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Full Length Research Article

INSECT VECTORS OF PATHOGENS IN SELECTED UNDISPOSED REFUSE DUMPS IN KADUNA TOWN, NORTHERN NIGERIA.

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ABSTRACT

Eleven species of insects were collected in three orders and seven families, namely Blattidae, Serabidae, Muscidae, Fanniidae, Culicidae, Calliphoridae and Psychodidae. Of the three orders, Diptera was represented by five families (Muscidae, Fanniidae, Culicidae and Psychodidae) followed by the order Dictyoptera and Coleoptera with one family each (Blattidae and Serabidae respectively). The Family Muscidae had three genera represented by the species *Musca domestica, Ophyra leucostoma,* and *Stomoxys calcitrans* while the Families Caliphoridae and Serabidae were represented by two species each. Muscoid flies had the highest abundance of 70.3% (457/650), followed by mosquitos with 6.8% (94/650) and Drain flies 4.9% (32/650). The most abundant species was the house fly *Musca domestica* within the muscoid family with 47.7% while *Onthophagus obliquus* from the family Serabaediae had the least abundance with 6 individuals. The occurrence and abundance of these vectors suggests that vector-borne disease transmission is prevalent in Kaduna metropolis. The health implications of the presence of these insects and their role in disease transmission are highlighted. Proper disposal of refuse dumps is recommended to avoid public health problems associated with filth transmitted insects.

Keywords: Insects, refuse dumps, diseases, Kaduna, Nigeria.

INTRODUCTION

Many countries in Africa do not have efficient waste collection and disposal services, which often results in both environmental and health problems for the people. In Nigeria, the sources of solid waste are commercial, industrial, household, agricultural and educational establishments (Babayemi & Dauda, 2009). Proper waste management is not only regarded as a political tool and an indicator of good government policy, it is also an important element for good health (Oyedele, 2009). The consequences resulting from improperly managed wastes include its serving as reservoir of pathogens, habitat for pests such as rats, flies and mosquitoes, reduction of usable land area of the society, obstruction of motorable roads and general nuisance and societal problems in residential areas (Oyedele, 2009). Other negative aspects associated with unmanaged solid waste include negative impact on the value of properties surrounding it, acid rain and contamination of aquifers or water table.

The generation of urban solid wastes in Nigeria is on the increase owing largely to accelerated rural-urban migration, industrilisation, poverty, decreasing standard of living, poor governance, population growth and low level of environmental awareness (Adewumi, *et al.,* 2005; Anonymous, 2012a). The quantity of the wastes generated is enormous, with an average household rate of 0.44-0.66kg per capita (Solid Waste Report, 2004; Ogwueleka, 2009). In Oyo State, Afon & Okewole (2007) estimated that 50.90 ton of waste was generated daily while Ogwuleke (2009) estimated higher quantities of 8518 ton/day for Lagos, 5222 ton/day for Kano, 4513 ton/day for Ibadan, 3418 ton/day for Kaduna, 3927 ton/day for Port Harcourt, 808 ton/day for Makurdi, 2804 ton/day for Onitsha, 400 ton/day for Nsukka and 492 ton/day for Abuja. When studying the impacts of poor management of waste in Nigeria enumerated by many workers, the emphasis has been mainly on microbial fauna, risk of heavy metal transfer to the ground and above vegetation (Onwughara *et al.,* (2010), environmental problems related to clogging of drainage pipes (Folorunsho & Awosika, 2001), contamination of gaseous environment by toxic substances and contact with smoke from burning of solid wastes in dumpsites (Babayemi & Dauda, 2009, Oyelola *et al.,* 2009). Only isolated reports have been made on entomological aspects despite the significant role that the insect vectors found in such surroundings play in public health. As a result, our knowledge of the biology, ecology and the relationship of insect vectors to various diseases are scanty. With the realization that it is practically impossible to maintain a strict sanitary condition in Kaduna town with the current rapid growth in population of the city, inventory of filth flies will be taken from selected refuse dumps in Kaduna town and discussed in relation to the diseases they are known to transmit. Understanding the epidemiology of diseases depends on the knowledge of the biology and ecology of the insect vectors implicated in the transmission of such diseases.

MATERIALS AND METHODS

Study Area: The investigation was carried out between July and November, 2011 in Kaduna town, one of the largest cities in northern Nigeria located at latitude of 10.6 (10° 35' 60 N) and a longitude of 7.45 (7° 27' 0 E). Spatially, Kaduna covers an area of about 25 km long and 8-10 km wide from Katabu in the north to NNPC in the south (Max Lock, 2008) and has an estimated population of 1,422,000, making it the sixth largest city in the country with annual growth rate of 8.32% (UNDP, 2007). The design was to survey 15 sites from low, medium and high socio economic income localities.

Collection of insects and their preservation: Four types of sampling devices were used to collect insects from the different survey sites, namely sweep nets, sticky traps, water traps (Onyido *et al.,* 2009) and pitfall trap. All the insects caught were placed in 70% alcohol and taken to the laboratory for identification using dichotomous keys.

RESULTS

Table 1 shows the characteristics of the refuse dump sites studied and their categorization according to socio-economic income status. Table 2 shows the types of insects encountered. There was a clear difference in the type of insects caught between the 3 different income class groupings:

Insects from high income class: Only 3 species of insects were encountered in the few refuse collection points visited and in low numbers, representing 10.3% of the total catch. These are *Mucsa domestica*, *Ophyra leucostoma* and *Periplanata americana* (Table 3).

Medium income class: Eight species of filth flies were encountered in refuse dumps within the medium income areas, accounting for 33.1% of the total insects caught.

Low income class: All the 11 species of filth flies encountered in this study occurred here and constitute 56.6% of the total catch.

TABLE 1. REFUSE DUMPS SURVEYED AND THEIR CHARACTERISTICS

Income status	Survey sites	Coordinates	General description
Low	Nagwamatse Road Dump Kaduna Cenral Market U/Kudu T/Wada Rigasa T/Nupawa Sabon Tasha Makera Kawo	N10.531621, E7.459082 N10.52313, E7.428768 N10.52544, E7.463298 N10.520619, E 7.411262 N10.539437, E 7.403001 N10.519754, E 7.421046 N10.450295, E 7.458512 N10.479456, E 7.413236 N10.580508, E 7.449349	-Very dense residential settlements. -Numerous refuse dumps -Markets -Poor drainage system. -Open defaecation in refuse dumps -Free roaming domestic goats, sheep, chickens, dogs.
Medium	Kabala Costain Barnawa	N10.501885,7.440981 N10.473,7.433041	-Human residential settlement. -Few shops. -Some hotels. -Private schools. -Private clinics. -Some free roaming animals. -Fuel stations. -Markets
High	U/Dosa Afaka U/Rimi Dump Badarawa	N10.566386, E 7.450209 N10.588776, E 7.408258 N10.527054, E 7.462558 N10.558708, E 7.447141	-Modern residential settlement. -Hotels -Private schools -Private clinics -Kiosks

TABLE 2. THE DIFFERENT INSECT VECTORS COLLECTED AND THEIR ABUNDANCE

Order	Family	Genus	Species	No collected	% Abundance
Dictyoptera	Blattidae	Periplaneta	*P. americanus* (cochroach)	29	4.5
Coleoptera	Serabaediae	Canthon	*Canthon pelularis* (Dung beetles)	08	1.2
		Onthophagus	*Onthophagus obliquus*		0.9
Diptera	Muscidae	Musca	*Musca domestica* (House fly)	310	47.7
Diptera	Muscidae	Ophyra	*Ophyra leucostoma* (Black gabbage fly)	98	15.1
Diptera	Muscidae	Stomoxys	*Stomoxys calcitrans* (Stable fly)	49	7.5
Diptera	Fanniidae	Fannia	*Fannia scalaris* (Latrine fly)	29	4.5
Diptera	Culicidae	Aedes	*Aedes* spp	44	6.8
Diptera	Calliphoridae	Chrysomya	*Chrysomya rufifacies*	16	2.5
		Chrysomya	*Chrysomya megacephala*	29	4.5
Diptera	Psychodidae	Clogmia	*Clogmia albipunctatus* (Drain fly)	32	4.9
				650	

Altogether insects belonging to 3 orders were caught, namely Coleoptera, Dictyoptera and Diptera. The dipterans were the most abundant (N=575, 88.5%) and had more diverse group represented by 4 families and 7 species. The Coleopteran family Serabaediae was represented by 2 species (N=14, 2.1%). All the remaining families had 1 species each (Table 2).

Within the Dipteran family, Muscidae represented by the house fly *Musca domestica* (Linnaeus, 1758) was the most abundant (N=310) followed by the Black gabbage fly *Ophyra leucostoma* (N=98) and stable fly *Stomoxys calcitrans* (N=49). The Order Dictyopteran (family Blattidae) represented by the cockroach *P. americanus* had an abundance of 29 (4.5%)

DISCUSSION

The investigation reaffirmed that Kaduna metropolis is littered with refuse dumps, an indication that indiscriminate dumping of wastes is still prevalent in the city. All the 11 species of insects encountered in this study are all closely associated with humans and human-generated waste, a situation that Wells (1991) consider to increase the potential for mechanical transmission of filth associated pathogens.

The negative effect of uncontrolled dumping of wastes in developing countries has been summarized (Siboe *et al.,* 1996, Guevart *et al.,* 2006 and Onyido *et al.,* 2009). Worth mentioning are the reports of Lakshmikantha, (2006) from Bangalore who highlighted the danger of waste disposal sites in the spread of diseases to people living in the immediate vicinity; Pukkala and Ponka, (2001) who observed that waste increase the incidence of cancer and asthma in houses built in sites that have been previously used as refuse dumps; Pach *et al*., (1996) who highlighted a high frequencies of toxic methemoglobinemias in people living in the vicinity of refuse dumps. A common observation in all the reports was that refuse dump sites constitute a habitat for vectors and nuisance organisms that are capable of acting as transmitters of diseases.

Out of the 7 families of insects encountered in this study, Muscidae (house fly and gabbage fly) and Blattidae (Cockroaches) were found in all the 15 study sites irrespective of income status of the residents.

The cockroaches (Family Balttidae) occur in all the sites visited. They are known to feed on human faeces and transmit such

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TABLE 3. TABLE 2. THE DIFFERENT INSECT VECTORS COLLECTED ACCORDING TO SOCIAL INCOME STATUS OF AREA OF COLLECTION

Income status	Insect Order	Family	Genus	Species	No collected	% Abundance
High	Dictyoptera	Blattidae	Periplaneta	*P. americanus* (cochroach)	4	10.3
	Diptera	Muscidae	Musca	*Musca domestica* (House fly)	46	
	Diptera	Muscidae	Ophyra	*Ophyra leucostoma* (Black gabbage fly)	17	
					67	
Medium	Dictyoptera	Blattidae	Periplaneta	*P. americanus* (cochroach)	10	33.1
	Diptera	Muscidae	Musca	*Musca domestica* (House fly)	120	
	Diptera	Muscidae	Ophyra	*Ophyra leucostoma* (Black gabbage fly)	20	
	Diptera	Muscidae	Stomoxys	*Stomoxys calcitrans* (Stable fly)	10	
	Diptera	Fanniidae	Fannia	*Fannia scalaris* (Latrine fly)	10	
	Diptera	Culicidae	Aedes	*Aedes* spp	21	
	Diptera	Psychodidae	Chrysomya	*Chrysomya megacephala*	9	
			Clogmia	*Clogmia albipunctatus* (Drain fly)	15	
					215	
Low	Dictyoptera	Blattidae	Periplaneta	*P. americanus* (cochroach)	15	55.6
	Coleoptera	Serabaediae	Canthon	*Canthon pelularis* (Dung beetles)	8	
			Onthophagus	*Onthophagus obliquus*	6	
	Diptera	Muscidae	Musca	*Musca domestica* (House fly)	144	
	Diptera	Muscidae	Ophyra	*Ophyra leucostoma* (Black gabbage fly)	61	
	Diptera	Muscidae	Stomoxys	*Stomoxys calcitrans* (Stable fly)	39	
	Diptera	Fanniidae	Fannia	*Fannia scalaris* (Latrine fly)	19	
	Diptera	Culicidae	Aedes	*Aedes* spp	23	
	Diptera	Calliphoridae	Chrysomya	*Chrysomya rufifacies*	16	
			Chrysomya	*Chrysomya megacephala*	20	
	Diptera	Psychodidae	Clogmia	*Clogmia albipunctatus* (Drain fly)	17	
					368	

diseases as amoebiasis caused by *Entamoeba histolytica* (Rao *et al.,* 1971) as well as Girdiasis (Kasprzak & Majewska, 1981) through dissemination of cysts. Cockroaches are also capable of transmitting zoonotic *Toxoplasma gondii* that can induce abortion in pregnant women. A study by Cotton *et al.,* (2000) showed that exposure to cockroach antigens may play an important role in asthma-related health problems.

The two species of beetles encountered in this survey, namely *Canthon pelularis* and *Onthophagus obliquus* (Family Coleptera) occur only in the low income areas. They are known to transmit oocysts of *T. gondi* (Saitoh & Hagaki, 1990) and that of *Isospora* as well as the anthropozoonotic protozoan *Cryptosporidium parvum* which they acquire from animal manure (Mathison & Ditrich, 1999). Besides transmission of diseases, coleopterans are known improve the nutrient cycle of the soil through burrowing and consumption of dung (Brown, *et al.,* 2010).

The house fly *Musca domestica* (Family Muscidae) are found in all the sites surveyed. They are usually associated with decomposing substrate of solid urban wastes (Morales & Wolff, 2010) which probably account for their dominance in this study. This fly is known to be a vector of both zoonotic and non-zoonotic protozoan parasites such as *Sarcocystis* spp (Markus, 1980), *Taxoplasma gondii* (Wallace, 1971), *Isospora* spp (Khan & Huq, (1978), *Giardia* spp (Doiz *et al.,* 2000; Graczyk *et al.,* 2003; Kasprzak & Majewska, 1981; Szostakakowska *et al.,* 2004), *Entamoeba coli* (Khan & Huq, 1978), *E. histolytica/dispar* (Khan & Huq, 1978), *Endolimax nana* (Khan and Huq, 1978), *Pentatrichomonas hominis* (Khan and Huq, 1978), *Hammondis* spp (Khan & Huq, 1978) and *Cryptosporidium parvuum* (Clavel *et al.,* 2002; Graczyk *et al.,* 1999; Graczyk *et al.,* 2000; Graczyk *et al.,* 2003; Szostakakowska *et al.,* 2004). *Musca domestica* are also implicated in the transmission of bacteria such as *Salmonella, Shigella, Campylobacter, Escherichia, Enterococcus, Chlamydia* and many other species that cause illness (Sanchez-Arroyo & Capinera, 2008). The biology and ecology of this fly may be responsible for its efficiency in the transmission of human parasites such as its adaptation to feeding on garbage and its widespread distribution and abundance almost anywhere people live, the long life span of the adult female of up to 25 days, high fecundity of the female (to lay about 500 eggs in 4 days) and the ability to travel for several kilometers (Ebeling, 1978; Hedges, **(**1980).

The Black garbage dump flies *Ophyra leucostoma* were encountered in all the sites studied. They do not bite man or animals, but they do feed on a wide range of liquid substances and breed in garbage, chicken droppings, livestock manure and other decaying organic matter. They are known to transmit diseases mechanically by contaminating food and causing such infections as polio, typhoid fever, dysentery, and food poisoning.

Stomoxys calcitrans was not collected in the high income areas perhaps because of the absence of suitable breeding environment and absence of scavenging animals to serve as source of bloodmeals in the refuse dumps. The flies have been reported to harbor a variety of pathogens that cause diseases in man and animals, such as viruses, bacteria, protozoa, fungi, larvae and eggs of helminths (Philpoot & Ezeh, 1978; Oliveira *et al.,* 2002). A group of German scientists has even put together a theory associating *S. calcitrans* to the beginning of the HIV pandemic that is threatening the world today (Kerr, 2002). The female fly usually laid eggs in decaying vegetable matter mixed with manure or composted bedding. In this study, decaying organic matter with manure constitutes a greater component of the refuse dumps investigated and probably provides a good breeding ground for the flies. Both sexes feed on the blood of any available host during daytime. The presence of different species of scavenging livestock (goats, sheep, dogs and few pigs) and even man in most of the refuse dump sites visited may be providing bloodmeals for the flies.

The latrine fly *Fannia scalaris* was not collected in the high-income areas but found in both medium and low-income areas. These flies prefer to breed in excrement, decaying animal and plant matter and deep semi-fluid latrine material. None of these conditions occur in the high-income areas visited. The period it takes to hatch from egg to adult is 15 to 30 days: both the nature of the refuse dumps and frequency of evacuation of wastes will not permit the flies to breed effectively and complete its cycle. The flies are reported to cause accidental enteric, urinary, auricular, and urogenital myiasis (Eldridge, & Edman, 2003).

Aedes mosquitos, the vectors of yellow fever were the only species encountered in this study and even then, they were not collected from the high-income areas. A possible reason for their absence could be the absence of water holding containers for the females to lay eggs. This finding agrees with that of Mbanugo & Okpalaononuju (2003) whose survey did not also reveal the presence of malaria transmitting *Anopheles gambie* and *An. Funestus.*

Species of *Chrysomya* were not collected in the high-income areas but only from the medium and low income areas surveyed. These species prefer to perform oviposition on dead organisms not available in high-income dumps. They are known to causes myiasis in humans and animals. There are ongoing studies to determine their roles in the transmission of diarrhea-causing *E-coli*.

The drain fly *Clogmia albipunctatus* (family Psychididae) was not collected from the high-income areas. The larvae is known to utilize the slime on the side of bathroom and kitchen drains, sewage disposal beds, rain barrels, and garbage cans as their preferred living and breeding grounds. Such places usually have low oxygen content. Although these flies do not bite, they nevertheless harbour diseases that may possibly be transmitted to humans. Their presence in large numbers has been reported to pose a hygienic problem, especially in hospitals (Anonymous, 2006, Verheggen *et al*., 2008) and cause or exacerbate bronchial asthma (Drain fly control, 2012).

Generally, the result from this study shows that only few species of flies were collected from refuse dumps in high-income areas. Anonymous (2012b) explanation shed some light on why such could happen: Firstly, most residents of high-income areas engage the services of private refuse collectors to empty their trash containers at home. The few residents that evacuate their rubbish by themselves collect them carefully in refuse bags and drop them on designated concrete spots awaiting collection. Secondly, the residents of high-income areas are mostly senior government officials, politicians, business men and diplomats who have influence over those in government to get them do their wish.

Our results further shows that more fly species were collected from the medium and low-income areas and in greater abundance. Again, Anonymous (2012b) explained that it is so because the residents in low-income areas are mostly poor citizens who do not exert any form of influence. They are people who find it difficult to make ends meet as most of them have large families and in most cases have no formal education. Their economic activities are mainly trading and petty marketing with majority working as junior civil servants (Watchmen, Drivers, and labourers), earning very low salaries and therefore unable to engage the services of private refuse collectors. Low-income areas are usually densely populated and not served with adequate sanitary facilities. It is these inadequacies that lead to indiscriminate disposal of refuse into drains, gutters, and waterways, and to open defecation.

A summary from the World Bank report (2000) recognised that Nigeria lacks a comprehensive strategy on sanitation. This lack of comprehensive strategy was perhaps responsible for the frequent transfer of responsibility of waste disposal between different ministries (Ministry of Water Resources, Ministry of Health, Ministry of Works and Housing and the Ministry of Environment), a situation that compounded the precarious situation. The report further noted that at present, only individual solutions are used at the household level to address sanitation problems, such as the use of pit latrines, septic tanks and storage. The reported investment of N240 million in 2008 and outsourcing of refuse waste management to more than 30 contractors by the State government (Max Lock, 2008), did not appear to have made any impact as Abdullahi *et al.,* (2010) reported the presence of more than 340 refuse dumps within the metropolis alone 2 years later. The number of refuse dump sites within the city is growing daily with the security challenges posed by 'Boko Haram' because the refuse collectors are now scared of explosives hidden in refuse bags (The Punch, 2012). Already, several refuse dump sites have sprung up across major cities in the State, including areas previously cleared (Weekly Trust, 2011; The Tide, 2012).

The following recommendations are suggested:

i. The State government should mount Health Education Campaign at the local government areas on self method of refuse collection/disposal and other positive health habits such as waste reduction, re-use, and waste separation at the grassroots level.
ii. The government should re-introduce and empower the sanitary house to house inspection by health officers and sanitary inspectors. The present monthly sanitation exercise is not adequate. Abrokwah (1998) observed that ignorance, negligence and absence of law to punish sanitary offenders are the major causes of waste management problems in Kumasi, Ghana.

It is concluded that the result from the present investigation is consistent with previous reports in which similar insects capable of transmitting pathogens were identified in refuse dumps (Vlcek, 1991). Since populations of synanthropic insects can grow rapidly within a short time, control efforts directed against them should be continuous and sustained in order to keep to the barest level the influence of these insects in the spread of diseases.

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