Parasitology and urban livestock farming in Nigeria: prevalence of ova in faecal and soil samples and animal ectoparasites in Makurdi

E A Omudu[a*] and E U Amuta[b]

ABSTRACT

Domestic environmental pollution resulting from urban livestock farming was investigated in Makurdi using parasitological techniques. The test tube flotation technique was used for the parasitological analysis of animal faecal matter and soil samples collected from residential premises. Ectoparasitic fauna of dogs, goats, sheep and cattle cohabiting with humans within the same residential compound were also collected and identified. The hand-picking and body brushing methods were employed to search for ticks, fleas, lice and mites. Of the 150 soil samples examined, 55 (36.7 %) were positive for 1 or more eggs of helminth parasites. There was no significant difference in the distribution of eggs in the soil samples from the 3 areas sampled ($\chi^2 = 0.046$, df = 2, $P > 0.05$). *Ascaris* species were the dominant parasite eggs found. Of the 180 faecal samples examined, 107 (59.4 %) were positive for 1 or more eggs of helminth parasites. Chi-square analysis showed no significant difference in the level of infection of different animal faeces sampled ($\chi^2 = 5.74$, df = 4, $P > 0.05$). *Ascaris* species were again the dominating helminth parasite eggs found. There was also no significant difference in the prevalence of helminth eggs in the animal faecal samples from the 3 areas sampled ($\chi^2 = 5.99$, df = 4, $P > 0.05$). A total of 1908 ectoparasites was recovered (ticks: 32.80 %; lice: 22.43 %; fleas: 22.06 % and mite: 22.69 %). There was no significant difference in infestation animals between sexes ($\chi^2 = 0.10$, df = 4, $P > 0.05$). The predominant genus encountered for ticks were *Amblyomma,* while *Linognathus* (43.90 %), *Ctenocephalides* (97.38 %) and *Sarcoptes* (58.89 %) were most predominant for lice, fleas and mites respectively. The public health implications of the findings, especially as these relate to the increasing incidence and prevalence of zoonotic infections, are discussed.

Key words: contamination, ectoparasites, helminth eggs, urban domestic environment.

Omudu E A, Amuta E U **Parasitology and urban livestock farming in Nigeria: prevalence of ova in faecal and soil samples and animal ectoparasites in Makurdi**. *Journal of the South African Veterinary Association* (2007) 78(1): 40–45 (En.). Department of Biological Sciences, Benue State University, Makurdi, Nigeria.

INTRODUCTION

In order to meet the ever-increasing demand for animal protein in Nigeria and at the same time generate additional income, most families in urban areas now engage in livestock farming. The economic benefits of urban livestock farming notwithstanding, it is important to note that the practice of breeding cows, sheep, goats and pigs in and around human dwellings has increased human–animal contact, with serious zoonotic implications. Nwoke observed with distress that this association has now made it possible for parasites and pathogens naturally harboured by these livestock (and hitherto restricted to animals) to commonly infect people[21,22]. Increase in the prevalence of faeco-oral zoonotic diseases in South America and Africa have for long been a subject of investigation[24,28]. Considering environmental deterioration accompanying increased urban livestock farming and burgeoning urban population in Nigeria, increased incidence of zoonotic helminthiasis is expected.

The incidence and prevalence of zoonotic infections is on the increase especially in developing countries[17]. Among helminth zoonoses affecting humans in Africa are those with domestic and/or peridomestic cycles and reservoirs in pigs, dogs, goats and cattle. Serious contamination of the urban environment with animal faeces have been reported in Chile, Abidjan, Malaysia and Nigeria[2,17,28,29]. Though the entire urban population is at risk of contracting zoonotic infections either through direct contact with animals or indirectly through ingesting food, water, vegetables or soil contaminated with animal faeces, animal breeders, occupants of the residences where animals are raised and abattoir personnel are most at risk[7,21,24,33].

Zoonotic helminth pathogens that may be contracted from dogs, goats, sheep, pigs and cattle in Nigeria include *Toxocara* species, *Echinococcus* species and *Taenia* species[9]. In addition, these animals also naturally harbour ectoparasites such as ticks, fleas, mites and lice. The clinical features resulting from these infestations and the pathological consequences of the diseases transmitted by these parasites in domestic animals have been widely documented in Nigeria and elsewhere[4,15,26,31,34]. The economic losses resulting from ectoparasitism of livestock runs into billions of US dollars worldwide[18,5].

Ectoparasites such as ticks, lice, fleas and mites may parasitise humans and have been incriminated in the mechanical transmission of pathogens while sucking human blood and in causing direct damage to the skin by vesication, irritation, invasion of tissues and stimulation of allergic responses[1,32]. Incidence of the tapeworm (*Dipylidium caninum*) in children who had accidentally swallowed dog fleas (*Ctenocephalides canis)*[20] and the infestation of 41.5 % of school children in Badagry near Lagos with *Tunga penetrans,* a flea that can cause serious inflammation of the feet, leading to ulceration and fibrosis, are all public health consequences of the close association with livestock[1]. Human infestations resulting from mites (*Sarcoptes scabiei)* and ticks from dogs, cats, goats and cattle occasionally occur as a result of frequent close contact with these animals. Human babesiosis, tick paralysis and intensive pruritic dermatitis sometimes progressing to papular eruption have been reported amongst livestock handlers in parts of Africa and Australia[4,22,28].

Having observed the large concentration of roaming livestock scavenging for food and littering streets of Makurdi with their faeces, this study was designed to investigate the environmental and public health implications of urban livestock rearing especially as it relates to zoonotic helminthiasis. The objectives were to collect and identify ectoparasitic fauna of dogs, goats, sheep, pigs and cattle being

[a]Department of Biological Sciences, Benue State University, Makurdi, Nigeria.

[b]Department of Biological Sciences, University of Agriculture, Makurdi, Nigeria.

*Author for correspondence:
E-mail: eddieomudu@yahoo.com

Received: September 2006. Accepted: February 2007.

raised by urban farmers and to parasitologically analyse faecal and soil samples collected from within residential premises for ova of animal helminths.

MATERIALS AND METHODS

Study area

Makurdi, the capital of Benue State, Nigeria, is fast becoming a metropolitan centre with attendant health, social, housing and environmental problems. It lies between latitude 07°15′–07°45′N and longitude 08°15–08°40′E. The town lies in the guinea savanna vegetative belt and on the bank of the 2nd-largest river in Nigeria, River Benue. The river divides the town into north and south banks and the town covers an area of 16 km^2 (Fig. 1). The river constitutes the main source of water supply for the inhabitants of the town. The sudden influx of commercial and developmental activities that resulted from rapid urbanisation has side-lined many indigenous people and urban migrants, consequently, the populations of poorer residential areas such as Wadata, Wurukum and North Bank are beginning to swell. These 3 high-density residential areas were selected for sample collection.

Wadata

Wadata constitutes a reasonable population of the town, located along the bank of the river towards the western end of the town. The area is densely populated with inadequate water supply, sanitary and waste management. Drainages are open and blocked by piles of rubbish. In addition to residential houses, there is a market, a prison yard, an abattoir, a rice mill, and thriving burnt-brick production along the bank of the river (Fig. 1). The inhabitants of this area are largely Hausas and Jukuns who are active fishermen. The majority of the Hausa residents combine livestock keeping and other forms of petty trade. It is therefore very common for many households to keep goats, sheep and cattle on residential premises and to practice free-range systems of husbandry.

Wurukum

This is another residential settlement within the metropolis; the actual study was conducted in a portion called Angwan-Jukun. It is known for its unhygienic conditions, overcrowding, poor state of housing and lack of clean water. Heaps of refuse block access to the road while municipal waste disposal facilities are non-existent. The Jukun ethnic group used to be the predominant residents but this is rapidly changing owing to the influx of other ethnic groups as a result of lower rents. Landmark facilities include a rice-mill, an abattoir and vegetable farms along the river bank. The predominant animals kept by the residents inthis area are goats and pigs which are reared under a free-range system. Their faeces are usually used as manure for the vegetable farms.

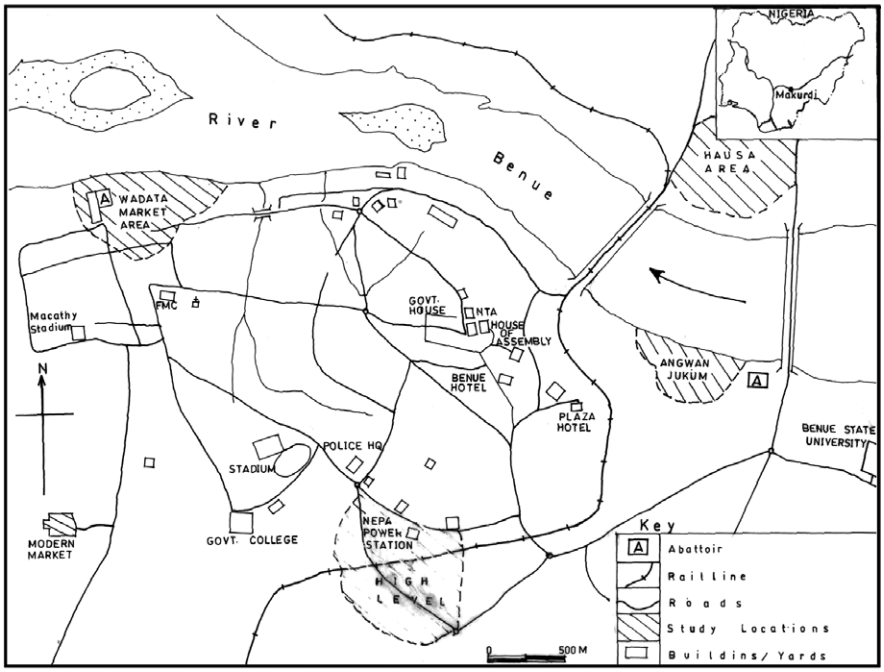

Fig. 1: **Makurdi town showing study locations** (hatched).

North Bank

The north bank area is located across the river towards the north; the actual study site is the area called Angwan-Sariki (Fig. 1). The area is densely populated and there are prominent gully erosion sites and these gullies serve as refuse dumps. The residents in this area are also engaged in free-range rearing of cattle, sheep and goats, trading and other small-scale businesses. The majority of the residents lack clean water and depend on the river for water. Sanitary conditions are poor and most drainages are blocked with piles of rubbish.

Parasitological examination of soil for eggs of helminths

The test tube flotation method was used[5,19]. Five grams of the soil sample were mixed thoroughly with distilled water. The suspension was strained through a net mesh to remove coarse particles. The filtrate was centrifuged for 3 minutes and the supernatant decanted. The resultant sediment was further broken-up by shaking and tapping the tube. The sediment was mixed with zinc sulphate solution (specific gravity of 1.2). This was added up to the brim of the test tube until a positive meniscus formed and allowed to stand for a 5 minutes with a cover slip to collect any floating eggs. The cover slip was then removed and examined microscopically.

Parasitological examination of faecal samples

Faecal samples were collected from the ground using stainless steel teaspoons to put the material into specimen bottles containing normal saline solution (0.85 % NaCl). Each sample solution was washed and filtered through fine grades of mesh sieves sized 90, 60 and 30 into sieve tubes to prevent loss of adult parasites and ova. The filtered solution was poured into centrifuge tubes and centrifuged for 5 minutes at 1500 rpm using an electric centrifuge. The supernatant was then poured off leaving behind the sediments, after which 1 or 2 drops of the sediment were placed on a glass slide and viewed under a light microscope for identification of ova, larvae and adults helminth parasites. Parasites were identified using the keys provided[26]. The direct wet mount technique was also used for fresh specimens, and isolation of visible worms[32,27].

Sampling methods for ectoparasites

Ectoparasites were collected from dogs, goats, sheep, pigs and cattle with the assistance of members of the household. Ticks were collected using the hand-picking and hair-brushing methods[16]. The entire animal's body was inspected and brushed with special attention paid to the ears, the area around the eyes, the axillae and the groin as recommended[26]. Fleas, mites and lice were collected by combing and brushing the animal's entire body

Table 1: **Prevalence and types of parasite ova and larvae found in soil samples in Makurdi.**

Area	No. of compound sampled	No. with parasite ova (%)	*Ascaris suum*	*Toxocara vitulorum*	*Toxocara canis*	*Ancylostoma* species	*Trichuris* species	*Strongyloides* species	Larvae of free-living nematodes
Wurukum	50	22(44)	12	7	14	9	4	5	2
Wadata	50	18(36)	9	7	11	3	–	7	3
North Bank	50	15(30)	10	4	2	6	1	4	3
Total	150	55 (36.7)	31	18	27	18	5	16	8

Table 2: **Prevalence of identified helminth eggs and larvae in animal faeces in Makurdi.**

Animal	No. examined	No. positive (%)	No. with *Toxocara vitulorum* (%)	No. with T*oxocara canis* (%)	No. with *Strongyloides* species (%)	No. with *Trichuris* species (%)
Cattle	41	27 (65.9)	10 (24.4)	–	10 (24.4)	7 (17.1)
Sheep	45	23 (51.1)	10 (22.2)	–	8 (17.8)	5 (11.1)
Goats	53	34 (64.2)	14 (26.4)	–	10 (18.9)	10 (18.9)
Dogs	41	23 (56.1)	–	23 (56.1)	–	1 (2.4)
Total	180	107 (59.4)	34 (18.9)	23 (12.8)	28 (15.6)	23 (12.8)

surface onto a white cloth dipped in formalin to prevent fleas from jumping and mites and lice from creeping away[32].

Preservation and identification

Ectoparasites collected were transferred to the laboratory in clearly labeled specimen bottles containing 70 % alcohol. The sex and type of animal from which the parasites were collected was noted and recorded on each specimen bottle. Ticks, lice, mites and fleas were identified using keys and illustrations[26,32,28].

RESULTS

Of the 150 soil samples collected from residential premises where livestock farming is practiced, 55(36.7 %) were positive for 1 or more parasite ova. *Ascaris* species were most frequently encountered, and comprised *A. suum* (22.8 %), *T. vitulorum* (13.2 %), *Toxocara canis* (19.8 %) and *T. cati* (9.5 %) (Table 1). Soil samples collected from various homes revealed high levels of contamination with animal faeces. There was, however, no significant difference in the prevalence of eggs in the soil and level of contamination in the 3 areas sampled ($\chi^2 = 0.046$, df = 2, $P > 0.05$). More premises in Wurukum, however, recorded a higher percentage (44 %) of homes with ova of parasites than Wadata and North Bank. Compounds visited had no special provision for the disposal of animal faeces and animal faeces were treated as household refuse.

Of the 180 faecal samples comprising 41 cattle, 45 sheep, 53 goats and 41 dogs analysed, 107 (59.4 %) were positive for helminth eggs. The helminth species identified were *Toxocara vitulorum* (18.9 %), *Toxocara canis* (12.7 %), *Strongyloides* (15.5 %) and *Trichuris* (12.7 %) (Table 2). Chi-square analysis showed no significant difference in level of infection of animal faeces sampled ($\chi^2 = 5.74$, df = 4, $P > 0.05$). Though more positive cases were encountered in samples collected from the North Bank (Fig. 2), this was however not statistically significant when compared with the other areas sampled ($\chi^2 = 5.99$, df = 4, $P > 0.05$).

A total of 221 domestic animals were examined for ectoparasite infestation (43 cattle, 45 sheep, 45 goats, 44 pigs and 44 dogs) and 1908 ectoparasites were recovered. Ticks accounted for 32.80 % of all ectoparasites while lice, fleas and mites accounted for 22.43 %, 22.06 % and 22.69 %, respectively (Table 4). The highest infestation rates were seen in cattle and pigs. While 75 % of the cattle examined had ticks, 88.63 % of the pigs were infested with fleas (*Tunga* species) (Table 3). There was no significant difference in the rates of infestation between male and female animals ($\chi^2 = 0.10$, df = 1, $P > 0.05$).

Amblyomma species were the most dominant ticks encountered (40.10 %) and were recovered from 38.79 % of all animals that were infested with ticks. *Linognathus* species (43.90 %), *Ctenocephalides* species (97.38 %) and *Sarcoptes* species (58.89 %) were the most predominant species of lice, fleas and mites, respectively (Table 4). A comparison of the 3 study sites showed that even though more ectoparasites were encountered in the North Bank area, this difference was not statistically significant ($\chi^2 = 1.83$, df = 4, $P > 0.05$). The distribution of the ectoparasites in the 3 areas showed no consistent pattern (Fig. 3).

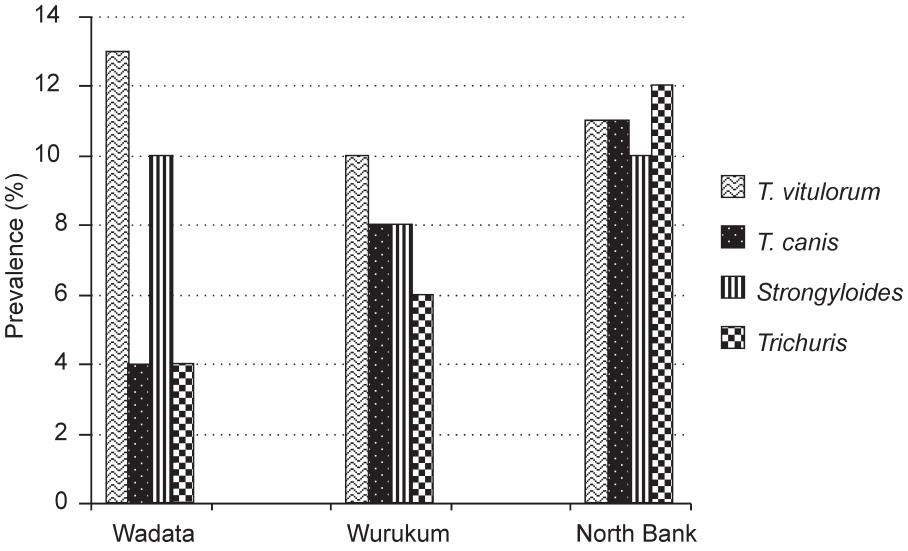

Fig. 2: **Prevalence of helminth eggs and larvae in faeces of examined animals.**

Table 3: **Sex-related prevalence of ectoparasites on animals examined.**

Animal	Ectoparasites	Male			Female			Total		
		No. examined	No. infested	% infestation	No. examined	No. infested	% infestation	No. examined	No. infested	% infestation
Cattle	Ticks	23	17	73.9	20	13	65.0	43	30	75.0
	Lice		4	17.9		3	15.0		7	16.3
	Fleas		–	–		–	–		–	–
	Mites		3	13.4		1	5.0		4	9.3
Sheep	Ticks	19	5	26.3	26	7	26.9	45	12	26.6
	Lice		9	47.4		11	42.3		20	44.4
	Fleas		5	26.3		7	26.9		12	26.6
	Mites		3	15.8		7	26.9		10	22.2
Goats	Ticks	21	10	47.6	24	14	58.3	45	24	53.3
	Lice		12	57.1		13	54.2		25	55.5
	Fleas		4	19.5		6	25.0		10	22.2
	Mites		13	61.9		7	33.3		20	44.4
Pigs	Ticks	21	12	57.1	23	13	56.5	44	25	56.8
	Lice		12	57.1		17	73.9		29	65.9
	Fleas		20	95.2		19	82.6		39	88.6
	Mites		7	33.3		9	39.1		16	36.4
Dogs	Ticks	24	14	58.3	20	11	55.0	44	25	56.8
	Lice		15	62.5		9	45.0		24	54.5
	Fleas		10	41.7		10	50.0		20	45.4
	Mites		6	25.0		4	20.0		10	22.7
Total		108			113			221		

DISCUSSION

The widespread contamination of residential compounds with eggs of animal helminth parasites observed in this study is epidemiologically significant. These findings agree with others reported elsewhere[33,29,14] and in Nigeria[10,8,2]. The presence of potentially pathogenic helminth parasites in the home environment highlights the risk of human infection. The viability of these parasite eggs under different environmental conditions is focal in the transmission of zoonotic diseases. Contamination of residential compounds with eggs and larvae of animal helminth parasites as observed in this study indicates the possibility of transmission of soil-borne zoonotic infections.

Nigeria is currently experiencing an unprecedented rise in urban livestock farming[21,22]. The large concentration of roaming farm animals or those restricted within residential homes reduces hygienic standards and increases the risk of acquiring zoonotic diseases. Epidemiological data on zoonotic diseases in Nigeria are scarce but immunological studies in other developing countries reported high numbers of visceral larva migrans cases in children, which was attributed to the tendency of children to swallow soil while playing and soil contaminated with helminth ova and larvae of domestic animals[25]. Apart from the risks resulting from the accidental ingestion of contaminated soil, handling of these animals could also predispose humans to infections. Serological surveys in Djibouti amongst livestock handlers and abattoir personnel concluded that abattoir personnel and livestock breeders carried more zoonotic infections which are transmitted by contact with animals than other population groups[7].

The heavy infestation of animals cohabiting with humans by ectoparasites of veterinary and medical importance has severe consequences for arthropod-borne zoonotic diseases. Species encountered in this study and infestation rates observed agree with findings reported in some parts of Nigeria[15,30,12,16,34] and elsewhere[4,31]. The predominance of ticks, especially species incriminated in the transmission of babesiosis and other livestock diseases, has serious economic consequences for livestock farmers and the industry. Anaemia may also result in heavy infestation, thereby weakening the animals and even killing younger ones.

The ability of these traditional animal ectoparasites to bite humans and suck human blood and sometimes transmit zoonotic diseases is the main concern in this study. Ticks from dogs and other livestock have been reported to occasionally

Table 4: **Species of ectoparasites infesting examined animals.**

Type of ectoparasite	Species of ectoparasites	No. of animals infested (No. of ectoparasites recovered)					Total no. of animals infested. (ectoparasites recovered)	% infestation of ectoparasites species
		Cattle	Sheep	Goats	Pigs	Dogs		
Ticks	*Amblyomma*	11 (96)	6 (7)	9 (61)	9 (29)	10 (38)	45 (231)	36.9
	Boophilus	7 (53)	2 (4)	5 (13)	7 (16)	13 (50)	34 (136)	21.7
	Hyalomma	8 (81)	4 (6)	4 (10)	9 (25)	–	25 (122)	19.5
	Rhipicephalus	4 (27)	–	6 (41)	–	15 (69)	25 (137)	21.9
							129 (626)	
Lice	*Linognathus*	–	20 (59)	6 (7)	8 (48)	13 (130)	47 (244)	57.0
	Haematopinus	–	–	–	17 (85)	–	17 (85)	19.8
	Heterodoxus	–	–	–	–	11(22)	11 (22)	5.1
	Bovicola	7 (29)	–	9 (48)	–	–	16 (77)	18.0
							91 (428)	
Fleas	*Ctenocephalides*	–	12 (132)	10 (23)	–	17 (79)	39 (234)	55.6
	Pulex	–	–	–	–	3 (11)	3 (11)	2.6
	Tunga	–	–	–	34 (176)	–	34 (176)	41.8
							76 (421)	
Mites	*Sarcoptes*	4 (23)	4 (55)	13 (89)	21 (57)	7 (31)	49 (255)	58.9
	Demodex	–	6 (73)	7 (61)	18 (28)	3 (16)	34 (178)	41.1
							83 (433)	

bite humans and transmit Lyme disease, tick paralysis, human babesiosis and relapsing fever in parts of North America, Africa and Australia[32,20,28] though these diseases have never been reported in Nigeria. Mild dermatitis sometimes progressing to papular eruption in humans infested with scabies mites have been documented[6]. Dog and cat fleas on the other hand have been reported to transmit *Dipylidium caninum* in children who accidentally swallow infected fleas while playing with pets[28,32]. School children in Badagry near Lagos, Nigeria, were infested with *Tunga penetrans*, a flea that can cause serious inflammation of the feet, leading to ulceration and fibrosis[1]. They explained the high prevalence of infestation to close association of children with large numbers of pigs (another host) that roam about in the area.

The large concentrations of roaming animals as well as those restricted within residential homes reduces hygienic standards and increase the risk of acquiring arthropod-borne zoonotic infections. Though human infestation with ticks and other ectoparasites is not widespread in Nigeria, the dismantling of the biological barriers between livestock and man has resulted in the emergence and re-emergence of new zoonotic infections[24].

The usage of residential premises to rear livestock also poses serious challenges to ectoparasite control. Traditionally, ectoparasites are controlled using effective insecticides either by spraying on animals or by dipping the animals in swim pits. Some of the organophosphorus compounds used are toxic to humans and their application within the domestic environment may have serious residual consequences. Some ectoparasite species are capable of living for prolonged periods independent of the host and may also develop resistance to chemicals used for their control. Other obstacles to controlling vector-borne zoonotic infections include: diversity of social, cultural and administrative structures, inadequate education of the population and overcrowding of both animals and humans in an already deteriorating urban environment[17,24].

Urban livestock farming will no doubt exacerbate the environmental and public health problems being experienced in many urban areas in the developing world. It is a common experience these days to see livestock roaming in and around houses in search of food. While feeding, they defecate indiscriminately, seeding residential and recreational areas with excreta-borne pathogenic organism[14,29,23]. The large concentration of these livestock scavengers in search of food in

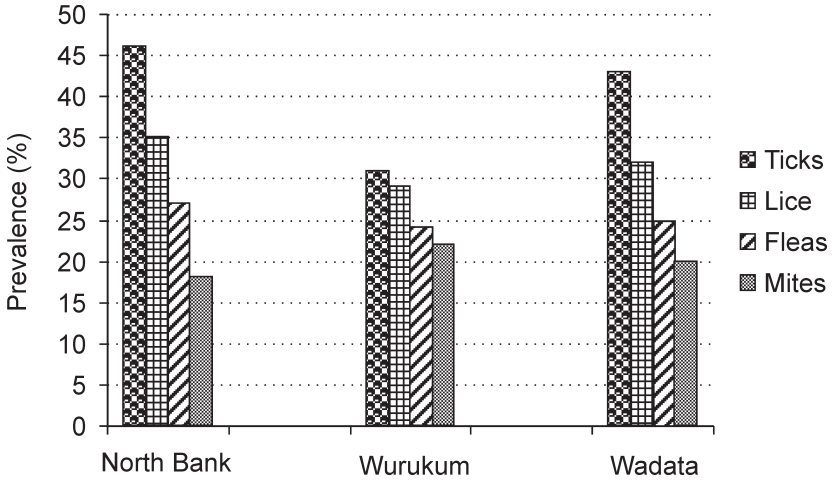

Fig. 3: **Prevalence of ectoparasites on examined animals in the 3 study areas.**

cities reduces the hygienic standards and increases the risk of their acquiring and disseminating zoonotic diseases to the human population.

The benefits of urban livestock farming, especially in meeting the demand for essential animal protein notwithstanding, it is important to note that helminth zoonoses are becoming a major health problem in developing countries with domestic and peridomestic cycles and reservoirs in pigs or cattle[24]. The enforcement of already existing prohibition on stray and roaming animals in urban areas will go a long way to preventing environmental pollution. For the urban livestock farmers, interactive health education, highlighting the zoonotic disease implications of cohabiting with animals will enhance the adoption of more responsible and hygienic animal handling and production.

REFERENCES

1. Ade-Serrano M A, Ejezie G C 1981 Prevalence of tungiasis in Oto-Ijanikin village, Badagry, Lagos State, Nigeria. *Annals of Tropical Medicine and Parasitology* 75: 471–472
2. Ajayi O O, Duhlinska D D 1998 Distribution of *Toxocara* eggs in different soil types in Jos and Dutse-Kura, Plateau State, Nigeria. *Journal of Pure and Applied Sciences* 1: 31–37
3. Amuta E U, Omudu E A, Ahmed A S 2004 Bacteriological and parasitological evidence of soil contamination in relation to sanitary facilities in selected schools in Makurdi, Nigeria. *Journal of Pest, Disease and Vector Management* 5: 337–347
4. Bryson N R, Horak I G, Hohn E W, Louw J P 2000 Ectoparasites of dogs belonging to people in resource poor communities in North West Province, South Africa. *Journal of South African Veterinary Association* 71: 175–179
5. Byford R L, Craig M E, Crosby B L 2004 *A review of ectoparasites and their effect on cattle production.* Bulletin of Veterinary Entomology 13, New Mexico State University, Las Cruces
6. Carter G R 2001 External parasitic diseases of dogs and cats. International Veterinary Information Service. http://www.ivis.org (accessed 30 July 2005)
7. Chantal J, Bessière M H, Guenno B, Dorchies P 1996 A serological survey of some zoonotic diseases among abattoir personnel in Djibouti. *Bulletin da la société de pathologie Exotique* 89: 353–357
8. Chiejina S N, Ekwe T O 1986 Canine toxocariasis and the associated environmental contamination of urban areas in eastern Nigeria. *Veterinary Parasitology* 22: 157–161
9. Dada B J O 1980 Taeniasis, cysticercosis and echinococcosis/hydatidosis in Nigeria: 1 – prevalence of human taeniasis, cysticercosis and hydatidosis based on a retrospective analysis of hospital records. *Journal of Helminthology* 54: 281–286
10. Dada J O, Belino E O 1979 Prevalence and public health significance of helminth ova in dog faeces deposited on the streets of Zaria, Nigeria. *Annals of Tropical Medicine and Parasitology* 73: 495–498
11. Etim S E, Akpan P A 1999 Studies on geophagy as a risk factor for geohelminthiasis in Calabar, Nigeria. *Nigerian Journal of Parasitology* 20: 91–98
12. Etim S E, Akpan P A, Okon V E 1996 A survey of ectoparasites of dogs in Calabar, Nigeria. *Nigerian Journal of Parasitology* 17: 132–136
13. Fashuyi S A 1983 Prevalence of helminth eggs in human faeces deposited on the streets of Lagos, Nigeria. *West African Journal of Biological Sciences* 2: 135–138
14. Gyorkos T W, Nelson E, Maclean J O, Soto J C 1999 Parasite contamination of sand and soil from daycare sandboxes and play areas. *Canadian Journal of Infectious Diseases* 5: 17–20
15. James-Rugu N N, Iwuala M O E 1998 Studies on the prevalence and factors influencing tick infestation of dogs, sheep and goats in Plateau State, Nigeria. *West African Journal of Biological Sciences* 8: 70–80
16. James-Rugu N N 2000 A survey of ticks and tick borne parasites of sheep and goats from Bassa Local Government Area of Plateau State, Nigeria. *Journal of Pure and Applied Sciences* 1: 35–43
17. Mage C, Genery J, Reynal P H 1995 Parasitology and animal husbandry: present situation and projected evaluation. *Veterinary Bulletin* 13: 265–270
18. Morgan N O 1988 Potential impact of arthropod vectors of animal diseases on the United States livestock industry. In *CRC Handbook of Pest Management in Agriculture* 1: 99–105. CRC, Boca Raton
19. Mizgajska H 1993 The distribution and survival of eggs of *Ascaris* in six different natural soil profiles. *Acta parasitologica* 38: 170–174
20. Nas H 2004 *Discussion on zoonotic parasite transmission and life cycles.* Veterinary Services Department Publications, Foster and Smith, USA
21. Nwoke B E B 2001 Urbanization and livestock handling and farming: the public health and parasitological implications. *Nigerian Journal of Parasitology* 22(1&2): 121–128
22. Nwoke B E B 2004 The impact of changing human environment and climate on emerging and re-emerging parasitic diseases. *Guest Lecture: 28th annual conference of Nigeria Society for Parasitology, Owerri, Nigeria*, 22–24 September 2004
23. Omudu E A, Amuta E U, Unoqur L B, Okoye L A 2003 Prevalence of *Toxocara canis* ova in dog faeces and soil samples collected from public parks in Makurdi. *Nigerian Journal of Parasitology* 24: 137–141
24. Pawlowski Z S 1996 Helminthic zoonoses affecting humans in Africa. In Lindberg R (ed.), *Veterinary medicine: impacts on human health and nutrition in Afirca.* SLU/Repro, Uppsala, Sweden: 41–50
25. Petithory J C, Loye J, Beddok A 1993 Epidemiological data on the visceral larva migrans syndrome. *Parasitology Today* 11: 20925
26. Shah-Fischer M, Say R 1989 *Manual of tropical veterinary parasitology.* Technical Centre for Agriculture and Rural Cooperation, CAB International, Wallingford.
27. Torres P, Franjola R, Perez J, Miranda J 1995 Intestinal geohelminthiasis in man and domestic animals in riverside sections of the Vaidivia river basin, Chile. *Boletin Chileno de Parasitologia* 50: 57–66
28. Torrance W 2005 Ectoparasites.http://www.northerngroomers.co.uk/ectoparasites (accessed 3 June 2005)
29. Uga S, Oikawa H, Lee C C, Ral S K 1996 Contamination of soil with parasite eggs and oocysts in and around Kuala Lumpur, Malaysia. *Japanese Journal Medicine and Hygiene* 24: 125–127
30. Umeche N, Chanama M J 1996 Ectoparasites of West African dwarf goats in Anambra State, Nigeria. *Journal of Pest, Disease and Vector Management* 1: 1–3
31. Wilson D D, Bram R A 2003 Exotic arthropod pests of livestock intercepted at United States ports of entry. *Publication of the United States Animal Health Association* 88: 303–311
32. Wentworth B B 1988 Arthropods of public health importance. In *Diagnostic procedures for mycotic and parasitic infection.* American Public Health Association, Washington, DC
33. Xu Longqu J, Yu Senhal C, Chen Q W 1994 Survey of human infection and soil pollution with soil-transmitted nematodes. *Chinese Journal of Parasitic Disease Control* 7(3) 171–174
34. Yanan E G, Shamaki B U, Dede P M, Uzoigwe N R 2005. Population dynamics and predilection sites of ticks in experimental cattle kept in Vom, Plateau State, Nigeria. *Abstract No. 22: 36th Annual Conference of Entomological Society of Nigeria, Port Harcourt; Nigeria,* 9–12 October 2005