PARASITES OF COCKROACHES IN THE UNIVERSITY OF NIGERIA, NSUKKA, ENUGU STATE, NIGERIA

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ABSTRACT

This study was carried out to determine the ectoparasites and endoparasites of cockroaches at the University of Nigeria, Nsukka. The prevalence of parasites in cockroaches, their presence, abundance, and the role of cockroaches as potential carriers of human and animal parasites were determined. A total of 170 adult cockroaches were caught. Cockroaches were identified as Periplaneta americana 116(68.24%), Blatella germanica 45(26.47%), and Blatta orientalis 9(5.29%). A total of 89.7% of P. americana and 42.2% of B. germanica were infected, while none were infected in B. orientalis. Ascaris lumbricoides eggs (87%), Strongyloides spp. (51%), Hammerschmiditiella diesingi (10%), Leidynema spp. (6%), Toxascaris leonina (0.7%) and unknown parasites (6%) were found in P. americana. A. lumbricoides (40%), S. stercoralis (8.9%), H. diesingi, and Leidynema spp. (13.3%) were found in B. germanica. P. ameriana caught in toilets were more infected (96.1%) when compared to those from dump sites (92.6%), classrooms (66.7%), and hostel rooms (87.0%). None of B. germanica and B. orientalis were caught in the toilet. Infected B. germanica were 20.0% in offices, 64.7% in dump sites, 30.7% in classrooms, and 30.0% in hostel rooms. Almost all encountered parasites were possible pathogens for both human and zoonotic diseases. The parasites can be spread easily by cockroaches as mechanical vectors. The university community, the government, and the general public should create awareness of health education and pest control management approaches to contain and manage the population and diseases of cockroaches at the University of Nigeria, Nsukka.

Keywords: Cockroaches, Disease vectors, Parasites, Public health

INTRODUCTION

Cockroaches are special species of insects that are found all over the world with about 4600 known species and over 460 genera. They have been in existence for about 300 million years and are the world's most common insects (Chamavit *et al.*, 2011). The species of cockroaches, German cockroach - *Blattella germanica* Linnaeus, 1767 (Blattodea: Ectobiidae), American cockroach - *Periplaneta americana* Linnaeus, 1758 (Blattodea: Blattidae), and Oriental cockroach - *Blatta orientalis* Linnaeus, 1758 (Blattodea: Blattidae) are considered the most common pests to humans (Onah *et al.*, 2023).

Generally, cockroaches are known to be found in warm, moist environments with abundant food, sewers, and wet decaying areas are their natural habitats (Alzain, 2013). According to Nedelchev *et al.* (2013), cockroaches are found in restaurants, enterprises for the food industry, grocery stores, and other places, but they can also be observed outside residential areas, like dumps, under firewood, mines, and in unheated homes. During the summer months, they can be seen in open areas – in yards or the streets (Nedelchev *et al.*, 2013). Although cockroaches are seen as household pests, less than 1% are adapted to human-dominated habitats (Schapheer *et al.*, 2017).

A parasite is an organism that lives on or in a host and gets its food and nutrients at the expense of its host (CDC, 2016). It depends on its host for survival. Without a host, a parasite cannot live, grow and multiply. For this reason, it rarely kills the host, but it can spread diseases, and some of these can be fatal (Balingi, 2023).

Cockroaches play an important role in serving as hosts for many parasites; these parasites can be ecto or endo parasites. Endoparasites live inside the host (bloodstream, red blood cells, etc.) while ectoparasites live outside the host (skin, nose, etc.). Cockroaches are known to carry bacteria, protozoa, helminths, fungi, and viruses; however, their role or direct transmission of these infectious agents has not been well understood (Etim *et al.*, 2013). Several evidences show that cockroaches are carriers of medically important parasites including helminths and protozoa (Al-Bayati *et al.*, 2011; Chamavit *et al.*, 2011; Kinfu and Erko, 2008; Bala and Sule, 2012). Several species of bacteria and fungi that can cause human diseases have been isolated from cockroaches (Fotedar *et al.*, 1991; Salehzadeh *et al.*, 2007; Al-Bayati *et al.*, 2011). Such pathogenic microorganisms are isolated from cockroaches probably because cockroaches frequently feed on human faeces. Apart from acting as mechanical carriers of microorganisms, cockroaches are the major sources of indoor allergens (Rosenstreich *et al.*, 1997). Exposure and sensitization to cockroach allergens are associated with asthma-related health problems (Rosenstreich *et al.*, 1997), the magnitude of which depends on race and socioeconomic status (Sarpong *et al.*, 1996).

Cockroaches have been known to be a reservoir host for a lot of parasites including mycotic, bacterial, helminth, and nematode parasites. Studies have been carried out to determine the composition and abundance of cockroaches in the University of Nigeria Nsukka but none has been done to determine the parasites these cockroaches harbor. The environment of the University of Nigeria Nsukka is not completely clean; many people living on and around the campus are still unaware that these cockroaches carry parasites; hence the need for this study. Therefore, this study investigates the presence, prevalence, and abundance of ectoparasites and endoparasites of cockroaches at the University of Nigeria Nsukka.

MATERIALS AND METHODS

Study Site: The University of Nigeria, Nsukka is located in Nsukka, Enugu State, Southeastern Nigeria with geographical coordinates of 7°24′15″ to 7°24′45″ East and 6°51′45″ to 6°52′15″ North (Figure 1).

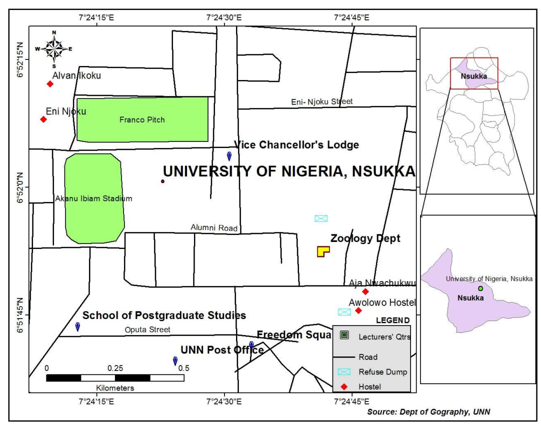

Figure 1: Map of the University of Nigeria, Nsukka. Source: Department of Geography, University of Nigeria, Nsukka, Enugu State, Nigeria

Nsukka has a tropical climate with two seasons; rainy and dry seasons. The average temperature is 30.25 ± 7.04°C; the warmest month is February with a temperature of 37.4ºC / 99.32ºF while August is the coldest month with a temperature of 23.04ºC / 73.47ºF. Maximum wind speed occurs in December with speed of 1.79 ms^{-1} and a minimum of 0.89 ms^{-1} in October. Annually maximum atmospheric pressure over the area occurs in July with a pressure of 963.4 hPa, while the minimum (959.9 hPa) occurs in April. Nsukka typically receives about 165.79 millimetres of precipitation and has 201.51 rainy days (55.21% of the time) annually (Weather and Climate, 2024). The peak of rainfall occurs in

September with 108.55 mm and the least is in January and December (Onyenucheya and Nnamchi, 2018).

Activities in the Study Area: The study area is a tertiary institution that comprises over 20000 students, lecturers, University workers, etc. It is a place of academic activities, seminars, symposiums, and other social and religious activities. There are residential areas for both students and staff working in the University.

Collection of Cockroach Samples: Samples of cockroaches were collected from student's hostels, staff quarters, classrooms, offices, toilet ends, and dump sites. Cockroaches were collected using empty jars coated with a thin film of Vaseline and baited with assorted food items such as a piece of bread soaked in water, biscuits, roasted fish, or crayfish. They were also collected using sweep nets, sticky traps (constructed using cardboard paper and adhesive), and manual catching with the aid of forceps. The cockroaches were collected in a sterile bottle and transported to the laboratory. Samples of cockroaches were examined using methods described by Akunne *et al*. (2013), Hamu *et al*. (2014), and Onah *et al*., 2023). Standard keys (Choate *et al*., 2008) were used to identify, authenticate, and determine the species and sexes. Voucher specimens for *P. americana* (ZEB-MNH-*P. americana*), *B. germanica* (ZEB-MNH-*B. germanica*), and *B. orientalis* (ZEB-MNH-*B. orientalis*) were deposited in the Departmental Museum of Natural History for referral purposes. Adult cockroaches with intact body features were the samples that were examined in the laboratory.

Determination of Ectoparasites of Cockroaches: Isolation of ectoparasites of cockroaches was done using the method described by Bala and Sule (2012). Each cockroach was euthanized by chloroform and placed in a test tube containing 2 ml of normal saline. The test tube was shaken vigorously for two minutes to detach any parasite or their immature stages from the external body of the cockroach. The fluid was centrifuged at 3000 rpm for 5 minutes. The supernatant was decanted and the residual deposit was placed on a clean glass slide with a cover slip and viewed under an x40 microscope objective lens. The parasites seen were counted and identified using standard taxonomic keys (Thienpont *et al*., 1979; Atiokeng Tatang *et al*., 2017). The parasites recovered were expressed as a percentage abundance of the isolates as described by Iboh *et al*. (2014).

Determination of Endoparasites of Cockroaches: Endoparasites of cockroaches were isolated using the method described by El-Sherbini and El-Sherbini (2011). The cockroaches were fixed on a dissecting Petri dish; the head severed first, followed by the legs and the abdomen was opened using fine pointed forceps. The gut and other abdominal organs were removed using fine needles, while the intestine was examined under the microscope for detection of parasites. The excised gut and the intestine were then homogenized in 5 ml of sterile saline solution and the sample was considered an internal body homogenate sample. These samples in the Petri dishes were viewed with a hand lens and microscope. The parasites present were identified using taxonomic keys (Thienpont *et al*., 1979; Atiokeng Tatang *et al*., 2017) and examined using a light microscope. Adult worms were further observed using a magnifying glass or hand lens (Okafor-Elenwo and Elenwo, 2014) and further viewed under the microscope.

Statistical Analysis: Differences in the prevalence of parasite infection in cockroaches were computed using Chi-square analysis. Prevalence of infection was calculated as the proportion of the number infected to the number examined. The abundance of parasites was calculated as the number of parasites divided by the number of hosts examined. T-test and analysis of variance (ANOVA) statistics were used to separate significant means arising from sample location and species accordingly.

RESULTS

A total of 170 cockroaches were collected from hostel rooms, staff quarters, classrooms, dumpsites, toilets and offices within the

University of Nigeria, Nsukka. The cockroaches collected were of three species, namely *P. americana*, *B. germanica,* and *B. orientalis*. *P. americana* was relatively more abundant (68.24%) than *B. germanica* (26.47%) and *B. orientalis* (5.29%). *P. americana* was the only species found in the toilet, where it also had the highest abundance (Table 1). *B. orientalis* was the least abundant and was only found in classrooms and dumpsites.

The majority of *P. americana* examined for ectoparasites and endoparasites were infected. The prevalence of infection in *P. americana* was 89.7%, 104 out of 116 examined were infected (Table 2). The prevalence of infection in *P. americana* was above 65% at all the sampled sites. The prevalence of infection in *P. americana* was significantly different between the sites sampled ($\chi^2 = 11.25$, df = 3, p = 0.01). The overall prevalence of *B. germanica* was 42.2%. Species of *B. germanica* collected from dump sites had the highest prevalence of infection (64.7%), while those collected from offices had the least (20.0%). The difference in the prevalence of infection in *B. germanica* with regards to the site of collection was, however, not significant ($p>0.05$).

Parasites Abundance in Cockroaches: The parasites collected were *Ascaris lumbricoides* Linnaeus, 1758 (Ascaridida: Ascarididae) eggs, *Strongyloides stercolaris* Bavay, 1876 (Rhabditida: Strongylidae), *Hammerschmiditiella diesingi* Hammerschmidt, 1838 (Oxyuridomorpha: Thelastomatidae), *Leidynema* sp. Leidy, 1850 (Oxyuridomorpha: Thelastomatidae), *Toxascaris leonina* V. Linstow, 1902 (Ascaridida: Toxocaridae), and unidentified parasites. *A. lumbricoides eggs* were the most prevalent in both *P. americana* and *B. germanica* (75.0% and 40.0% respectively). The prevalence of unidentified parasites and *T. leonina* in *P. americana* was low (0.7%). The differences in prevalence of the parasite species in both cockroach species were significant ($p<0.05$).

The number of each of the parasite species collected and their abundances are summarized in Table 4. A total of 150 *A. lumbricoides* eggs, 70 *S. stercolaris*, 20 *H. diesingi*, 21 *Leidynema* sp., 12 two unidentified parasites, and 2 *T. leonina*. The parasite abundance of *A. lumbricoides* eggs was 1.12(53.85) in *P. americana* and 0.44(58.67) in *B. germanica*.

DISCUSSION

Speculations have always been made on the involvement of cockroaches as possible vectors of diseases in communities (Etim *et al*., 2013). However, their role in the direct transmission of pathogens has seldom been established (Bala and Sule, 2012). Findings from this study indicated that cockroaches are reservoirs and mechanical transmitters of parasites. This agreed with previous studies (El-Sherbini and El-Sherbini, 2011; Alzain, 2013; Nedelchev *et al*., 2013; Morenikeji *et al*., 2016; Onah *et al*., 2023). They are also considered the most common pests in human habitation (Hamu *et al*., 2014).

Three species of cockroaches (*P. americana*, *B. germanica,* and *B. orientalis*) were found to be dominant in the University of Nigeria, Nsukka. This may be due to the presence of a suitable environment for breeding and their ability to reproduce and survive. This was in line with the findings of Bala and Sule (2012) and Onah *et al.* (2023). These species of cockroach, especially *P. americana* are known to reproduce rapidly and thrive in habitats with availability and abundance of diverse food materials, suitable refuge, and lack of comprehensive control efforts. From this study, *P. americana* was a good candidate in the transmission of parasites ($p< 0.05$). This may be a result of their adaptation to different environmental conditions and their tendency to be more active in search of food and sites to lay their eggs as asserted by Bala and Sule (2012). This was in agreement with the findings of Atiokeng Tatang *et al*. (2017) in Melong Subdivision, Littoral, Cameroon. Furthermore, *P. americana* was trapped more easily than *B. germanica* and *B. orientalis* as was reported by Bala and Sule (2012). *B. germanica* and *B. orientalis* look to be sedentary in their behaviour, this finding was in agreement with the findings of Atiokeng Tatang *et al*. (2017) where *P. americana* tended to be more active when compared with the other two species.

Table 1: Relative abundance of cockroaches in the University of Nigeria, Nsukka

Sampled sites	*Periplaneta americana* (% Abundance)	*Blatella germanica* (% Abundance)	*Blatta orientalis* (% Abundance)	Total
Hostel rooms	$23(19.83)^{c3}$	$10(22.22)^{b3}$	$0(0.00)^{a1}$	$33(19.41)^{2}$
Classrooms	$15(12.93)^{c2}$	$13(28.89)^{b4}$	$3(33.33)^{a2}$	$31(18.24)^{2}$
Dump sites	$27(23.28)^{c4}$	$17(37.78)^{b5}$	$6(66.67)^{a3}$	$50(29.41)^{3}$
Toilet ends	$51(43.97)^{b5}$	$0(0.00)^{a1}$	$0(0.00)^{a1}$	$51(30.00)^{3}$
Offices	$0(0.00)^{a1}$	$5(11.11)^{b2}$	$0(0.00)^{a1}$	$5(2.94)^{1}$
Total	$116(68.24)^{c}$	$45(26.47)^{b}$	$9(5.29)^{a}$	170(100)

$^{a-c}$values with different superscript letters on the same row are significantly different (p<0.05), $^{1-5}$values with different superscript numbers on the same column are significantly different (p<0.05)

Table 2: Prevalence of parasites in cockroaches within the University of Nigeria, Nsukka

Sampled sites	*Periplaneta americana*		*Blatella germanica*		*Blatta orientalis*	
	Number caught	Number infected (%)	Number caught	Number infected (%)	Number caught	Number infected (%)
Hostel rooms	23^{c}	$20(87.0)^{c}$	10^{c}	$3(30.0)^{c}$	0^{a}	0(0.0)
Classrooms	15^{b}	$10(66.7)^{b}$	13^{d}	$4(30.7)^{c}$	3^{b}	0(0.0)
Dump sites	27^{d}	$25(92.6)^{d}$	17^{e}	$11(64.7)^{d}$	6^{c}	0(0.0)
Toilet ends	51^{e}	$49(96.1)^{e}$	0^{a}	$0(0.0)^{a}$	0^{a}	0(0.0)
Offices	0^{a}	$0(0.0)^{a}$	5^{b}	$1(20.0)^{b}$	0^{a}	0(0.0)
Total	116	104(89.7)	45	19(42.2)	9	0(0.0)
Chi-square value	$\chi^2 = 11.25$, df = 3, p = 0.01		$\chi^2 = 5.85$, df = 3, p = 0.12		$\chi^2 = 2.45$, df = 3, p = 0.01	

$^{a-e}$values with different superscript letters on the same column are significantly different (p<0.05)

Table 3: Prevalence of parasites by species in cockroaches at University of Nigeria, Nsukka

Parasites	Number infected (%)	
	Periplaneta americana (n = 116)	*Blatella germanica* (n = 45)
***Ascaris lumbricoides* eggs**	$87(75.0)^{e*}$	$18(40.0)^{e}$
Strongyloides stercolaris	$51(44.0)^{d*}$	$4(8.9)^{c}$
Hammerschmiditialla diesingi	$10(8.6)^{c*}$	$2(4.4)^{b}$
***Leidynema* sp.**	$7(6.0)^{b}$	$6(13.3)^{d}$
Unknown parasites	$7(6.0)^{b*}$	$0(0.0)^{a}$
Toxascaris leonina	$1(0.7)^{a*}$	$0(0.0)^{a}$
Chi-square value	$\chi^2 = 353.91$, p < 0.001	$\chi^2 = 64.84$, p < 0.001

*$^{a-e}$values with different superscript letters on the same column are significantly different (p<0.05), *value on the same row for each parasite species with an asterisk are significantly different (p<0.05) using t-test pairwise comparison*

Table 4: Parasites recovered, parasite abundance and mean intensity of parasites in cockroaches collected from the University of Nigeria, Nsukka

Parasites	Parasite recovered			Parasite abundance		Mean intensity	
	***Periplaneta americana* (n = 116)**	***Blatella germanica* (n = 45)**	**Total**	***Periplaneta americana***	***Blatella germanica***	***Periplaneta americana***	***Blatella germanica***
***Ascaris lumbricoides* eggs**	130 (86.67)[f*]	20 (13.33)[d]	150 (54.15)[e]	1.12 (53.85)[e*]	0.44 (58.67)[d]	1.49 ± 0.55[ab*]	1.11± 0.32[bc]
Strongyloides stercolaris	65 (92.86)[e*]	5 (7.14)[c]	70 (25.27)[d]	0.56 (26.92)[d*]	0.11 (14.67)[c]	1.27 ± 0.45[a]	1.25± 0.50[c]
Hammerschmiditialla diesingi	17 (85.00)[d*]	3 (15.00)[b]	20 (7.22)[c]	0.15 (7.21)[c*]	0.07 (9.33)[b]	1.70 ± 0.67[b]	1.50 ± 0.71[d]
***Leidynema* sp.**	15 (71.43)[c*]	6 (26.57)[c]	21 (7.58)[c]	0.13 (6.26)[bc]	0.13 (17.33)[c*]	2.14 ± 0.69[c*]	1.00 ± 0.00[b]
Unknown parasite	12 (100)[b*]	0 (0.00)[a]	12 (4.33)[b]	0.10 (4.80)[b]	0 (0.00)[a]	12.00 ± 0.00[d*]	0.00 ± 0.00[a]
Toxascaris leonina	2 (100)[a*]	0 (0.00)[a]	2 (0.72)[a]	0.02 (0.96)[a]	0 (0.00)[a]	2.00 ± 0.00[c*]	0.00 ± 0.00[a]
Total	243 (87.73)*	34 (12.27)	277 (100)	2.08* (100)	0.75 (100)		

*[a-f]values with different superscript letters on the same column are significantly different (p<0.05), *value on the same row for each parasite species with an asterisk are significantly different (p<0.05) using t-test pairwise comparison*

Cockroaches collected from the toilets had more parasites, probably, because they were easily exposed to faeces and contaminated by fecal matter. As a result of the high mobility of cockroaches, they easily deposit parasites carried on their bodies or within them on food and other parts of the house. Similar findings were reported by Tatfeng *et al.* (2005), El-Sherbini and El-Sherbini (2011), Etim *et al*. (2013), Iboh *et al.* (2015), Atiokeng Tatang *et al*. (2017), and Onah *et al.* (2023), where more parasites were isolated from cockroaches found in the toilets. It was followed by those caught in dumpsites and in the hostel rooms. Because of the constant moisture, *B. germanica* and *B. orientalis* were not present in toilets while *P. americana* were present in all sites. This can be explained by its great adaptation to diverse habitats (Atiokeng Tatang *et al*., 2017).

The parasites identified in this study are helminths which are all known parasites that produce disease in humans and animals, many reports have shown these parasites to be common in different localities, especially in the area where personal hygiene is lacking. *A. lumbricoides* eggs and *S. stercolaris*, which are responsible for ascaridiasis and strongyloidiasis respectively, were the most abundant. This is accorded with the study of Onah *et al.* (2023). *A. lumbricoides* eggs were more abundant than other parasites, this gave credence to Atiokeng Tatang *et al*. (2017), Alzain (2013), and Onah *et al.* (2023) and was in disagreement with the studies of Iboh *et al*. (2014) and Haile *et al*. (2018).

The highest transport rate of *A. lumbricoides* eggs observed in the present study can be explained by the fact that *Ascaris* eggs have an inner shell layer of lipoprotein nature which makes them more resistant to harsh environmental conditions and air-borne as reported by Smith (1996) compared to the eggs of other nematodes. Another reason is that *Ascaris* eggs can survive in adverse environmental conditions. It might also be due to the over-dispersion of *Ascaris* eggs in the environment as a single female *Ascaris* lays a relatively large number of eggs (200,000 eggs/day) as asserted by Soulsby (1982). The legs of many species of cockroaches are morphologically modified with comb-like tubercles, spines or hairs and are useful during feeding and grooming processes, they are highly involved in the contamination of food and water in human dwellings as well as in the transmission of pathogens as reported by Busvine (1983).

Based on capture sites, cockroaches caught in the toilets had more parasites because they were readily exposed to human faecal matter. As a result of their high mobility, they release these parasites (*A. lumbricoides* eggs, *S. stercolaris, H. diesingi*, *Leidynema* sp., and unidentified parasites).

Mix infestations were observed among cockroach species and different capture points. This result may probably explain the non-specificity of cockroaches in their role as parasite vectors. The differences in hygienic conditions in these various areas may account for the variation in the parasite carriage rate among different settings. Thus, the potential of cockroaches to transmit diseases cannot be underestimated.

Conclusion: Cockroaches constitute an important reservoir for pathogens; therefore, control of cockroaches will substantially minimize the spread of infectious diseases in our environment. Close contact with cockroaches especially in human dwellings should be managed. There is a need to properly educate the population on the dangers associated with cockroaches and how to control them. Environmental hygiene is very necessary and should be encouraged in every nook and cranny of the University environment, as well as in all localities to reduce the population and effects of arthropod pests especially cockroaches in human surroundings. The school management and Government should intervene by providing Health Education programmes aimed at inculcating environmental sanitation among inhabitants of the University community.

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