

A Survey of Rats Trapped in Residential Apartments and Their Ectoparasites in Makurdi, Nigeria.

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Abstract: In recent years there has been a reported increase in the number of domestic premises complaining about rat infestation. Successful management of rodent problems depends upon correct identification of the rodent species involved and on obtaining information on the biology, ecology and behaviour in domestic ecological setting. In this study, we surveyed rodents' infestation in residential buildings and their ectoparasites fauna in Makurdi, Nigeria were investigated. The rodents were trapped using locally fabricated traps and body brushing techniques was used to collect their ectoparasites. A total of 1,438 were captured with *Rattus rattus* accounting for 58.2%, while 1,571 ectoparasites were collect from 63.0% of the rodents with ticks accounting for 54.9% of all ectoparasites. There was no significant difference in rodents' infestation in the six study location ($P > 0.05$). The overall rodent ectoparasite index was 1.09 signifying a potential risk to human health. Apartments with multiple tenants, those with evidence of housing disrepair and pit latrines had higher infestation rates. The public health implications of these findings were discussed with emphasis on protection of human health through a comprehensive and participatory rodent control strategy.

Key words: Rats infestation, Ectoparasites fauna, Zoonotic implications.

INTRODUCTION

Rats and mice are possibly the most damaging rodents based on economic losses and health-related issues. They are constantly associated with unsanitary habitats, such as sewers and pit latrines and thrive in overcrowded apartments. It has been reported that nearly 4 million rats are born everyday and 10 rats for every human alive^[1]. This high abundance is expected to lead to more contact between humans and rats resulting more than ever to debilitating rat borne zoonoses with the increased density of human population^[2]. Rodents are carriers of viral, rickettsial, bacteria and parasitic diseases which they transmit through their ectoparasites, by food and water contaminated by rodent excreta, through direct contact with rodent excreta and by rat bite. A survey of a wide range of parasites of brown rats on United Kingdom farms reported that they were infected 13 zoonotic species with a range of 2-9 simultaneously per rat^[3] other results from studies in urban area also suggest that rats could be a serious risk to health of humans and domestic animals^[4]. Deteriorating urban environment has long been associated with rodent infestation; Langton *et al.*^[5] found a trend to link unfitness of housing with rat infestation. Residential properties that are less than satisfactory in respect of

fitness for human habitation situated in area with poor sanitary condition and high densities support the infestation of rats, consequently; rats in urban areas are regarded as common indicator of degraded environment.

Rat borne diseases currently on the rise include; Hantavirus, a viral disease capable of causing severe and often fatal illness^[6]. Leptospirosis, a potentially serious bacterial illness with about 6000 cases in Thailand alone killing 350 people in the year 2000^[1]. Lassa fever, a disease endemic in West Africa infects an estimated 100,000 to 300,000 people per year with approximately 5000 deaths^[7]. Rodents have also been linked to spread of emerging diseases like SARS in Asia^[8]. The involvement of rodents in the transmission of babesiosis, cestodes, trematodes and nematodes has exacerbated the transmission of these parasites^[9,10,11,12]. Pathogens transmitted by rodent bites or bites by their ectoparasites are listed among the serious emerging infectious diseases worldwide^[13,14,15].

The growing public health concern about rodent borne zoonoses coupled with the deterioration of waste disposal system in many urban areas in Nigeria justifies an extensive investigation of rodent infestation to determine species distribution, identify risk factors and examine their role in disease epidemiology. At the moment, such epidemiological information is scarce in

Nigeria. The few pioneer studies on rat infestation in this country were concentrated in the South-eastern part of Nigeria^[16,17]. This current study intends to identify rodent species infesting human residences in Makurdi (North-central Nigeria) and identify their ectoparasite fauna. We hope our findings will provide the critical baseline information needed to design and implement a comprehensive national rodent prevention and control strategy.

MATERIALS AND METHODS

Description of Study Area: Makurdi, the capital of Benue State, Nigeria, is fast becoming a metropolitan centre with attendant health, social, housing and environmental problems. The town lies between latitude 7°15' – 7°45'N and longitude 8°15' - 8°40'E. The town lies in the guinea savanna vegetative belt and on the bank of the second largest river in Nigeria, River Benue. The river divides the town into North and South banks and the town covers an area of 16km². 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 urbanization 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 three high-density residential areas (i.e. Wadata, Wurukum and North Bank) and sub-urban settlements like Logo 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, abattoir, a rice mill, and thriving burnt-brick production along the bank of the river. 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 in 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 due 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 of this area are goats and pigs which are reared under a free-range system. Their faeces are usually used as manure for the vegetable farms.

North Bank: The north bank area is located across the river towards the north; the actual study site is the area called Angwan-Sariki. The area is densely populated and there are prominent gully erosion sites and these gullies serve as refuse dumps. The residents of 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.

Advocacy and Pre- Survey Visits: Pre-survey visits were made to selected study sites to interact with residents and seek their permission and consent to participate in the study. After permission was obtained from willing residents, the study team returned on a later date to conduct house inspection using a household checklist. The checklist included information on number of rooms in an apartment/compound/flat, number of persons sleeping in a room, type of toilet, number of households sharing kitchen. Indicators for apartment maintenance also included on the checklist were presence of mold growth, location of waste bins, leakage of water sink, cracks on the wall, peeling paint and roof leakage.

Capture and Identification of Rodent Population: Rodent infestation was investigated by visual observation of rat signs such as droppings, tracks, runs or burrows, rub marks and damaged stored products. After which locally designed traps were placed at strategic rat signs points and/or near available food source. The traps were set using pieces of smoked fish as baits. Two sets of traps were employed for this study, the smaller types can only catch one rat at a time while the bigger types had capacity to capture up to ten rats without resetting. Captured rodents were identified to species level by: (I) taking major standard measurement of the head, body and tail lengths (II) making comparison with museum specimens and (III) using field guides and reference to keys on vertebrate pest websites^[18]. The sex of each rat was determined by examination of the genital region.

Collection, Identification and Estimation of Ectoparasite Fauna: Captured rodents were examined immediately for ectoparasites by brushing the body. Adequate pre-cautions were strictly adhered to by wearing hand gloves, protective garment and air filters. The brushing started from the head, followed by the neck, the trunk and the tail. Visible ectoparasites such as ticks that could easily be removed without brushing were removed with a pair of forceps. The whole body of the rat was brushed onto cotton wool soaked in Formalin. The ectoparasites recovered were preserved in specimen bottles containing 70% alcohol and later identified using keys provided in Pratt and Smith^[19]. Ectoparasites recovered from each rat were counted, the number of tick, fleas, lice and mites collected from the rat examined divided by the total number of rats examined gives the ectoparasite index

$$\text{Rodent ectoparasite index} = \frac{\text{number of ectoparasites collected from examined rats}}{\text{Total number of rats examined}}$$

Data Analysis: Data was analysed using SPSS computer software employing simple percentage and chi-square analysis to test significant difference in species distribution in study locations. Estimation of rodent ectoparasite infestation was based on calculated index respectively.

RESULTS AND DISCUSSION

A total of 1,438 rodents were captured, *Rattus rattus* accounted for 58.2% of all captured rodents from residential buildings. Other rodent species captured were *M. natalensis*, *M. musculus* and *R. norvegicus*, 54.9% of captured rodents were female (Table 1). There was no significant difference in rodents' infestation in 6 study locations ($P > 0.05$). 63.0% of captured rodents were infested with ectoparasites, a total of 1,571 ectoparasites were collected with ticks accounting for 54.9% of all ectoparasites (Table 2). Rodent – ectoparasite index of High level, Wadata and Logo were greater than 1, an indication of a potentially dangerous situation with respect to increased risk for humans. The ectoparasites comprised ticks *Haemophysalis* and *R. sanguineus* species (74.3%), fleas *Xenopsylla* species (31.3%), lice *Polyplax* species (69.3%) and mites *Dermanyssus* and *Myocoptes* species (71.9%).

R. rattus was the most infested rodents species accounting for 53.3% of all ectoparasites collected (Table 3), the overall rodent ectoparasite index was

1.09, however, the rodent tick, flea, mites and lice index was lower than 1. Chi-square test indicated that sex of the rats did not influence the level of ectoparasite infestation ($P > 0.05$).

A total of 1,438 rodents were captured from 300 residential apartments from the six study locations within the metropolis giving an overall ratio of 4.79 rats to 1 apartment. *Rattus rattus* accounted for 58.2% of all captured rodents; other species encountered were *Mastomys natalensis*, *Mus musculus* and *Rattus norvegicus*. Housing conditions like crack in wall, type of toilet and cooking and food storage habits significantly influence rodent infestation, for instance, apartments with crack in wall accounted for 60.5% of captured rodents and this was significantly higher than those captured from apartment without cracks ($X^2 = 5.19$, $df = 1$, $P < 0.05$) (Table 4). However, there was no significant difference in the rate of infestation based on household refuse disposal practices ($P > 0.05$).

Discussion: This study has shown that rodent infestation in residential apartments in Makurdi is high and species captured are those reported frequently encountered elsewhere indicating widespread distribution. This high prevalence in infestation corroborates other studies in Nigeria^[12,16,17,20,21] and elsewhere^[5,9,10,13,21]. It is now more likely than ever to experience greater levels of destructive activities of rodents especially as it relates to contamination of food and extensive damage to buildings and equipment. Sudden increase in rodents sighting, contact with humans and rodent bites are already being reported even in developed countries in North America and Europe^[2,13,22]. As housing and urban sanitation continue to deteriorate resulting to uncontrolled generation and accumulation of solid waste in many developing countries, an increase in direct man-rodent contact is expected and this is epidemiologically important. Battersby *et al.*^[4] reported that the presence of rats in urban areas is a common indicator of degraded environment. A high correlation has been reported between houses with widespread litter and rat infestations^[4,5].

Rodents and rodent-borne diseases may become more serious in human population. High rat population densities and overcrowding favour the transmission of parasitic diseases, particularly those spread by direct contact or short distance aerolization^[4]. The zoonotic transmissions of these rat-borne infections are exacerbated in communities where standards of environmental and personal hygiene are not maintained. The ability of rodents to directly or indirectly transmit human diseases can never be over-emphasized. More worrisome now is their involvement in the epidemiology of new and emerging infectious diseases

of epidemic proportion^[2,6,8,15]. Lassa fever, a serious rat-borne disease first discovered in Nigeria in 1969, is now endemic in the whole West Africa sub region because the rodent species (*Mastomys* also known as Multimammate rat) which carry the virus are spreading rapidly throughout the region. Serious outbreaks of Lassa fever have also been reported among refugee populations in Liberia and Sierra Leone^[23,24]. Some States in North central Nigeria reported epidemics if the disease in Late December 2007^[25], the spread of the epidemic to other parts of the country is eminent considering the increase of movement of human and goods during the December holiday period.

The high infestation of captured rodents by ectoparasites as observed in this study is of serious zoonotic importance, the role of these ectoparasites in rodent-borne diseases has long been established since the days of the Black Death^[26]. Species of lice, fleas, ticks and mites encountered in this study are those commonly reported from Northern Nigeria^[12], North Africa^[27], Europe^[14,21] and the Americas^[28,29]. However, while ticks *Haemophysalis* species were the most prevalent ectoparasites encountered in this study, Mbanong *et al.*^[12] and Stojcevic *et al.*^[21] reported lice *Polyplax* species to be more prevalent.

Table 1: Distribution of rodents' species captured at study locations

Species	Study locations						
	Modern Market	North Bank	High Level	Wadata	Wurukum	Logo	Total
<i>Rattus rattus</i>	152	133	201	129	122	101	838 (58.2%)
<i>Mastomys natalensis</i>	9	13	-	7	9	6	44 (3.1%)
<i>Mus musculus</i>	-	-	11	-	30	15	56 (3.9%)
<i>Rattus norvegicus</i>	111	109	-	114	87	79	500 (34.7%)
SEX							
Male	102	105	101	121	122	98	649 (45.1%)
Female	170	150	111	129	126	103	789 (54.9%)
Total	272	255	212	250	248	201	1438

Table 2: Ectoparasite infestation of rodent captured at study location

Study location	Number captured	Number infested	Ticks	Fleas	Lice	Mites	Total ectoparasites	Rodent ectoparasite index
Modern Market	272	84	60	19	76	28	183 (11.8%)	0.67
North Bank	255	154	108	26	12	34	180 (11.4%)	0.70
High Level	212	198	161	2	59	27	249 (15.8%)	1.17
Wadata	250	151	255	3	79	29	366 (23.3%)	1.46
Wurukum	248	123	76	31	103	37	247 (15.7%)	0.99
Logo	201	196	204	28	89	25	346 (22.0%)	1.72
Total	1438	906 (63.0%)	864 (54.9%)	109 (6.9%)	418 (11.4%)	180 (11.4%)	1571	

Table 3: Rodent species captured and their ectoparasite infestation

Species	Number captured	Number infested	Ticks	Fleas	Lice	Mites	Total
<i>Rattus rattus</i>	838	588	467	48	221	102	838 (53.3%)
<i>Mastomys natalensis</i>	44	21	78	12	37	17	144 (9.1%)
<i>Mus musculus</i>	56	37	103	22	51	36	212 (13.5%)
<i>Rattus norvegicus</i>	500	260	216	27	109	25	377 (23.9%)
Total	1438	906	864	109	418	180	1571
Ectoparasite index			0.6	0.07	0.3	0.1	1.09

Table 4: Housing and sanitary characteristics of sampled premises with number of rats captured

Housing and sanitary indices	Modern market	North bank	High level	Wadata	Wurukum	Logo	Total
Number of houses inspected (number of rats captured)	50 (272)	50(225)	50 (212)	50 (248)	50(250)	50 (201)	300 (1438)
Number of houses with crack	28 (170)	18 (150)	30 (157)	26 (141)	41 (151)	23 (103)	166 (871)
Number without crack	22 (102)	32 (105)	20 (55)	24 (107)	09 (99)	27 (98)	134 (567)
Number of houses with pit latrine	26 (150)	15 (156)	25 (112)	20 (152)	32 (161)	40 (190)	158 (771)
Number of house with flush toilet	24 (122)	35 (99)	25 (100)	30 (96)	18 (89)	10 (11)	142 (667)
Number of houses without kitchen/food store	23 (112)	17 (90)	09 (32)	05 (40)	21 (65)	11 (75)	86 (414)
Number of houses with kitchen/food store	27 (160)	33 (165)	41 (180)	45 (208)	29 (185)	39 (126)	214 (1024)
Number of houses that patronize authorized refuse dump	10 (102)	39 (140)	30 (90)	28 (125)	39 (155)	24 (141)	17 2(753)
Number of houses that patronize unauthorized refuse dump	40 (170)	11 (115)	20 (122)	22 (123)	11 (95)	26 (60)	128 (685)

Figures in parenthesis () are number of rodents captured

This study is a critical step to estimating and assessing the status of rodent infestation in Makurdi, Nigeria. The study documented four species of rodents in human dwellings in the town and their ectoparasite fauna which are of veterinary and medical importance. Poor housing and overcrowding results in closer contact and makes it easier for these ectoparasites to bite rodents and humans. As environmental and socioeconomic conditions favouring rodent infestation continue to persist in many rural and urban centres, community-wide rodents control strategies with strong emphasis on community participation needs to be employed to prevent the proliferation of rodent population. However, further epidemiological and zoonotic investigations needs to be conducted in order to ascertain the role of household rodents in the lifecycle of emerging new infections in Africa.

Our study reveals that residents of apartments investigated endure close association with rodents. Species captured belong to the cosmopolitan commensal rodents (*Rattus rattus*, *R. norvegicus*, *Mus musculus* and *Mastomys natalensis*) often found in close association with people in dense settlements. These species seem to be widely distributed in Nigeria as evident from other studies^[12,17,16,20]. The importance of adequate housing and sanitation for the maintenance of health has long been a topic of scientific and public health policy discussion. We established in this study that crowded, unsanitary, and dilapidated housing conditions exacerbate rodent infestation in our study locations. Houses with disrepair indicators and poor sanitary conditions accounted for higher rodent captured when compared with those without evidence of disrepair. This finding corroborates a recent report that

housing quality increase risk of rodent infestation and lassa fever in refugee camps^[24]. These factors contribute to substantially increase the amount of waste generated and the inability of environmental health authorities to keep pace with refuse disposal challenges. Accumulating solid waste greatly increase rodent breeding, increased rodent population discourage other efforts on environmental health improvement and lead to increase rodent man contact^[13,22]. This could be responsible for general apathy exhibited by residents to the rodent infestation problem as demonstrate by lack of control initiative.

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