.

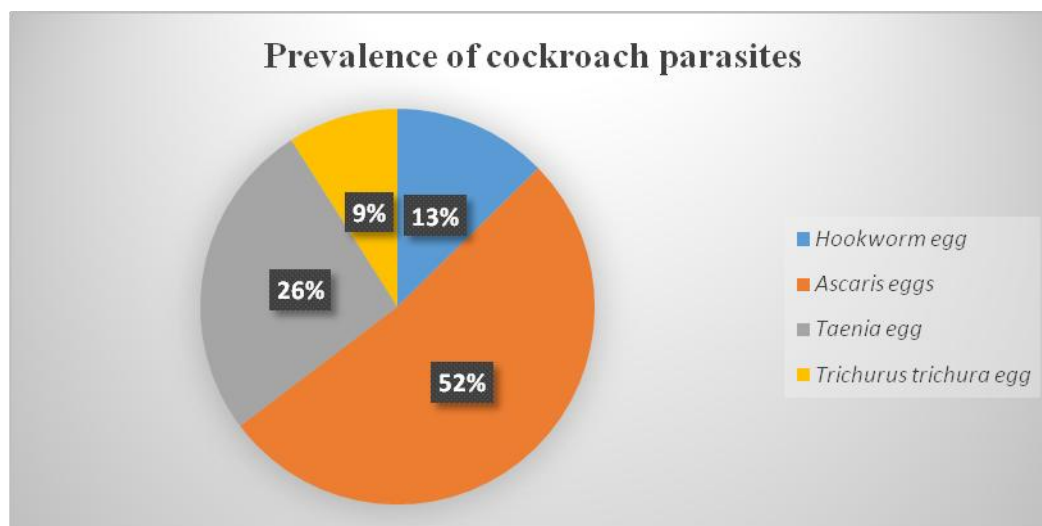


Figure 1: Chart showing the prevalence of cockroach parasites

From Figure 1, among the parasites that were recovered from captured cockroaches, *Ascaris* eggs had the highest percentage prevalence of 52%, followed by *Taenia* egg which had 26%, *Hookworm* egg had 13% while *Trichuris trichiura* egg had the least prevalence of 9%.

Table 4: Prevalence of all parasites (of cockroaches) collected from different sites and the number of parasites found in the study area

Collection Site	Prevalence of parasites from cockroach species				Total Number of parasite
	<i>Hookworm egg</i>	<i>Ascaris eggs</i>	<i>Taenia egg</i>	<i>Trichuris trichiura egg</i>	
Toilet	16	70	33	12	131(59.3%)
Kitchen	12	45	25	8	90(40.7%)
Total	28	115	58	20	221

$\chi^2_{cal} = 0.064; df = 3, \chi^2_{critical:\alpha=0.05} = 7.815$

From the chi-square analysis as shown in Table 4, the statement of the hypothesis is accepted; implying that there is no significance difference in the prevalence of parasites of cockroach species, recovered from the collection sites at 0.05 alpha level of significance. This is because the critical chi-square value of 7.815 is greater than the calculated chi-square value of 0.064 at 0.05 alpha level.

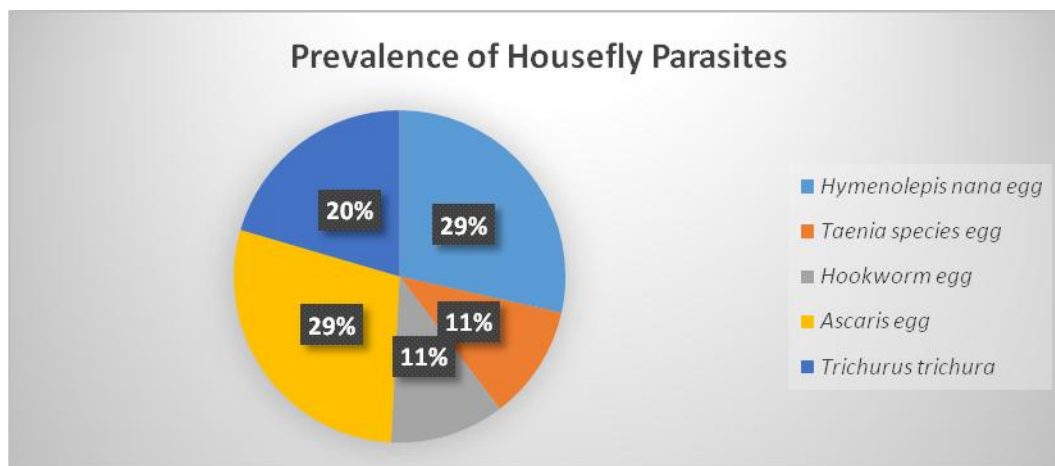


Figure 2: Chart showing the prevalence of housefly parasites

From Figure 2, among the parasites that were recovered from captured houseflies, *Hymenolepis nana* egg and *Ascaris* egg had the highest percentage prevalence of 29% each, followed by *Trichuris trichiura* 20%, while *Taenia species* egg and *Hookworm* egg had the least prevalence of 11% each.

Table 5: Prevalence of all parasites (of houseflies) collected from different sites and the number of parasites found in the study area

Prevalence of parasites from housefly species						
Collection Site	<i>Hymenolepis nana</i> egg	<i>Taenia species</i> egg	<i>Hookworm</i> egg	<i>Ascaris</i> egg	<i>Trichuris trichiura</i>	Total No of parasite
Toilet	42	16	11	38	45	152
Kitchen	30	13	18	56	26	143
Refuse D	52	17	18	35	17	139
Home baits	32	15	14	28	24	113
Total	156	61	61	157	112	547

$\chi^2_{cal} = 1.828; df = 5, \chi^2_{critical:\alpha=0.05} = 11.070$

From the chi-square analysis as shown in Table 5, the statement of the hypothesis is accepted; implying that there is no significance difference in the prevalence of parasites of housefly species, recovered from the collection sites at 0.05 alpha level of significance. This is because the critical chi-square value of 11.070 is greater than the calculated chi-square value of 1.828 at 0.05 alpha level.

Table 6: Prevalence of parasites recovered from Cockroach Spp based on location

Location	No. Collected	No. examined	No. of Recovered parasites	Prevalence (%)
Owerri Municipal	513	253	72	28.5
Owerri West	485	226	78	34.5
Owerri North	464	233	71	30.5
Total	1,462	712	221	31.0

Table 6 shows prevalence of parasites recovered from *Cockroach Spps* based on location. The result revealed that the prevalence of parasites of cockroach species in Owerri Municipal was 28.5%, that of Owerri West was 34.5% and that of Owerri North was 30.5%. Therefore, these parasites were more prevalent in Owerri West followed by Owerri North while Owerri Municipal has the least prevalent.

Table 7: Prevalence of parasites recovered from Housefly Spps based on location

Location	No. Collected	No. examined	No. of Recovered parasites	Prevalence (%)
Owerri Municipal	1,357	549	179	32.6
Owerri West	1,308	639	200	31.3
Owerri North	1,014	496	168	33.9
Total	3,679	1,684	547	32.5

Table 7 shows prevalence of parasites recovered from *Housefly Spps* based on location. The result revealed that the prevalence of parasites of Housefly species in Owerri Municipal was 32.6%, that of Owerri West was 31.3% and that of Owerri North was 33.9%. Therefore, these parasites were more prevalent in Owerri North followed by Owerri Municipal while Owerri West has the least prevalent.

Discussion

From the findings of this study, it was revealed that the cockroach species identified were *Periplaneta americana*, *Supella longipalpa*, and *Blatella germanica*. Housefly spp identified were *Musca domestica*, *Musca sorbens*, *Calliphora vomitoria*, *Chrysomya rufifacies* and *Chrysomya megacephala*. This confirmed the presence of medical importance peri-domestic insects of different species in the study area. Researchers have made speculations on the involvement of cockroaches as possible vectors of diseases in communities. But the role of cockroaches in the direct transmission of pathogens has seldom been established (Etim *et al.*, 2013). Findings from this study indicated that cockroaches are transmitters of parasites. The identified parasites were *Hookworm egg*, *Taenia egg*, *Trichuris trichuira egg*, and *Ascaris egg* of the total cockroaches examined. This is in agreement with previous studies done by Naghani *et al.* (2011); Bala and Sule (2012) in Sokoto; and Etim *et al.*, (2013) in Calabar, Nigeria. These species of cockroaches were found to be dominant in human habitations in the study area. This could be mainly due to their cosmopolitan distribution (association with human activity such as global commerce) and to their ability to reproduce and to survive more easily in tropical climate region.

However, *Ascaris eggs* had the highest percentage prevalence of cockroach parasites. *Ascaris egg* is a species of roundworm associated with Ascariasis. *Ascaris* is the most common roundworm infection. According to the WHO (2012), as many as one billion people were infected by *Ascaris eggs* worldwide, this figure was alarming and confirmed the large number seen in this study. *Ascariasis* is highly prevalent in places without modern sanitation like the sites where this study was carried out. According to the Center for Disease Control, hookworm infections occur in an estimated 576 to 740 million people worldwide (CDC, 2010). It mainly affects people in developing nations in the tropics and subtropics due to poor sanitation (CDC, 2010). The poor sanitary conditions of the farm centre and hostel which yielded the highest number of hookworm confirmed earlier reports (Getacherv *et al.*, 2007; CDC, 2010; WHO, 2012).

Statistically, no significance difference in the prevalence of parasites of cockroach species, recovered from the collection sites at s 0.05 alpha level of significance. It appeared that the prevalence of the parasites is not depended on the breeding sites of vectors. This simply allows the understanding that the parasites in these areas have the same probability to be

carried by cockroaches. Mix infestations were observed among cockroach species and among different capture points. This result may probably explain the non-specificity of cockroaches in their role of parasites vectors. Thus, the potential of cockroaches to transmit diseases should not be ignored or simply rejected but should be investigated further.

The study showed that houseflies carry some parasites on their body. Three parasites were found associated with housefly were *Hookworm egg*, *Hymenolepsis nana egg*, *Taenia species egg*, *Trichuris trichiura*, and *Ascaris egg*, which was in agreement with earlier reports of Ajero and Nwoke (2007) and Wanna *et al.* (2008), where they reported the presence of these parasites in houseflies. The implication of status of houseflies in the transmission of parasites is of serious public health concern to the study area since houseflies are known to live in close association with human beings. Houseflies are common around the household, in garbage and in human and animal excreta; they are vectors of pathogens (Getacherv *et al.*, 2007).

A simple chi square test was used to test if there was a significant difference in the prevalence of the parasites species on the houseflies, based on locations and it was found that there was no significant difference in the prevalence of the parasite species based on location. It appeared that the prevalence of the parasites is not depended on the breeding sites of vectors. Among the parasites that were recovered from captured flies, *Ascaris egg* had the highest percentage prevalence of housefly parasites. Prevention and control of the morbidity and possible mortality associated with these housefly and parasitic infections and reduction can be based on chemotherapy, environmental sanitation, health education (WHO, 1998). This goes to show that houseflies have a negative psychological impact as they are considered as nuisance and a sign of unhygienic conditions. Houseflies spread diseases because they feed freely on human food and filthy matter alike. The flies pick up disease causing organisms while crawling, feeding and thereby contaminates food and drinks while feeding. These contaminated food materials cause bacteria disease like typhoid, cholera, dysentery and virus diseases like viral hepatitis.

Conclusion and Recommendations

Peri-domestic insects such as flies and cockroaches can significantly contribute to the spread of food-borne parasites diseases in both developing and developed countries. Findings of this study indicate a relatively high infectivity rate in the disease vectors. Since this study detected this high rate of parasites in the houseflies and cockroaches, their role in disease transmission cannot be over emphasized. This highlights the prevalence of such disease like malaria, cholera, yellow fever and diarrhoea in the study area. Hence, there is need to raise awareness on the need to improve hygiene and sanitation in the communities so as to prevent a possible outbreak. Therefore, trash should be properly disposed into sealed containers; dumpers should be emptied regularly and kept as far away from buildings. Manure and other decaying animal materials should be promptly removed.

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